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Socioeconomic analysis

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Editors:
Jadranka Švarc
Jasminka Lažnjak
Željka Šporer
Darko Polšek

Institut
društvenih znanosti
Institute
of Social Sciences
IVO PILAR

Zagreb, 2004.

FOREWORD

This publication presents the revised papers from the conference "Knowledge Based Society: A Challenge for new EU and Accession Countries" which was held in Zagreb on the 23rd and the 24th of October 2003. The conference was a part of the project "Social evaluation of science, higher education, and technology" carried out by the Institute of Social Sciences "Ivo Pilar" in Zagreb and supported by the Ministry of Science, Education and Sport, Republic of Croatia.

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Zagreb, Adelaide

Editors:
Jadranka Švarc
Jasminka Lažnjak
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Darko Polšek

INTRODUCTION

Jadranka ŠVARC

Jasminka LAŽNJAK

KNOWLEDGE-BASED ECONOMY AND KNOWLEDGE SOCIETY: SOME STARTING POINTS

FROM KNOWLEDGE ECONOMY TO KNOWLEDGE SOCIETY

Scholars, policy makers and the public would all agree that we live in a knowledge based economy and in a knowledge society (KBE/S). But, despite the growing body of literature and analytical studies on the subject, these terms still have a variety of meanings. Nevertheless, they all share the underlying assumption that a knowledge based economy/society appears when capital is replaced by knowledge as the main source of economic growth.

Therefore, the standard definition of knowledge based economies would be: "economies which are directly based on the production, distribution and use of knowledge and information (OECD, 199:7). We could say that KBE/S tends to mark a new economic and social regime where "the capacity and ability to create new ideas, thoughts, processes and products, and to translate these into economic wealth" (Huggins, 2004) is essential.

Although the productive power of knowledge could be traced back to the dawn of civilization, the KBE/S is substantially different from the previous regimes due to the growing, fast, systematic and organized integration of scientific achievements, methods, and instruments into industrial and economic processes. KBE/S has roots in the 2nd industrial revolution (at the turn of the 19th century) marked by the emergence of the first knowledge-based industries in USA – chemical and electrical engineering (Rosenberg & Nelson, 1994; Nelson, 1990) based on the scientific achievements in chemistry and physics. These industries were supported by the simultaneous development of chemical and electrical engineering as academic disciplines taught at universities for the fist time in the history of science. In 1996 Simon Kuznets wrote that "the epochal innovation that distinguishes the modern economic epoch is the extended application of science to the problems of economic production" (Abramovitz, 1989:55), providing us with a criterion for making a distinction between this type of modern society and the earlier ones.

"The father of modern economics" Adam Smith in his great book *Wealth of nations*, 1776 (Abramovitz, 1989:4) says that the improvements in machinery could also be made by a philosopher and a men of speculation (Arora & Gambardella, 1994), recognizing as early the productive power of knowledge and the significance of science as an economic activity.

The foundations of the contemporary KBE were laid down by the mid twentieth century neoclassical growth theories which perceive technological change as a driver of economic growth (Solow, 1957; Abramovitz, 1956) together with the new growth theories formulated by Paul Romer some thirty years later (Romer, 1989, 1990). All of these theories consider knowledge and related technological change as drivers of economic growth. However, the former consider technology as an exogenous factor, a phenomenon unrelated to the pace of economic growth and social change while the latter believe that technology change is endogenous to economy and society and requires deliberate human action. Particularly stressed are the government policy and incentive measures focused on the public investments in knowledge and science as a pool for generating new ideas and technologies (Romer, 1994).

The endogenous growth theory has helped recognize that social action and socio-economic and cultural factors also matter when technology and economic development is concerned. Paul Resnick, one of the leading authorities in socio-technical capital noted[1] that the growing literature on social structures and dynamics, usually defined as "social capital" confirmed its correlation with the positive individual and collective outcomes in different areas of human life like health, crime, good government and economic development. In this context he particularly emphasized Putnam's analysis of the American society (Putnam 1993 and 2000) and Knack and Keefer's paper on social capital (1997).

The social aspects of KBE are rarely discussed independently. Knowledge society is usually considered a by-product or side effect of KBE. For that reason is the distinction between knowledge economy and knowledge society often obscured. One of the first papers dealing with knowledge society is the article "The Use of Knowledge in Society" (Hayek, 1945).[2] Peter Drucker, according to many the guru of the knowledge society, wrote in 1957 that "productive work in today's society and economy is work that applies vision and concepts – work that is based on the mind rather than the hand".[3]

Similarly, Stan Davis and Jim Botkin (1994) pointed out that the next wave of economic growth is going to come from knowledge-based business. They also tried to emphasize the difference between information economy/ society and knowledge economy/society. They deem that "we are in the cusp of the transition from information to knowledge, with knowledge meaning the application and productive use of information" (Davis and Botkin, 1994). Even if information economy/society and knowledge economy/society are quite close in meaning, there is also a significant difference resulting from the different ways of information exploitation and computer technology usage. Information economy is based on the exploitation of information in the sense of "taking data which consist of numbers, words, sounds and images – and putting them into meaningful patterns: a printed page, a photography, a musical score, etc., and their processing by the *"crunching" power of* computers". Knowledge economy, on the other hand, is based on "smart products" that put this meaning-composed information to productive use, while the application of computer is shifted from "computing" to "connecting" or "communicating" that make the modern concept of information and telecommunication technologies (ICT).

MOVING TOWARDS KNOWLEDGE BASED ECONOMY/SOCIETY: THE NEED FOR A NEW POLICY PARADIGM AND SOCIAL CHANGE

Davis and Botkin, (1994) stressed that the emergence of KBE/S requires not only a *technology change* embodied in new technologies and innovations, but also "a new way of thinking". In other words, technological change requires social recognition, assimilation and adaptation embodied in *social change*. The recent works dealing with the long-waves of economic development such as technological regimes and techno-economic paradigms (Perez, 2003) recognize the importance of social change for acceptance of new technologies. The new techno-economic paradigms such as KBE/S require social change embodied in the new organization of institutional infrastructure, management and origination, political and socio-cultural adaptation and absorption (Perez, 2003).

The recognition of the social impact of technology and understanding of economic growth as a social process begin with new conceptualization. The macroeconomic interpretations of the crisis in the seventies based on the environmental growth theories were challenged by the new conceptualization of innovation process (Mytelka & Smith, 2002:1473). The definition of the process of analytical change as formulated by evolutionary economists (Nelson & Winter, 1982; G. Dosi, 1982; Freeman, 1988a, 1988; Abramovitz, 1989) led to the conclusion that "technological change is, in its development and application, fundamentally a social process, not an event, and should be viewed not in static, but in dynamic terms (OECD, 1992). The 1988 Sundqvist Report[4] on "the interdependence of technical, economic and social change", and its conclusion in particular, (OECD, 1992) marked for the developed (OECD) countries the turning point in their approach to technology. It was finally recognized that the emerging technological change or innovation as a driving force of economic growth is not a spontaneous process but a process constructed within certain economic and social system (Freeman, 1988). Economic growth could, therefore, be accelerated by creating proper socio-economic and institutional environment which fosters innovations. The national system of innovation (NSI), a concept developed by Lundvall (1988), recognizes such an environment. Christopher Freeman was the first to apply NSI in practice (1988) in his comparative studies of American and Japan post war economies (Mowery & Oxley, 1995). NSI is a concept that has had an astonishing take-up and still has the greatest impact on policy thinking (Mytelka and Smith, 2002:1472) when networks and interactions among different actors are needed for the knowledge production and exploitation.

The concept of NSI is rooted in the recognition of the rapid economic rise of some Far East countries e.g. Japan and Korea which, if compared with the USA, the leader in the organized efforts to apply scientific knowledge to industry, must be considered scientifically underdeveloped. This recognition has seriously shaken the faith in the power of scientific achievement as a driving force of economic development and has shifted the multitude of strategic policies from science to technology innovation and NSI as a comprehensive system for the effective materialization and commercialization of knowledge (Nelson, 1990; Rosenberg and Nelson, 1994; Mowery, 1992)

The linear model of innovation in which science is an implicit factor in generating new technologies was abandoned as "primitive" (Abramovitz, 1989:29) and was substituted by the interactive model in which innovations are expected to appear at any phase of innovative chain, scientific research not necessarily involved.

Once the "European paradox" (European Commission, 1995) was identified, the concepts of innovation, innovation capacity and NSI have spread all over Europe and have become the focus of EU development polices (Arundel et al., 2000). The concepts were fully fledged at The Lisbon European Council Summit held in March 2000, where the new strategic goal for the EU "to become the most competitive and dynamic knowledge-based economy in the world" was set. This goal was further expanded by the Barcelona European Council in 2002 and by the Commission Communication on Innovation Policy in 2003 (European Commission, 2004).

Countries like Sweden, United States, Korea, Finland, Ireland and Australia (OECD, 2001) that closely correspond to KBE/S have developed a range of new institutions, organizations, methods and models that encourage innovations. The new institutional structures for technology transfer and commercialization of research like technology/business centers and science parks; the new organization of scientific research like public-private partnerships and research consortia; the new financial sources for technology based business like venture and seed capital; the protection of intellectual property rights in academic sphere; the domination of business sector in performing and investing in R&D; the heavy public investment in education and generic technologies (bio- and nanotechnologies); these are just some elements of the deliberately created models for accelerating knowledge based economic growth.

Following the conclusion that scientific research is indispensable but not sufficient to achieve competitiveness, scientific policies are gradually being replaced by innovation policies and by the national systems of innovation (NSI) which accept technological innovation as a driving force of economy and which incorporate science and research as important but not exclusive factors in innovation generation.

Universities and academic community are, for the first time since the "golden 1950s and 1960s", facing a growing demand for the justification of public expenditures.

The changing role of universities and public research has became the issue for many scholars (Lucas, 1996, Horgan, 1996, Readings, 1996) culminating with T. Kealey's (1996) rather shocking book in which he claims that the public funding of science and technology is not only unnecessary but also counter-productive.

Since the success of NSI is determined by the efficient translation of research results and knowledge into commercially successful innovation and economic wealth, universities and public institutes, the traditional creators of new knowledge, are facing dramatic changes in organization, functioning, evaluation, institutional arrangements etc. Presently, these changes reflect the concepts of the new knowledge production (Gibbons, 1994, Nowotny et al., 2001), the 2nd university revolution (Etzkowitz, 1989), and the new contract between science and society (Ziman, 1989).

The essence of these changes is in the growing demand for close co-operation between academic science and industry in order to accelerate technological change and innovation. Therefore, "it is not surprising that the link between universities and industry has become a political issue" (Lundvall, 1988).

Indeed, in the 1990s, many economically successful countries replaced their national science policies with innovation policies as *new policy paradigms* offering a new way of political and economic management of national resources that grounded growth in knowledge and research. But in the transition countries innovation policy has been poorly understood and the construction of the national systems of innovation has been neglected. Policy measures aimed at innovation capacities, technological change or knowledge-based growth factor have been pushed aside to give way to other, politically and socially approved, priorities like macroeconomic stabilization, privatization, trade liberalization, foreign direct investment, social cohesion, etc. So, the questions remain: Why haven't transition countries recognized knowledge and innovation as new driving forces of economic growth? Why have they missed a chance for fast progress towards KBE?

The two key reasons could be identified. The first has to do with the obsolete growth model based on traditional industries and with the linear model of innovation which hindered the adaptation of socio-economic structures and management to the new techno-economic paradigm based on the appropriation of knowledge. The other is deeply socially rooted since it is closely related to the ability of a human being or a nation for adaptation and assimilation of KBE as a new techno-economic paradigm. Such adaptation and assimilation would require a brake with the existing organizational habits in technology, economy, management and social institutions all strongly influenced by the country-specific and historically inherited socio-cultural factors like norms and values, business and political ethic, leading personality, organizational and management habits, etc.

Therefore, moving towards KBE calls for tremendous social changes simultaneous with technological and economic changes.

Unfortunately, the transition and developing countries still ignore the need for social change. In contrast to the developed countries, they have neglected the fact that a new economy requires a new society. Semi-modernism (de-industrialization, de-scientization and re-traditionalization) (Županov, 2002) is the main feature of the transition countries as well as the reason why they can't understand that the role of human and social capital in creating economic growth is equal to the role of physical capital (including technologies as embodied knowledge). Human capital by definition consists of knowledge, skills and health embodied in individuals while social capital refers to the norms and networks facilitating co-operation either within or between groups. The well-being of nations, the role of human and social capital, mutual trust and respect, honesty, team work, transparency, open-mind, tolerance, cultural diversity and similar values build up social capital needed for economic growth based on knowledge and innovation. Political, institutional and legal arrangements interact with social and human capital to influence the well being of humans (OECD, 2001:12).

In other words, the promotion of technological change and innovation into a driving force of economic growth is not possible without social change towards modern knowledge society. Knowledge society implies adoption and diffusion, at practical and reflexive levels, of the idea of knowledge, innovation and education as the key concepts with regard to human well being and the standard of living. All of the main segments of society   entrepreneurs, political and intellectual elite as well as labor   should be prepared to accept novelty, to permanently learn and to change traditional values, norms and behavior towards the promotion of knowledge, innovation and education. Only the educated people, the cosmopolites who feel like the citizens of the global word could overcome cultural and historical heritage that hinders a nation's innovation capacities and willingness for constant learning. Therefore, the human capital in terms of educated citizens and the social capital in terms of an open mind, trust, tolerance, readiness to accept novelty and adapt to constant change are of the highest importance.

Following this line of argument   that, in addition to the economic resources, economic growth requires social recognition, assimilation and the deliberate action the conference intended to highlight the social aspects of becoming a KBE. The first chapter discusses the science–industry-government interplay seen through the Triple Helix model as a NSI. The second chapter deals with the potentials and obstacles for KBE in Central and Eastern Europe while the third chapter brings some case studies from these countries. In fourth chapter the emphasis is on the role of innovation, technology and organizational change in economic growth. The last, fifth chapter discusses education, values and ethics required for knowledge based society. Finally, the appendixes provide the guidelines for an innovation policy for Croatia seen as a typical transition country, as well as some basic statistical data on knowledge intensity and related factors for the transition and developed countries.

THE CONFERENCE CONTRIBUTION

The first part of the Conference was devoted to the triple helix (TH) as a national innovation system. As **Prof. Henry Etzkowitz**, one of the authors of the Triple Helix theory, stressed in his plenary speech, both the industrially advanced and the developing countries have been experimenting to find the better mixtures of functions and institutions in the triple helix of university-industry-government relations. They have been applying different models of TH. The developed countries have been inclined towards the "laissez faire" triple helix regime (the USA was a prototype for such models) while the East European Countries or the ex-socialist block where the state governed both the universities and the industry as well as the cooperation between the two, used to have a "static" triple helix model. Both are now moving towards the same format of TH, the so-called TH III which transcends the national boundaries and which can be described as the "full functioning TH model". TH III consists of the three parts: the knowledge space, the innovation space and the consensus space. From the CEE countries point of view the most difficult as well as the most important is the consensus space as it represents the meeting point for different groups to discuss problems and strategies. Such meeting place requires the existence of the civil society – the category still non-existent in some countries as "it presumes collaboration between actors in which all partners have a say".

To be successfully integrated into the EU networks of knowledge the transition countries need to upgrade their national innovation systems. As **Franz Mali** suggests, for the small CEE transition countries the adherence to the strategic goals of the European Research Area (ERA) should be at the heart of innovation policy. ERA advocates the revolutionary new idea of research and the new innovation paradigm based on the integration of R&D polices with other policies: educational, competition, regulatory, regional and foreign policies. The acceptance of the ERA philosophy as well as the possible integration with ERA is typically hindered by the inherited scientific system and the provincial spirit which feels threatened by the openness to the world and which causes scientific inbreeding.

In the second chapter, "Potentials and Obstacles for KBE in CEEC", **Slavo Radošević** points out that the growth of the CEE was not based on domestic R&D or on the local technology effort but on the low and medium technology FDI, the "re-allocations" (from the unproductive parts of industry to the services, from the less to the more efficient firms) and the purchase of "embodied" technologies (machinery, equipment, plants). Enterprises do not innovate on their own; their technology capability depends on the "supply chain" i.e. the immediate business environment the suppliers, the buyers, the clients, the competition and the related social networks. The demand for new technology and R&D was lacking as innovation consisted of the downstream activities like the reverse engineering, the process/product imitation and the purchase of the new, most often imported, equipment.

The combination of the decrease in governmental funding and the low demand for R&D from local industry has blocked the structural change of R&D towards an innovation system and has resulted in the overall shrinking of R&D. Most intriguingly, the R&D systems started to decline in both kinds of CEE countries: in those with the economic growth like Poland, as well as in the growth declining countries like Russia. The transformation of some CEEC during the 1990s e.g. Poland, Hungary and Slovenia shows that R&D system plays a relatively limited role in economic recovery. Innovation does take place even if the innovation policy is ineffective, which points to the crucial question: is innovation policy indispensable for CEEC?

The CEEC' business surveys provided by **Slavo Radošević** revealed that CEEC businesses have, for the first time, been encountering the problems of the supply of the trained work force and new technology. This, rather new, phenomenon suggests that growth based on reallocations, supply chain and FDI has reached its limits and that international competitiveness and technology upgrading requires, in the long run, an innovation system that will connect domestic R&D and industry development. Therefore, NIS as a link between science (in the broadest sense), universities and industry seems to be an indispensable tool for establishing the KBE/S.

Devrim Göktepe's comparative analysis of the six developed countries' national programs for fostering networking among the users and producers of knowledge clearly stresses the crucial role of government in increasing innovation, competitiveness and the commercialization of knowledge. In all of the six countries programs follow the top-down approach and the governments' agencies provide the institutional, legal and financial structures necessary for innovation networks.

The key factor of the EU success is networking especially in the light of the forthcoming enlargement, as the EU is based on the network of relations between national governments, industries and knowledge centers.

As CEEC have suffered, **Željka Šporer** stresses, the different degrees of isolation from the globalization trends of the Western economies, entering the EU can be very painful and frustrating. CEEC have, in the 1990s, failed to adapt their institutions to the new technology paradigm based on information and telecommunication technologies (ITC) and knowledge transformed into innovations. The comparative analysis of the indicators of knowledge-based growth clearly demonstrates that that majority of CEEC significantly lag behind in basic infrastructure necessary for developing knowledge based economy. For example, the proportion of the GNP spent on R&D as well as the number of researchers in the total population is much lower than in the developed countries, all of which suggests the low capacity for innovation. The state still dominates the business sector in financing and performing R&D, which illustrates the low level of using knowledge and research for production and economy. The lag behind in ITC (mobile phones, Internet users, number of personal computers) is the most serious problem, as ITC is the back-bone of a knowledge based-economy.

Still, some indicators like the educational indicators (the number of students, the proportion of GDP spent on higher education) as well as the indicators of the openness of economy do not differ much from those of the EU countries, demonstrating that CEEC have the potential for faster development.

The third chapter is devoted to the four case studies illustrating the potentials and obstacles for KBE in Central and Eastern Europe as analyzed in Chapter II. **J. Švarc and J. Lažnjak** have identified the four main failings of the Croatian NIS for which the state of semi-modernism and the lack of social capital are to be blamed.: /1/ the insufficient technology capabilities of business companies, /2/ the inadequate structure of R&D sector, /3/unsatisfactory science-industry cooperation and /4/ the inappropriate environment. These are the same shortcomings that other CEE countries must deal with. The authors emphasized the so called "Croatian research paradox" which reflects the fact that, although the total investment in R&D (GERD) in Croatia (amounting to 1.2 % of GDP) is quite satisfactory, the industrial R&D sector almost disappeared during the transition period and the public R&D sector, the national knowledge pool, is seriously weakened. A general diagnosis would be that the problems are not so much in "inputs" as in "outputs", resulting from the inadequate structure of R&D sector and an inefficient NIS.

The Croatian R&D system is, like in many CEE countries, still dominated by the public sector since the state invests about 0.55% of GDP and employs about 83% of researchers, while the industry invests the modest 0.43% of GDP and employs only 18% of researchers. In comparison, in the developed countries the science system is dominated by the industry which invests more then 1% of GDP (in the fast growing countries more then 2% of GDP) and employs the majority of researchers and scientists (from 50% of the total number of researchers in the EU to 65% in the OECD countries).

Vesna Andrijević-Matovac offers a brief overview of the Croatian NIS and of the innovation activities of Croatian business firms for the purpose of exploring the possibilities for the improvement of the Croatian NIS. Although the state administration[5] has introduced new measures and established institutions that have paved the way for an innovation system, the Croatian NIS is still in its infancy. The measures for its improvement should concentrate on ensuring /1/ a suitable environment (legal, administrative measures), /2/ an adequate input (skilled work force, basic science) and /3/ a communication improvement (science-industry cooperation, raising the public awareness of the importance of innovation).

To sum up, the Croatian NIS is suffering from the lack of institutions and mechanisms for brining ideas, innovations and research results to commercial products as well as for creating enterprises. Therefore, the construction of NIS and the articulation of an innovation policy is a major challenge for every CEEC with a tendency towards KBE.

Our Slovenian colleagues, **Maja Bučar and Franz Mali** confirmed the above stated ideas. Slovenia is one of the most developed EU accession countries. It is, according to the Candidate Countries Innovation Scoreboard, ranked fourth and has 5 indicators out of 18 close to or above the EU average. Nevertheless, it is still without a sound innovation policy and there are wide gaps in its innovation performance, particularly in the areas of the business sector such as high tech venture capital, the ratio of BERD to GDP, the SME's innovation activity, the employment in the high-tech services, the number of patents, etc. The science policy is still dominant over the innovation policy while business firms are too slow in changing and innovating their production programs, products and techniques. In Slovenia, same as in other CEE countries, the powerful orthodox scientists who acknowledge only basic science and the so called "high-quality" publications together with the orthodox economists who believe in the market–driven technological restructuring oppose its innovation policy. **Maja Bučar** emphasizes Freeman's observation that the technological leapfrog catch-up with the technology of the next decade was always supported by the conscious action of the government. Institutional innovation, infrastructure, investment in education and S&T as well as the science-industry-government cooperation are the necessary prerequisites for such change.

The two case studies of agricultural sector in Croatia (seed potato and *pyrethrum* flowers) by **Mira Krneta** and **Anči Leburić** testify that in countries like Croatia TH a democratic procedure of decision making has so far not been practiced in the domains of entrepreneurship, science and technology. Since these domains are the social spheres where (sub) political decisions on innovations could be made and implemented, the failure of social changes is even greater.

Therefore, as Etzkowitz points out, the meeting place for reaching the consensus between the different actors is immanent for the civil society and thus the civil society is immanent to TH. After the collapse of socialism CEEC broke with their bureaucratically organized innovation systems, but each of them failed to build up a TH exactly because they lack a meeting point, a consensus place to build up an innovation policy. The developed countries are gradually replacing the obsolete linear model with the "assisted linear model" a series of innovative policies and programs at the national level to assist the translation of research results into economic uses. The developing countries lack such structure. The CEEC industrial model based on foreign direct investments (FDI), concludes Etzkowitz, had no need for domestic R&D resources or national innovation policy.

The **fourth chapter** explores the role of innovation, technology and organizational change in economic growth. **Sonja Radas'** analysis of business firms' satisfaction with the collaboration with research institutions in Croatia, clearly points out that the first and the foremost pre-condition for the science-industry cooperation is strengthening firms' innovation and technological capacity.

There are three major motives for firms to cooperate with science: seeking new technologies that bring competitive advantage, resolving specific problems or using the name of a research institution as a product quality guarantee. Still, only innovative and technology-based firms are prepared to collaborate with science because they have the technological capability to benefit from more demanding and innovative projects. Correspondingly, firms with sufficient financial resources supported by financial institutions, investors and the tax system are more likely to engage in the science-industry cooperation, all of which speaks in favor of building up a proper environment.

Similar data on Croatia's lag behind in technology, education and research are provided by **Sanja Tišma, Krešimir Jurlin and Anamarija Pisarović.** They have stressed the utmost importance of active innovation policy in contrast to passive market liberalization or substitution by import. The traditional, relatively inflexible model of research activities at universities traditionally organized and financed by the state should be modernized. Accordingly, the business R&D devastated by defensive restructuring, privatization and mere survival should be revitalized. The government has the crucial role and should take the risk of technological renewal and the introduction of innovation to companies. Therefore, the government should support R&D in the business sector and the science-industry cooperation to promote the recognition of knowledge and technology as production factors.

Maybe the most important as well as the most neglected aspects are the intellectual property rights in the research sphere, business consultancy and venture or seed capital that complements more traditional banking resources for knowledge-based entrepreneurship.

The comparative overview of the role of venture capitalists (VCs) in the developed and CEEC economies is provided by **Domagoj Račić** and **Ilian Petkov Iliev**. In the developed economies VCs play an important role that goes far beyond the "pure financial intermediary" and helps to develop the sector of innovative and new-technology based firms (NTBF). VCs act as facilitators of a firm's entry into the corporate networks, they assist the development of a firm's growth strategy and help the technology transfer from the research sector to the industrial sector by means of the commercialization of research results thorough the company start-ups or spin-offs. VCs could connect financiers, entrepreneurs, corporate executives, headhunters, consultants, customers, suppliers, researchers and the government profitable and innovative entrepreneurial projects. VC's mark the high-quality projects since their support means that a company has passed the due diligence process and has a reliable management team. However, in CEEC the role of a VC is hindered by the low innovative capacity of firms, the lack of the demand for SME's from the corporate buyers as an important exit route and by the low level technology transfer from science to industry. The domination of the technologically exhausted, non-attractive traditional industries and the power of multinationals (MNE) influence the selection of investments that fit into MNE usually low-tech and insignificant for national development, all of which dispels the VC's interest. Building VC industry in CEE countries requires substantial changes in entrepreneur culture, the improvement of skills of all actors (management, marketing, accountant, investment), the promotion of business angles and seed capital and the government administration's willingness to help this process by legal acts, financial help and innovation promotion.

Marina Dabić suggests that the need to build the technological capabilities of companies and the global competition pressure open the floor for an increased attention to the management of technology (MOT). Although there is little agreement on what MOT is, the most important aspect of MOT in the transitional countries is the "absorptive capacity" that enables companies to recognize the value of, acquire and use a new technology. The absorptive capacity is closely connected to the learning process, the accumulation of technology capabilities and social knowledge (knowledge grounded in close bonds within networks). MOT is, therefore, strongly connected to business and organizational culture which stimulates learning, flexibility and novelty. The successful managers of technology must demonstrate not only a considerable knowledge of engineering and business but must also possess basic skills in human interaction, leadership, teamwork and problem solving. Present business is "funky business" (Nordström, K. A & Ridderstrle, J. Differo, 1999 *Funky business*), therefore investing in organizational and cultural capability as well as in human resource management is becoming more profitable than investing in technology itself.

Jonathan Cooper and Ascendant Capital Advisory demonstrate how business consultancy works in practice, how an idea is brought to the market. When entrepreneurs as well as the state administration shall routinely use the consultancy services of this kind for supporting the science-industry cooperation, and when professionalism and transparency become the standard and not an exception, the infancy of the Croatian NIS will be over, and it will be ready for the next qualitative step. However, Ascendant Capital Advisory is an exception, not the rule.

The last, **fifth chapter** focuses on some very important dimensions of knowledge based society: education, values and ethics. The way to knowledge based economy is paved with learning and education as factors that form the human capital, intellectual and working skills. Therefore, the idea of "European education space", as **Denisa Krbec** explains, resembling the proposal for the "European research area" is fundamental to the contemporary structuring of the EU. The transition countries are facing the challenges of taking a part in the process of the "europeanization of education" and of adapting their university systems to the demands of integration, standardization and harmonization with Europe. However, the europeanization of education implies a changed role of universities according to the philosophy of the "second university revolution" i.e. the introduction of the commercial activities and university's contribution to the economic and technological development of the local community or a nation as a whole.

The traditional university paradigm is challenged by the paradigm of the entrepreneurial university that has a great impact on researchers' professional ethics. A shift from traditional values, norms and cognitive standards usually described as a Mode 1 towards the new model of knowledge production known as Mode 2 is in progress. **Katarina Prpić'** examination of the ethical code of the eminent young researchers (even if it couldn't reflect the general change of Croatian researchers' attitudes towards knowledge-based societies) revealed that the social dimension of young researchers' science ethics (responsibility to society, colleagues and funders/clients) is more similar to what is called the "new" research ethics than to the traditional academic, socially isolated value matrix. Unlike the social dimension, the cognitive dimension corresponds to the epistemological realism with an emphasis on objective, reliable, measurable and precise new knowledge. The essence of the knowledge based society is the production, diffusion and the commercialization of knowledge, all of which is much closer to the "new knowledge production" than to the traditional pursuit of truth. Therefore, the research ethics, the researchers' cognitive and social norms and values attract the growing interest of the policy makers who have research that corresponds to the needs of the knowledge economy in mind.

Željka Šporer particularly stressed the problem of social capital – the system of norms, values, networks and trust that help market economy and democratization. The most important goal of the societal policy is to decrease the uncertainty, regain the confidence into the institutional system and at the same time control negative elements of the social networks established in the previous, communist system. Similarly, **Matko Meštrović** concludes that the developing countries have failed to find a path of dynamic economic growth because of the missing links in the overall functioning of their economic and social systems. The need for the participatory forms of governance and efforts to strengthen social integration is evident now.

WHAT HAS THE CONFERENCE REVEALED: SOME POLICY IMPLICATIONS FOR CEEC

After almost the 15 years of transition, the economic growth of CEE countries has come to the point when catching up strategy should be planed, like those of the developed countries, according to the knowledge based factors. However, using R&D as economic and production factors demands a considerable change in the mindset of the political and intellectual elite tuned to the traditional economy that doesn't not recognize the management of technological change and innovation as a driving force of economic growth. The industrial as well as the science policy the two critical aspects of the new economy call for a radical change, because in the 1990s the role of R&D has been substantially changed and has come to be closely identified with the field of innovation. Similarly, the price-cost competitiveness has been turned into the innovation-based competitiveness and "innovate or liquidate" has become the new philosophy of industrial production. Still, in SEE countries the industrial as well as science policies have for decades remained almost the same.

CEEC are the typical examples of the institutional inertia (Freeman & Perez, 1998) and the institutional sclerosis (Lundvall & Johnson, 1992) preventing the recognition of innovation as the key concept of the economic development and the structural adjustment to the new techno-economic paradigm of the knowledge based society. There is an urgent need in CEE countries to overcome this institutional inertia and to change the science and industrial policies towards the **pro-active innovation policy** that should integrate R&D sector with the other parts of the social and economic system (education, industry, financing, administration, etc.). The final target is the production of innovation, new technologies, and human skills and, of course, the knowledge for human well-being.

Therefore, the construction of the national innovation system and the articulation of the innovation policy are the major challenges for any CEEC intent to achieve KBE. In contrast to the *laissez faire* and liberal market economy, an innovation policy is a deliberate and conscious action on the part of the political and intellectual elite to create the proper conditions for the innovation creation and the acceleration of the technological change surpassing pure market incentives. Therefore, new organizational mechanisms and institutions should be invented, introduced and deliberately experimented with in order to implement the interactive as well as the "assisted linear model" of innovation. The new financial tools like venture capital, the new institutions like technology and science parks and business incubators, the new organizational forms like technology foresight exercises, industrial clusters, development agencies and generic research are just some of the manifestations of numerous mechanisms intensively used by the innovation policies in developed countries, but so rarely in CEEC.

The significant differences in national innovation systems and policies across the countries and regions demonstrate that national innovation policy is deeply socially rooted and depends on historical heritage, culture, ethics, political attitudes and such.

Understanding that the establishment of NIS and the development of technology are fundamentally social processes creates a chance for social sciences and sociologist to analyze the political and historical development of their countries to understand the patterns of their technology development. Social studies should help construct the national innovation system and speed up economic growth. Today, the theory of Triple helix (TH) emerges as the most useful theoretic platform, analytical framework and normative approach for social research and social action for building NIS. Its strength is rooted in the basic assumption that TH shares with NIS the knowledge flow, cooperation and communication between science, industry and government, enabling co-evolution of these three helices (or players) and constructing the socio-economic system which encourages the commercialization of knowledge through innovations and new technologies. Such system is usually defined as national innovation system and social sciences are called to reflect, consider and analyze the social and economic aspects of NIS and take an active part in accelerating economic growth and social welfare.

Many suggestions for building NIS in CEEC can be found in the presented papers and conference discussions, but it seems more useful to concentrate on a few mutually linked factors that make the pillars of an active innovation policy aimed at entering KBE/S.

Technology capability building

The first and the foremost prerequisite for entering KBE is improving the companies' absorptive capacity for innovation, new technologies and research results through technology capability building (TCB) based on technology learning and accumulation. Investments in scientific research and human knowledge could be capitalized only through the individual business companies. The aggregation of the companies' technology capability generates the industrial technology development on the national level and, in the end, enables the structural adjustment to the new economy.

The higher the level of technology capability the more intensive the use of R&D. Therefore, each of the CEE countries could create and implement its own mechanisms, organizational and infrastructural institutions that support applied and commercially relevant research in the private industrial sector.

However, there are three common and basic infrastructural preconditions for further upgrading technology capability:

- strong information and communication technologies (physical communication networks, information literacy, computerization, "internet-nalization"),
- the effective system of standardization and quality management (harmonization with international standards, effective accreditation system)

- accelerated and permanent training in business management through a system of consultancy, seminars and courses with a view of introducing life-long learning.

Human capital

The human capital in terms of educated and skilled labor is the most decisive factor for entering KBE. The importance of human capital is two-fold: human capital, by nature, has the ability to learn, to achieve better skills for creating, absorbing, adapting, diffusing and using new technologies and innovations. On the other hand, human capital provides high literacy and technical skills that might help minimize cultural and historical heritage that hinders techno-economic development in transition countries. Learning has become the fundamental strategic process at the business firms' as well as the national level.

However, the traditional concept of education-work-retirement is no longer valid in KBE.

Different countries are now reorganizing their educational systems to enable people to learn continuously and to acquire new skills in the application of knowledge throughout their entire working lives. In CEEC significant governmental and private investments in vocational, university and life-long learning are imperative for the structural adjustment of the labor to the needs of KBE. It can not be disputed that he number of researchers and engineers as well as PhDs in natural and technical sciences is an indicator of labor adjustment. The most efficient techniques, measures and incentives to increase these numbers are open for discussion. The modernization of the curricula, the computerization of schools, the internalization of higher education, the quality guarantees, the efficient studies and the harmonization with the employment needs all of these are the educational policy issues of public concern.

The revitalization of the business R&D sector

Growth analysis shows that entering KBE is closely related to the strength of business R&D. In the developed countries the industry and the business sector dominate the science system since they invests much more (in relative and absolute terms) in R&D and employ almost the two thirds of all the researchers. However, R&D in CEEC countries is still heavily financed by the government and R&D is mainly conducted by the researches from the public sector. It simply means that the research activities are not focused on the commercialization of knowledge serving the industry or on the production of innovation which make the essence of KBE. Therefore, the urgent task of NIS in the transition countries is to strengthen industrial R&D in order to re-structure R&D systems towards the predominance of business R&D. The restructuring of R&D system heavily depends on the business firms' absorptive capacity for innovation and research results as only innovative and technology based firms are prepared to collaborate with the science sector. Therefore, the structural changes of R&D system are closely connected to the development of the first two factors firms' technology capability and human capital.

The science-industry cooperation

The science-industry cooperation is a mechanism widely used in the developed countries for the translation of R&D potentials into the new marketable technologies as well as for upgrading the innovative capacities of companies is. Since the distance between research and its application is narrowing and since the capitalization of the publicly funded research by business companies occurs regularly, the close science–industry co-operation has become a critical issue of modern innovation polices. The role of the government is decisive for the cooperation facilitation since the government, by the way of different measures and programs, shapes the legal and the administrative framework for that cooperation. In addition, it provides the financial incentives as well as suffers the risks of introducing new technologies and of commercializing the research results; all of which the business sector is usually reluctant to do. The models, programs and institutions for fostering science-industry cooperation that the national (or regional, e.g. the EU) governments are involved with are various and numerous. Joint science-industry -research projects, research consortia, the centers of excellence, fostering intellectual property rights in academic sphere, the concept of "Entrepreneur University", generic research, innovation centers, research/science parks, technology transfer centers; these are the aspects of the science-industry – government cooperation.

Speaking from the long-term economic growth perspective, the science-industry –government cooperation serves to speed up the technology development (technological change) above the market incentives or spontaneous economic growth. That is the reason why innovation polices concentrate so heavily on the phenomenon of the science-industry-government cooperation.

Social capability and consensus place

The integration of different sectors involved in innovation and knowledge production is the back-bone of the national system of innovation. This integration presumes the communication and cooperation between different actors and sectors, the free flow of information and the knowledge needed to discuss national priorities. The final goal is the harmonization of different interests and attitudes towards national consensus on the targets and tools of the national development. The national consensus requires a "meeting place" where the convergence of partial interests can take a place. The various aspects of the science-industry-government co-operation serve as such meeting place where co-evolution of the three key-players of the knowledge-based society should happen. However, from the CEEC point view, this meeting place is very difficult to achieve since, to establish a transparent discussion and spontaneous harmonization towards common policies and strategies, it requires democratic procedures and the institutions of the civil society.

The civil society is, in CEEC, hindered by the spirit of provincialism and semi-modernism that permeates all the levels of society. It is, therefore, imperative that the intellectual and political elite should emanate through the whole society the social capital in terms of establishing mutual trust and respect, honesty, team work, transparency, norms and values of an open mind, tolerance and cultural diversity. The frontier of technological development and economic growth depends on the laws, programs, policies, organizations, institutions, strategies and overall environment demanding societal changes: changes in culture, norms and values that meet the needs of the knowledge based society. Shortly, the technological capability is conditioned by the social capability.

The national knowledge pool

The fact that the 90% of the world's scientific knowledge and technology advances is produced in the developed countries could make the countries in transition think that nurturing the national scientific base is a waste of money and energy. However, *catching-up process* with the technology leaders is, for the transition countries, different from catching up among technology peers. The transition countries should have the three basic capabilities. The first is the capability to use high-tech and generic technologies (not necessarily to create them), to adopt and to modify foreign technological innovation for own development. The second is the capability to get the advantage of the foreign technologies primarily through the foreign direct investments and multinationals. The third is the ability to produce the small high technology products in order to enter some special or small niches in the international market. These challenges are not possible without the national pool of knowledge and domestic R&D resources.

In other words, the enlargement of the existing pool of knowledge is an essential input in the creation of the new technologies and innovations and the creation of the new technology capabilities needed for catching up. Therefore, the development of the national knowledge stock thorough the basic and the academic type of research as well as through the codification of tacit knowledge through the university education is a prerequisite for the long-term technological development and for the immediate involvement in the technology race. The national pool of knowledge enables countries to enter the new technology paradigm. Since sooner or later all technological paradigms run out, the countries which do not take care of their own R&D resources are in danger of a serious decline.

The case of the transition countries proves it.

FOOTNOTES

[1] Cited from Paul Resnick's speech: "Beyond Bowling Together: SocioTechnical Capital" at the Workshop on SocioTechnical Capital held in Ann Arbor, March, 2000: A slightly edited version appears in Human and computer interaction in the New Millennium, ed. By John Carroll, Addison-Wesley, 2001, chapter 29, pages 647-672.

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[4] OECD (1988), New Technologies in the 1990s: A Socio-economic Strategy, Paris.

[5] Ministry of Science and Technology and the Ministry of crafts and small and medium enterprises.

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I.

THE TRIPLE HELIX AS A NATIONAL INNOVATION SYSTEM

Prof Henry ETZKOWITZ

State University of New York, Science Policy Institute
Purchase New York, 10577 USA
Phone: (212) 864-4183, Fax: (914) 251-6603
E-mail: henryetzkowitz@earthlink.net

LEARNING FROM TRANSITION: THE TRIPLE HELIX AS AN INNOVATION SYSTEM

INTRODUCTION: INSTITUTION-FORMATION

The triple helix thesis is that the interaction among university-industry-government is the key to improving the conditions for innovation in a knowledge-based society. Industry is member of the triple helix as the locus of production; government as the source of contractual relations that guarantee stable interactions and exchange; the university as a source of new knowledge and technology, the generative principle of knowledge-based economies. Although the triple helix originated as a model of discontinuous innovation in the U.S., based on networking among institutional spheres, it has also been utilized to integrate disconnected resources in collapsed innovation systems and to enhance incremental innovation in developing countries.

Triadic interactions are a method of creating or renewing innovation systems in both advanced industrial and developing societies. The construction of a triple helix includes the creation of institutions for the production and transmission of knowledge; a consensus building process through which potential partners come together to collectively identify niches and design organizational mechanisms to realize an innovation strategy. More than technological change; innovation includes organizational inventions in the private and public spheres. In contrast to biological evolution, arising from mutation and natural selection, social evolution occurs through "institution formation" and conscious intervention.

The role of government in innovation was highlighted when the state was virtually removed from the innovation picture with the collapse of communism in Eastern Europe.[1] Nevertheless, when central planning was eliminated, some Eastern European S&T experts realized that a role for government in fostering innovation was necessary.[2] However, given the discrediting of the maximal state it was difficult to justify more than a minimalist state, confined to basic security and welfare activities. It became apparent that a new conceptual framework was needed to justify science and technology policy within a laissez-faire regime, focused on foreign direct investment (FDI) as its industrial policy. From two quite different statist and laissez faire starting points, a shift is underway to a common framework for innovation: university-industry government relations- the triple helix.

THE STRUCTURE OF THE TRIPLE HELIX

The triple helix model comprises three basic elements (1) a more prominent role for the university in innovation, on a par with industry and government in a knowledge –based society; (2) a movement toward collaborative relationships among the three major institutional spheres in which innovation policy is increasingly an outcome of interactions among the spheres rather than a prescription from government or an internal development within industry; (3) in addition to fulfilling their traditional functions, each institutional sphere also "takes the role of the other" operating on a y axis of their new role as well as an x axis of their traditional function.[3]

What is peripheral and what is central to innovation has been transformed in recent decades. The creation, dissemination and utilization of knowledge have become more directly involved in industrial production and governance.[4] This development has enhanced the significance of universities and other knowledge producing institutions to the other institutional spheres. The more explicit utilization of knowledge in industry and government, exemplified by the invention of the discipline of "knowledge management" and the growth of "intelligence" give knowledge producing institutions that have the organizational capacity to recombine old ideas, synthesize and conceive new ones a greater import.

Eastern European Universities lost most of their research functions during the Soviet era.[5] The breaking of the previous Humboldtian model of the unification of research and teaching was instituted both for reasons of political control, separating politically unreliable professors from students while utilizing their research abilities, but also from the belief that specialization of functions was a more efficient system. The future of Academy Institutes as independent entities or integrated into universities; the resuscitation of research in older universities and the emergence of new private universities, focused on teaching, have characterized transition in the academic sphere. In Eastern Europe and elsewhere, the restructuring of knowledge producing and disseminating organizations, in relation to industry and government, is a key element of the triple helix transition.

Universities are increasingly playing an entrepreneurial role as the source of future industrial development, both by establishing organizational mechanisms to transfer knowledge and technology and by playing a strategic role in regional development. While the entrepreneurial university originated at MIT early in the 20th century, it is still at a relatively early stage of development. The Second Academic revolution, the assumption by the university of economic and social development missions, follows from the First Academic revolution, the internalization of a research mission. Nevertheless, the entrepreneurial university retains the traditional academic roles of social reproduction and extension of certified knowledge but places them in a broader context as part of its new role in promoting innovation.

EMERGENCE OF TRIPLE HELICES

The transformation of the university is accompanied by similar innovations in industry and government. As firms take their new role in continually adapting and raising their technological level, they become a bit closer to what a university does in adopting educational modes and in sharing knowledge among firms. As government plays a role in supporting firm formation, as well as regulator of the rules of the game, it becomes a public entrepreneur. These innovations in specific local contexts are soon reinterpreted and applied around the world.

The triple helix model for innovation emerges from different societal starting points but converges to a common format. First, there is Triple Helix I, in which the state encompasses academia and industry and directs the relations between them. The strong version of this model could be found in the former Soviet Union and Eastern European socialist countries as well as France. Weaker versions could be found in many Latin American countries and to some extent in Scandinavian countries such as Norway.

The second Triple Helix model consists of separate institutional spheres where government, university and industry operate apart from each other, or at least this is the ideology of how they are supposed to behave in the US. In this model the University provides basic research and trained persons. It is expected that firms in an industry should operate completely apart form each other in competitive relationships, only linked through the market. Government is limited to only addressing problems that can be defined as market failures, with solutions that the private sector cannot or will not support.

TH III consists of overlapping institutional spheres; each taking the role of the other and with hybrid organizations emerging at the interfaces. In one form or another most countries and regions are presently trying to attain some form of TH III, with its university spin-off firms, tri-lateral initiatives for knowledge-based economic development and strategic alliances among firms (large and small, operating in different areas and with different levels of technology), government laboratories and academic research groups. These arrangements are often incentivized, but not controlled, by government, whether through new "rules of the game," direct or indirect financial assistance.

It is these latter two versions of the triple helix that currently generate normative interest. TH I is largely viewed as a failed developmental model. With too little room for "bottom up" initiatives, innovation was discouraged rather than encouraged. While the model could work relatively well for the early stages of catch-up (i.e. 1920s Soviet Union), it became a liability as innovation, both technological and organizational speeded up.[6] THII is a laissez faire model, often advocated as shock therapy to reduce the role of the state in TH I.

THE STATIST TRANSITION

In a "statist" triple helix government subsumes the other institutional spheres and attempts to coordinate them to promote innovation. In the late 1960s, Argentine physicist and science policy analyst, Jorge Sabato, developed a triadic innovation model as a development strategy for countries with weak industrial sectors. Government is expected to take a leading role in promoting high-tech development projects, especially in areas of national security, and bringing together the resources to realize objectives. In this model, universities typically play a supporting role, primarily providing trained person to work in the state bureaucracies, other large organizations and traditional professions.

Sabato took as his inspiration for his "triangle" model US World War II military R&D projects.[7] Perhaps, ironically, many of these projects had been initiated by academic leaders and the method of coordination adapted from university procedures, the committee system. Nevertheless, in the Latin American context of military regimes during the 1960's government attempted to combine import substitution polices with procurement strategies to create new high-tech industries. Although efforts in computer hardware had to be abandoned the human resources trained through these projects were later shifted to smaller scale initiatives in software, after the military era. Aircraft design of a regional jet from scratch had an advantage over planes that had been downsized from larger models in the US, so that effort survived.

Nevertheless, when the military regime ended in the early 1980's the way was open to initiatives from below in an era of declining resources. Some of the university discussion groups that had been the source of opposition to the previous regime now became the source for new innovation projects, adapting concepts like incubators to the Brazilian scene. In Eastern Europe, the emergence of civil society as a base for innovation initiatives was more uneven. Initiatives typically arose as survival strategies, taking pieces of institute resources and attempting to privatize them. Often, the old structures were maintained, even at sharply reduced rates of financing. Foreign direct investment (FDI), based on highly skilled labor became the dominant industrial strategy. The recreation of a local bottom-up innovation model connected to academic and other knowledge resources largely remains to be accomplished. The rest of this paper offers some guidelines for initiating an innovation strategy beyond FDI.

The transition from a statist regime to one of relatively independent, overlapping spheres is barely underway in Eastern Europe. The term "transition" in Eastern Europe usually denotes a movement from a model in which the state encompasses industry and the academic and research institute sectors to a *laissez faire* model of separate institutional spheres. Science and technology policy had formerly been a high priority, the centerpiece of regimes legitimated by a thesis of a scientific-technological revolution. In countries such as Hungary, the purview of the state no longer extended to innovation under post-Socialist regimes.[8] Ironically, the very advisors, usually from the US who tell Eastern Europe to move to a system where the sectors should not interact, to be completely separate, are coming from countries where the reverse is occurring, where the institutional spheres of university, industry and government are increasing overlapped.

Although research and production were formally linked by intermediary organizations during the socialist era, the government's focus was on quantity production, not qualitative innovation. Bureaucratic structures and controls had heretofore been an impediment to introduction of local inventions through technology transfer.[9]

In the face of an inefficient system for organizing technical change, movement across boundaries took place through informal connections, say from a branch research institute to an enterprise, taking place laterally rather than going through the official planning process. The transition was expected to take hierarchical structures apart and have the state, industry and academic sphere as independent entities. If the swing is precipitant, the statist model may cross over abruptly to a laissez fare mode, as for example occurred in Hungary after the collapse of communism and require reconstitution of government role in innovation at a later point in time.[10]

THE EASTERN EUROPEAN TRANSITION

The triple helix is instantiated both as an analytical framework and as a normative model. The paradox of Soviet and Eastern European science is the scale of resources, financial and human, devoted to the enterprise under socialism and the paucity of innovation achieved from that investment, outside of the military and space realms. A "scientific technological revolution," enunciated by Czech theorist, Radovan Richta, provided a linear framework for funding science at high levels with the expectation that it would translate into practical consequences. This socialist model had its conservative counterpart in Vannevar Bush's "endless frontier" thesis of funding science in expectation of long term practical results.

Whereas the socialist model of bureaucratic coordination that failed to transfer technology stayed intact, the hands-off US linear model of the early post-war was gradually modified into an assisted linear model with a loose organizational structure. A series of innovative polices and programs were adopted at the national and state levels to assist the translation of research into economic uses. By contrast, Eastern Europe underwent a sharp break from a bureaucratically organized innovation system to one with a lack of structure after the collapse of socialism. Borders opened up to an inflow of FDI on the one hand, to take advantage of a highly skilled, low waged labor force; higher level research personnel were not needed in this industrial model.[11]

Since the breakdown of socialism, many persons have emigrated, internally to other occupations and externally to scientific and technical posts abroad. Some of their technological innovations that were not taken advantage of at home, under the previous system, have become the basis of start-up firms abroad. Receiving countries have developed informal and formal mechanism to insert immigrating technical personnel and the technological innovations that they brought with them into an entrepreneurial environment. In the US attorneys specialized in intellectual property and firm formation, with links to angels, have been the preferred mechanism. In Israel, a government sponsored "Magnet Program", supplying significant financing and organizational support within incubator facilities with highly competitive entrance requirements, achieved great success.[12]

The positive outcome of the Socialist era is the highly trained and creative scientific and technical workforce that was created.[13] A significant S&T workforce remains in place and an educational and cultural system for supporting science continues to operate.[14] Even if ill funded, it constitutes the comparative advantage of the so-called transition countries.[15] Nevertheless, the key issue is still: how to constitute a structure to realize innovations at home so that they do not have to be taken abroad for this purpose.[16] How to create a viable innovation system has been the topic of conferences such as one recently held in Croatia on innovation and the triple helix.

A Workshop in Zagreb synthesizing local and international experience was a useful first step toward focusing attention on innovation. A next step should involve additional potential partners from academia and industry in the discussions. This could lead to an analysis of gaps in the innovation system and opportunities to fill them. Success cases and the circumstances that fostered them should also be studied for their replicability. Organizational experiments should be encouraged following a venture capital model of seeking out a few winners from among a large number of start-ups. Models for organizational innovation from abroad should be investigated for utilization in Croatia The triple helix training scheme to incentivize the regional level, adopted by the Swedish Innovation Agency, Vinnova, might be considered for introduction.[17]

The analysis and consensus development process is best instituted at the regional level, perhaps as a pilot project in two contrasting regions. The concept of the "entrepreneurial university" and how to adapt and reorient existing institutions of higher education to take a more active role in society, especially in fostering an innovation culture and practice, should be a major part of the discussion. Also, important to discuss is the role that government can play both at the national and regional levels and what new organizations and policy mechanisms might be introduced to foster innovation. Finally the role of industry must be considered; whether existing industry can be upgraded through the infusion of knowledge and what is the potential to create new industrial niches directly from the region's knowledge base and through hybridization with existing industries.

THE TRIPLE HELIX TRANSITION

Most regions have some fundamentals in place to foster innovation while others are missing. A "regional innovation environment" consists of the set of political, industrial and academic institutions that, by design or unintended consequence, work to improve the local conditions for innovation, as well as the gaps that they seek to fill. Both sides of the equation, the active and missing elements, should be included in a regional analysis. However, if one sphere is missing or constrained from participating, another may take its part. If a regional government is lacking, a university or industry association may take the lead in encouraging an industrial district to cooperate with universities or other knowledge producing institutions.

Regions may be viewed as "thick" or "thin" depending upon the presence or absence of innovation support structures, whether informal or formal. Thus, whether it makes sense for a region to create new organizational mechanisms depends upon whether firm formation is already taking place, for example, supported by a network of angels investors, or requires a formal support structure, such as an incubator facility, to take off. A region that is rich in business development requisites such as venture capital and an entrepreneurial culture may not have to develop explicit organizational mechanisms. On the other hand, a region that is lacking knowledge-based economic development activity may find it useful to develop an incubator or science park, in association with a university, to foster regional development.

CONSTRUCTING GROWTH SPACES

The ability to advance within and across technological paradigms may be conceptualized as occurring within three "growth spaces": knowledge, consensus and innovation. Knowledge spaces provide the epistemological source for technological development; consensus spaces denote the process of getting relevant actors to work together and innovation spaces, an organizational invention to enhance the development process. Taken together, in any sequence, they comprise the basic building blocks for knowledge-based regional development, that focuses on analysis of gaps in existing innovation systems and the invention or adaptation of organizational structures to fill these gaps.

The innovation process can start from any of these spaces and move, non-linearly, to another. Although successful instances are often reinterpreted to look like spontaneous developments, especially in *laissez faire* societies, historical cases can always be traced to the active intervention of an individual or group, an innovation organizer (IO). The innovation organizer is the individual or group that takes the lead in conceptualizing a strategy for knowledge based growth and activating hitherto untapped resources to realize a shared vision. Karl Compton, the President of MIT and the New England Council or business, political and academic leaders played this role in depression era New England. Frederick Terman, the Provost of Stanford played a similar role in the early post war. An Ontario entrepreneur is credited with mobilizing resources to jumpstart that region's high-tech industry in recent years.

THE KNOWLEDGE SPACE

The role of universities and other knowledge producing institutions is one key to establishing an effective knowledge space. Rather than only serving as a source of new ideas for existing firms universities are combining their research and teaching capabilities in new formats to become a source of new firm formation, especially in advanced areas of science and technology. In New England in the 1930's the concentration of universities and research institutes, became the basis of an economic and social renewal project when it was realized that there some academic research projects had commercial potential. In Mexico, during the 1980's, after the earthquake, government decentralized some of the research institutes from Mexico City to other regions of the country. Soon after the move, those institutes started working on local problems, becoming a resource for the area economy.[18]

Nevertheless, although research resources provide a potential for knowledge based development, there mere existence does not insure the result. San Francisco, New York and the Öresund Region (Sweden/Denmark) have high concentrations of bio-medical research but with strikingly different outcomes. San Francisco has a long-term and thriving biotech industry; Öresund has an emerging bio-medical industry and New York City has the bare beginnings. Columbia has a bio-medical incubator and New York University is opening one but these are scattered initiatives. On the other hand, the Medicon Valley project in the Öresund Region has brought together a series of initiatives in Lund, Malmö and Copenhagen in a strategic framework.[19]

THE CONSENSUS SPACE

Knowledge spaces are transformed from potential to actual sources of economic and social development through the creation of a "consensus space," a venue that brings together persons from different organizational backgrounds and perspectives to generate new strategies and ideas. A meeting place is needed to bring the different groups together, to analyze the problems of the regions and to arrive at a concept for taking the next step. In New England, the New England Council played the organizing role. In the state of Rio de Janeiro, there is currently a group of business people, academics and government officials who are meeting in the city of Niteroi, with the objective of creating a technopole.

Without bringing people together to formulate a project, the knowledge space may be underutilized. For example, New York City has one of the greatest concentrations of bio-medical research in the US.[20] However, there is very little economic development from that research. There has been no regional organizing process to take advantage of it. It has only recently been considered that it is necessary for area universities to be cooperating with each other, establishing joint centers as a first step to moving this research into the innovation space.[21] The need to fill gaps in the regional innovation environment also brought the research institutions of Long Island together to establish the Long Island Research Organization (LIRI), offering strategic management consulting to firms in the declining defense industry located in an inner suburban belt.

THE INNOVATION SPACE

The innovation space may be visualized as a dual set of ladders with cross bars between them. One ladder is the linear model of innovation; the other ladder is the reverse linear model of innovation. At each point along those ladders, we have placed small triangles to prepare the way for the base pairs. This is the element that makes these models assisted linear models. These are the incubator facilities, the technology transfer offices, the research centers, the consortia. On one side, on the linear ladder there is a research center; on the other side on the reverse linear ladder there is a technology transfer office or incubator meeting the organizational innovations on the other ladder and that is where an innovation space opens up. Where these movements from both sides occur, the reverse linear side and the linear side meet and something new results, such as an incubator with research oriented and close to market firms interacting, that wouldn't have existed without these interactions being encouraged.

The task in the consensus space is to arrive at a course of action to fill some gaps in the local innovation environment. Often, as a result, a new organizational mechanism is invented, whether it is the venture capital firm in New England in the 1930's, the Soft Center in Ronneby or the incubator movement in Brazil, in the 1980's. The very process of including actors from these various backgrounds in the strategy review and formulation process provided access to the resources required to implement the eventual plan. By moving the "new product" approach from the industrial sphere and tying it to the academic research process, MIT introduced an assisted linear model of innovation.

In the late 1970s and early 1980s, the Competitiveness Center of SRI International advised Midwestern states, in industrial decline, how to organize regional cooperative groups to revive their economies. When the economic downturn hit Silicon Valley these policy researchers brought their model home and helped establish an organization, Joint Venture Silicon Valley (JVSV), bringing together high-tech company executives, local government officials and academics for a series of public meetings.[22] A project to promote computer networks "Smart Valley," grew out of these discussions, formalizing some of the informal networks crucial to the development of high-tech industry in the region.[23]

The innovation process folds back in on itself when one space becomes the basis for the development of an other. For example, science parks, which originated at Stanford University as mechanism for firms that had originated from the university to maintain connection to the university, as well as provide an income stream to Stanford, were subsequently founded at other universities to assist the firm formation process as well as provide a site for existing firms to locate R&D units to interact with university researchers. Stand alone science parks were also established, primarily as a site for large corporate R&D units and branch R&D units of multi-national corporations. Recently, the science park process has come full circle as universities have been established at relatively academically isolated science parks such as Sophia Antipolis and Kista to provide a knowledge base for future firm formation.

THE EARLY 20TH CENTURY NEW ENGLAND TRANSITION

Potential growth spaces can be identified at the local, regional, national and multi-national levels and in cross-cutting developments that move diagonally through these levels. For example, it was already apparent in Boston, early in the 20th century, that it was necessary to replace firms whose technologies and products had been superceded, or whose businesses had moved elsewhere. An analysis of the Boston region found that the New England Council, a regional organization representing university, industry and government actors, played a key role in developing knowledge-based innovation strategy during the 1930's and 40s. In addition to the phases of development within a particular technological trajectory, there is also the issue of changing trajectories, crossing over from an old to a new one, to sustain a growth region. A region rooted in a particular technological paradigm is in danger of decline once that paradigm runs out.

Early 20th century New England had knowledge spaces, research fields with technological and economic development potential at universities such as MIT and Harvard. In the review that it undertook during the 1930's, the New England Council identified the region's comparative advantage in its concentration of academic research and a lack of support systems for firm formation as its weakness. The Council served as a consensus space where business, governmental and academic leaders came together to test existing ideas, try out new ones and develop solutions appropriate to the region's problems and opportunities. Finally, an innovation space was created that we are familiar with today as the venture capital firm. The process of filling gaps in a regional innovation environment may start with the knowledge space, move to the consensus space and then to the innovation spaces in a linear fashion or start from one of the other spaces and proceed non-linearly.

THE ENDLESS TRANSITION

There is an endless transition in innovation systems. The Boston region represents perhaps the most successful case of a region developing the ability to renew itself across technological paradigms.[24] The mechanical and textile industries of the late 19^{th} and early 20^{th} century were superceded by the minicomputer industry which was in turn replaced by the biotechnology industry. A concentration of broad-based research universities, a highly developed venture capital industry and state government programs to support innovation shortened the time between technological paradigms.

The three spheres of university, industry and government are those which in most cases are the ones that are central to innovation. However, in some situations such as in Africa where organizational resources to promote innovation are limited, it has been suggested that the "Innovation Organizer" role may temporarily be played by international donors.[25] Nevertheless, the triple helix of university-industry-government should not be viewed as a rigid framework. If one element is missing and another has appeared then, by all means insert that element into the framework to make your analysis or plan of action. The following specific suggestions have been abstracted from previous international experience:

1. *Spread entrepreneurial education throughout the university.* When it exists at present, courses in entrepreneurship are typically only offered in the business and engineering schools, and even then separately form each other, losing the opportunities for technical and business students to interact and create new ventures collaboratively. Just as every student learns to write an essay, setting forth ideas and experiences, and a scientific paper, matching evidence to hypotheses, every student should also learn to write a business plan, setting forth objectives and providing a market test of their viability.
2. *Network incubators and incubator firms.* When incubators exist they are often isolated entities sponsored by an individual university, municipality or business firm. Networked incubators have the possibility to encourage firms to undertake joint projects that neither could accomplish by themselves. A technology platform from a firm in one incubator can be made into a business in another incubator. International incubator networks can give start-ups some of the reach of a multi national firm, helping them to find marketing representatives abroad.

3. *Incentivize regional actors to collaborate and cooperate.* Especially in larger regions where there may be more than one university, multiple governmental units and several leading firms or clusters, centrifugal forces may keep potential partners apart. National agencies need to be cognizant that the relatively small incentives that may serve to bring triple helix actors together in a small region may not work in a large region where different groups may compete for leadership status rather than work out an accommodation. On the other hand, they may be willing to accept an invitation to cooperate made by a sufficiently prestigious actor, such as a leading firm in Silicon Valley or the Federal Reserve Bank in New York City.
4. *Create an array of venture capitals.* Over-reliance on a single type of venture capital instrument can result in stasis and gaps in fields where traditional funds are not active. Multiple venture capital agents, based on different premises, can create a division of labor in which later and early stage needs are met as well as social and business goals. Venture capital is a broader field than private partnerships or temporary public programs to incentivize a private venture capital industry. A balanced portfolio of venture capital entities is essential to the full economic and social development of a region.
5. *Develop Multiple Knowledge bases.* Too narrow a knowledge base can leave a region bereft when a technological paradigm runs dry, temporarily or permanently. The availability of alternative knowledge bases gives the region the potential to shift form one technological area to another and avoid gaps. A broad based university with several critical masses of intellectual activity with potential for capitalization is the basis of a triple helix region that is able to periodically renew itself. The Boston area's shift from textiles and metalworking industries in the early 20th century to mini-computers in the mid-twentieth century and currently to bio-technology, based on the breadth of its academic resources exemplifies this strategy.
6. *Create an Entrepreneurial Academic Entity.* If an entrepreneurial university, interested in the capitalization of knowledge and playing a leadership role in the economic and social development of its region does not exist, then it has to be invented. A new university may be founded for this purpose as MIT was in the mid 19th century or Linkoping in the late 20th century. An existing university may also be encouraged to play this

role. Alternatively a group of universities may establish an entrepreneurial unit, like the Stockholm School of Entrepreneurship to takes this role on behalf of a local academic community.

CONCLUSION: GREAT TRANSFORMATIONS

The thesis of national innovation systems has its counterpart in national traditions of science, that distinctive formats can be identified within the boundaries of the nation state. Nevertheless, just a science as an international phenomenon has outweighed national variants; the triple helix of university-industry-government relations is emerging as a common format that transcends national boundaries. As this takes place there is a shift from bi-lateral to trilateral interactions from single and double helixes to university-industry-government joint projects like the land grant universities in the US, the research schools program in Sweden and the incubator movement in Brazil. Whether starting from statist or laissez faire regimes, the movement is to a midpoint of relative autonomy of institutional spheres, on the one hand, and stronger interrelations and creation of new hybrid formats embodying elements of two or more institutional spheres, on the other.

The emergence of university-industry-government relations – a tri-institutional model of society – is the great transformation of late 20^{th} and early 21^{st} centuries. This transformation includes a shift from: manufacturing to service occupations; the individual firm to strategic alliances; tacit to codified knowledge; technical to organizational innovation. A sequence of organizational innovations within and across the institutional spheres create a strong science and industrial policy regime in the U.S. State programs provide seed funding for projects close to industry and fill the interstices in federal programs that hew to the research frontier, with notable exceptions of military related research programs. Nevertheless, extensions of federal research programs such as the Small Business Innovation research program (SBIR) fulfill a public venture capital function by providing funds that can be used to start firms as well as meet agency research needs.

The triple helix transition followed from the emergence of government-industry relations – a bi-institutional model of society – that constituted the great transformation in the 19^{th} century.[26] The Speenhamland law in England placed limits on exchange relationships in wage labor, guaranteeing workers a living wage. On the one hand, the market became the organizing principle of social relations while, on the other, government moderated exchange relationships to insure a living wage. Government-industry relations thus created a compromise that insured social stability in the wake of an industrial revolution that opened up new social chasms and conflicts. It also encouraged a shift in social relations from status to contract, gemeinschaft to gesellschaft, mechanical to organic solidarity and the invention of the social sciences to elucidate these transitions.

All societies are in transition in the 21st century, with no fixed endpoint to change in sight. The functional differentiation of institutions in the early modern era is being displaced by integration and hybridization of functions in the post-modern era. Although this process begins from the starting point of opposing formats for relationships among a triad of institutional spheres in different parts of the world, a secular trend toward a common format for innovation systems in the 21st century can be identified. Triple helices emerge as a trajectory that influences the future course and direction of innovation. However, such developments while implicit in the transition to knowledge based society are not inevitable. Although high tech-complexes consist primarily of cluster-like relations among firms and networks of technical entrepreneurs, their origins can usually be traced to institution-formation initiatives taken by university and government, as well as industry partners.

The transition from a laissez faire model to one of overlapping institutional spheres was initiated more than a century and a half in New England, beginning with the organizational effort in the 1840's to found a public/private technological university, realized with the founding of MIT as a "land grant school in 1862. A similar process, can be identified in the interactions of the Stanford Engineering School with local technical industry, some of which it helped found, from the late 19th century. The mid-twentieth century projects to create the Research Triangle in North Carolina and Sophia Antipolis in France involved strong participation by regional and national governments; whose role declined as the efforts became successful.

The enhanced role of the university as a knowledge creation dissemination and innovation organization, emanating from its classic institutional characteristic of rapid human capital flow through that encourages creation and diffusion of new ideas. An industrial penumbra arises around universities as they become involved, often in a leadership role, in regional coalitions for economic and social development. The construction or renovation of an existing university into an entrepreneurial format can be seen at various academic levels, ranging form leading classic universities such as Lund University in Sweden to emerging regional universities such as the University of Massachusetts, Boston.

Although the creation of a knowledge-based society has opened up new divides between advanced industrial and developing societies; it has also opened up the possibility to use existing knowledge resources such as academic institutions, present in virtually all countries, to overcome gaps.[27] Universities in developing countries, such as Zambia, have the opportunity to play a leading role in development but often must overcome attachment to classic university formats that are sometimes stronger than in the societies in which they originated.

Invention of policy ideas and mechanisms to create as well as enhance nascent triple helixes in societies where one or more institutional sphere, such as industry, may be largely lacking is the great challenge to innovation theory and practice of all perspectives.[28] The triple helix model posits that universities in transitional and developing countries take a leading role in catalyzing regional growth spaces.[29] As new universities are founded, greatly expanding higher education in all societies, universities in developing countries such as Ethiopia, must envision a broader role for themselves in the development process, than the narrow human capital function sanctioned by the ivory tower model.[30] The next great transformation will include developing, as well as advanced industrial countries in the promotion of innovation through the creation of entrepreneurial universities embedded in inter-institutional linkages.[31]

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Dr Franc MALI

University of Ljubljana, Faculty of Social Sciences
Kardeljeva pl. 5, SI-1000 Ljubljana, Slovenia
Phone: +386 1 5805-306, Fax: +386 1 5805-101
E-mail: franc.mali@uni-lj.si

THE NEED TO ACCOMMODATE THE NATIONAL INNOVATION SYSTEMS OF SMALL TRANSITIONAL COUNTRIES TO THE MAIN PRINCIPLES OF NEW EUROPEAN RESEARCH AREA

INTRODUCTION

The new concept of European Research Area (ERA) brings already now a lot of challenges for the member states of the European Union, as well as for the candidate and other Central and Eastern transitional countries. The latter must increasingly react to various challenges. On the one hand, they are still coping with the obstacles in the scientific system inherited from the past. On the other hand, the proposed new European model of research and development (R&D) requires from them the adaptation of their R&D and innovation systems as soon as possible to the main strategic goals put forward by the EU Commission.

In my contribution, I'm trying to show that the creation of Europe of knowledge is for small scientific communities in transitional countries a source of opportunity, but also of major challenges. The small countries in Eastern and Central Europe are meeting with the challenge of the increased processes of globalization. The recent processes of globalization are leading to unprecedented integration of nations and localities in the new global order. Even nations with very large human resources are forced to join their R&D efforts to supra-national entities. That is true for the situation in Europe as well. There is no doubt that after a more than two decades of action, common intervention had created a new R&D scene in Europe. The new European Research Area, as this idea is experienced among European countries, is in many respects not only new, but also revolutionary. The main thesis of my contribution is that for small transitional countries in Eastern and Central Europe it is very important to follow the strategic goals of ERA, i.e. to create strong university-industry-government relations, to establish the regional innovation networks, to strengthen inter-sectoral research mobility, etc. Namely, these changes are not important only because of the diffusing basic research findings to practice. They are also important because of re-definition of the whole developmental paradigm in this part of the world as well.

THE NATIONAL AND INTERNATIONAL SYNERGIES IN THE CONTEXT OF ERA

Let us say at the beginning some words about ERA. At first, the creation and development of ERA is presently high on the R&D policy agenda in Europe. The different actors at the European level work jointly towards the creation of a new Europe of knowledge. It has been a prime objective for the European Union (EU) since the Lisbon European Council of March 2000. Subsequent European Councils, particularly Stockholm in March 2001 and Barcelona in March 2002, have the Lisbon objective further forwarded. The main strategic goals of ERA written in different European Commission's documents are the creation of a network of scientific centres of excellence, a more co-ordinated implementation of national and European research programmes, a common system of scientific and technological references for policy implementation, a greater mobility of researchers in Europe, an introduction of the European dimension into scientific careers and the role of regions in the transfer of knowledge (see more: COM 2000 (6); COM 2002 (565); COM 2001 (346)).

For Brussels the coordinated implementation of international scientific and technological cooperation at national and European level is an essential precondition for a consistent overall R&D policy in context of ERA.

To be clear, ERA has established a new political context in which to develop a new strategy of international scientific and technological cooperation on the previous actions undertaken within the EU. Already in the near past, different forms of research networks were becoming an important element in the Europeanizing of R&D. If we use the words of John Ziman, through this form of globalization of science "...the traditional cosmopolitan individualism of science is rapidly being transformed in what might be described as transnational collectivism." (Ziman, 1994:218).

Discussions regarding the common EU research programs began already in the 60s in West-European countries. Notwithstanding, it was only at the beginning of the 80s that The First Framework Research Program (FP) was realized. The First Framework Research Program was reaction to the loss of West European companies in comparison to Japanese and US-American firms. It was also the response to the US Strategic Defence Initiative (SDI), which was supposed to provide a strong impetus not only to military, but also civilian R&D. Since the beginning of 80s The Framework Programs (FPs) hold the position of the main instruments of inter-European R&D collaboration. Today, after a more than two decades of common R&D policy actions, a new scene for scientists in Europe has been created. The ERA aims at a coherent restructuring of the Europe research system through greater co-ordination and co-operation in order to turn them into one true "Single Market for Research". It could be said that scientists today are no more appearing only as individual members of European scientific community who are competing for international recognition for their contributions to a world-wide knowledge base. They are increasingly becoming a members of strong research networks (see more: Laredo, 2001).

To implement the Lisbon strategy, the European Commission has embarked upon a series of actions to strengthen the research co-operation among different European countries. Sixth Framework Program is introducing a lot of new actions which are important for adaptability of R&D systems to new knowledge society. For Candidate countries as well as for all other transitional countries, the Sixth Framework Program (6FP) is not only important because it leads to the creation of partnerships with the scientific groups of different countries, but also because it focuses the research efforts to interdisciplinary, practically relevant and applicable problems. The scientific groups from Candidate countries and other transitional countries participating in the Sixth Framework Programmes (6FP) will have the additional opportunity to learn how to co-operate with the business sector.

As was noticed by different authors, already former Framework Programs have been approved as being highly successful in establishing closer links of co-operation between the academic research sector and industry (see more: Biegelbauer, 1998; Haller, 1999; Luukkonnen, 2000). For example, industries counted among the most influential advisers in the 5 FP (Nowotny et al., 2001). Industries also played at that time a prominent role in most technology foresight exercises. Of course, new dilemmas appear with the shift of the Framework Programs towards a more pronounced market orientation. e.g. a contradiction with the original principle, that EU should not promote the interests of particular companies, but should promote the competitiveness of European industries in general. Terttu Luukkonen extensively dealt with this complex issue (see for example: Luukkonen, 2000; Luukkonen, 2001). She noticed that "pre-competitive" character of FPs presupposes that the participants of a consortium in specific R&D project share the knowledge produced. The research results achieved in the context of FPs would be a limited "public good", to be shared by the all participants. This would lead sometimes to a conflicting situation at the policy level.

The tensions mentioned above were certainly one of the reasons that in the new ERA discourse is given a big attention to the issues of intellectual property rights. As is announced in a lot of strategic EU documents, it will be made a lot of steps towards a more efficient approach to intellectual property rights in filed of academic R&D (see for example: COM 2002 (565); COM 2002 (499); COM 2003 (58)). The priorities are the implementation of legislation to promote the development of a more effective and harmonized framework for intellectual property rights in Europe in generic scientific and technological fields (e.g. biotechnology and software), the launching of a process to identify and disseminate good practice and experience with regard to intellectual property systems applicable to public research institutions, the creation of Common EU Patent. The last strategic goal is hindered by different sort of reasons. The main reasons are disagreements in regard to language use and translation arrangements, the role of the National Patents Offices, and the common jurisdiction.

The ERA's approach should become the central pillar for the whole innovation policy discourse in Europe. It should motivate the interaction between different actors within the same sector, e.g. SMEs and large enterprises, or different sectors, e.g. co-operation between science and industry. What is much more important, ERA's approach should integrate R&D policy with other policies such as: education, competition, regulatory, regional, and foreign policies. This change has been often characterized as the transition to the new innovation paradigm (see more: Lundvall & Borras, 1998; Biegelbauer & Borras, 2003).

Following the rationales of new innovation policy is the key factor for Europe to compete with other big "players" on the world scene. Namely, as was already said, the concept of ERA is based on the assumption that in the times, when the United States and Japan has kept up and even increased their advantages in R&TD and innovations, Europe has felt behind.[1]

For the small European transitional countries, it is of paramount importance to exert their influence on the decision-making processes in Brussels (Thorsteinsdottir, 2000). Namely, it must be clear that the concept of ERA could lead to increasing disparities between small and large, between old and new EU countries, if the balance between the influence of all countries on the R&D decision-making processes at the European level should not be achieved.

There is not rare expressed the fear that the conflicts of interests between different stakeholders will increase with the projected enlargement of the EU.

It seems that the fears concerning the inferior R&D position of small countries in the enlarged Europe are exaggerated (see for example: Haller, 1999:376). Namely, in the near past exactly the small EU Member States have been able to develop in the context of EU R&D policy the most efficient R&D systems. But, I agree with the views that the first condition to avoid the conflict of interests between different type of stakeholders involved in European R&D policy is to create the conditions for consensus building at the different levels of decision-making.[2]

In this respect, the possibility for Candidate countries to approach to EU-funded research programs was very important. They have finally the same rights and obligations as the EU Member States. ERA should not only increase the European dimension of research in transitional countries. It should also help by full integration of Candidate countries into the global market, what is the key condition to strengthen their economies. In all European Commission's documents is expressed the need to help the Candidate Countries to play a more significant part in activities conducted within ERA and to become more fully integrated into more highly structured European research fabric. There is assessment that "...the action needs to be taken first of all by those who are involved in research and innovation and research policies, namely researchers, high-ranking officials and administrators, in particular the younger ones among them, who should be given access to the EU's best scientific research policy knowledge and expertise." (COM 2002 (565)).

The new concept of ERA requires effectiveness of R&D efforts at different administrative and organisational levels. In all of Europe, the increasing social complexity of R&D demands new institutional approaches. ERA is a best tool for intensifying the policy principles of competitive imitation with a recommendation to systematically use the methods of "benchmarking". Development of the methods benchmarking enable public authorities at national and regional levels to evaluate and improve their policies through exchange of good practice. The "benchmarking" seems to be of crucial importance in the context of EU enlargement. The ideas and activities developed on the European scale could be of great help in fostering changes in the national context (see for example Edler & Boekholt, 2001).

The Candidate and other transitional countries can receive necessary information to adapt their policies and systems and get them closer to those of the European Union. Some of the Candidate countries are already involved in great part of these activities (see more: Devan & Papanek & Borsi, 2002). Additionally, in Lisbona was also launched the institutional innovation which is called the "new open method of co-ordination". It is coupled with a stronger guiding and coordinating role for the European Council to ensure more strategic direction and effective monitoring of progress in the field of R&D. Its main goal is translate European guidelines into national and regional policies by setting specific targets and adopting measures, taking into account national and regional differences (see more: COM 2002 (565)).

Namely, the modern occurrences in R&D are all the time characterized by the global-local dialectics. The paradox of globalization is that we cannot even think about globalization without referring to specific locations and places. Globalization is dialectic process in which the global and local do not exist as polarities, but as combined and mutually impliciting principles. The concepts such as "national scientific community" (Stichwech, 1996:332) or "national system of innovation" (Nelson, 1993:3) are challenging with the processes of globalization, but not abolished. Also in the context of ERA, where supra-national and sub-national (e.g., regional) levels of steering are increasingly emphasized in the last times, there was not coming entirely to the abolishment of national context. In that sense, the general EU R&D course cannot be considered a whole supplement to the national R&D policies.

To change R&D policies in transitional countries, it would be necessary to take into consideration the successful cases of small EU-countries in 90s. Since the beginning of 90s Brussels strongly influenced the way in which individual EU Member States have structured and re-designed their R&D policies. As is indicated by different analysis supranational organizations such as OECD and EU have played an important role especially in the development and diffusion of the new R&D policies in small EU Member States (see more: Alestalo, 1999; Miettinen, 2002). The countries like Finland, the Netherlands and Denmark have re-designed their policy instruments and administrative structure under the influence of OECD and EU documents. These countries belong to the so-called "first movers" in the introduction of new "innovation paradigm" (see more: Biegelbauer & Borras, 2003). Although the interplay between stakeholders and policy-makers in this group of countries has worked very differently, their common characteristic was that they succeeded to establish strong communication channels between them. The Dutch government initiatives like "centers of excellency", "technology top institutes" or "research schools" did not have major problems in coming into being, as stakeholders were positively interested on those, not just for the new organizations, but also because they were economical viable through public funding (van Steen, 2003). Denmark reinforced and expanded the number of "contact-points" between stakeholders and the administration in the 1990s. Beside the traditionally active "technology councils", there were activated 29 different working groups (Christensen, 2003). In Finland key social actors also took part in the formulation of the new policy. Here was followed more tripartite model (Lemola, 2003).

In fact, in the last few years the new innovation concepts gradually find their way into the key strategic policy documents of Candidate countries as well. Let us take only one example. As is well known, the conclusions of the Barcelona European Council in March 2002 gave the EU the objective of increasing its research effort so that it approaches 3% of GDP by 2010. On the basis of these Conclusions, the Commission has presented a Communication entitled "More research for Europe: Towards 3% of GDP" (see: COM 2002 (499)). R&D decision-makers in all transitional countries expressed a strong ambition to follow this strategic goal.[3]

ERA AS A SOURCE OF OPPORTUNITY AND CHALLENGES FOR SMALL TRANSITIONAL COUNTRIES

The creation of Europe of knowledge is for small scientific communities in transitional countries a source of opportunity, but also of major challenges. In spite of numerous differences among the transitional countries concerning the organisation and mode of operation of their national innovation systems there exist a lot of common structural problems which are shared by all these countries. According to my view, the key structural and institutional issues of the national innovation systems which are, at the moment, present in all transitional countries are the following:

1. the big divide between the academic research business-economic sector and the absence of intermediary structures in relations between state, science and industry;
2. weak co-operation between science and industry at regional level;
3. the lack of inter-sector mobility of scientists.

That is the reason why the need to accommodate the R&D policies and R&D systems to the main principles of new ERA is so urgent for small post-communist countries in transition. Let us deal with the above mentioned topic more detailed.

THE NEW ROLE OF ACADEMIC SCIENCE IN KNOWLEDGE-BASED SOCIETY

The main strategic goal of ERA is to create knowledge society. The knowledge society depends for its growth on the production of knowledge, its transmission trough education and training, its dissemination trough information and communication technologies, and on its use through new industrial processes and services. In the last time the European Commission's Communications are oriented to re-think the new role of academic science (first of all university system) in a future knowledge-based Europe (see more: COM 2003 (58)). The changes in the position of the universities in a knowledge-based Europe have called the traditional "ivory tower" model of the university into the question. According to my view, for the transitional countries it would be useful to follow The Triple Helix model.

The Triple Helix and the ideas which define the ERA are strongly connected. As has been explained by different social scientists, the nature and process of recent scientific knowledge production is changing tremendously. This process of transition is variously described as post-academic science (Ziman, 2000), the Mode 2 (Gibbons et al., 1994) the post-normal science (Funtowicz & Ravetz, 1993), etc. It seems that especially the concept of The Triple Helix became in the mid 90s the symbolic banner of new theoretical and practical viewpoints on the changing role of academic science in the knowledge society (Eztkowitz & Leydesdorff, 1997; Etzkowitz & Leydesdorff, 2001). The concept could be used as a theoretical framework for the analysis of changes European R&D policy in 90s. Namely, the European R&D policy actors today expect academic science to be increasingly aware of its contribution to socio-economic development.

Let me only quote the paragraph from the already mentioned Brussel's document "Towards a European research area" to support this thesis. This document includes among others the following expectation: "Essentially, the non-existence of a European research area is due to the compartmentalisation of public research systems and the lack of coordination in the manner in which national and European research policies are implemented. Much needs to be done in this area, without however, putting unwieldy mechanisms in place. At the same time the barriers must be lifted between different disciplines, along with barriers that curb the movement of knowledge and persons between academic and business world." (Communication from the EU Commission, 2000:9)

The Triple Helix concept is centrally concerned with the question of how relation between academic science – industry – government is conceptualised in different institutional contexts. According to Henry Etzkowitz, it was one of the ironies of history that as post-communist countries moved from corporativistic to individualistic models numerous countries with a laissez faire capitalist tradition moved in the opposite direction. In the 90s in high developed industries in North America, Europe and Asia the style and extent of government intervention in economy have varied, but government –business – university interaction has always played a critical role (see more: Etzkowitz, 1994; Etzkowitz, 1996). Marja Alestalo noticed that especially in Nordic countries the functional changes in the state with a fluctuation from a liberal orientation to intensive state intervention and regulation are capable of explaining the characteristics of the political pressures to make the academic science system more utilitarian and marketable (see more: Alestalo-Hayrinen, 1999).

To come in transitional countries to the full realization of the Triple Helix it will be necessary to change the traditional academic values of scientists. Namely, without a change of values of academic scientists concerning the commercialisation and application of their research results it is not possible to expect the demanded changes.

Let us take the example from Slovenia as a small country in transition. Because of its smallness it could be said that there exist some additional problems. The small size of country does not necessary lead to a high degree of co-operation between different R&D actors or to the more flexible behavior of social actors in the field of R&D. On the contrary, with the limited formal mechanisms for co-ordination there is a risk that the system is poorly equipped to manage diversity and foster new opportunities and challenges. I tried to find in my research work, if there existed at all any reorientation of scientists in Slovenia regarding the so-called commercialisation of science. In the context of this empirical investigation the interviews among the representative sample of active researchers have been made in different time periods: in 1990, in 1995, and finally, in 2001. The surveys have concerned a very extensive range of issues and the respondents have been asked to answer questions about different aspects of R&D activity in Slovenia (see more: Mali, 1998; Mali, 2000; Mali, 2003). For the purpose of my discussion here, I will take into consideration only parts of my longitudinal empirical investigation, first of all those that concern the value orientation of Slovene scientists to application and commercialisation of research. The scientists in Slovenia interviewed in the context of my empirical investigation mostly insisted on the distinction between "pure" and "applied" science, in spite of the fact that this type of distinction has been suggested as artificial, in theory as well as in practical science policy actions (see Levitt, 1999; Ziman, 1994; Nowotny et al., 2001).

What is interesting for our discussion, is that the scientists in Slovenia interviewed also in the last time period of our empirical investigation (in the year 2001) expressed the opinion that the division between basic and applied science is very strict and for that reason justifiable. Additionally, most of them said that the industry should be in charge of the financing of applied research, and the state for financing basic research. In the year 2001, only about 30% of the scientists interviewed responded that the industry in Slovenia should play a more active role in the financing and strategic direction of basic science. This percentage was not much higher than in former time periods of our empirical investigations.

In all time periods of our empirical investigations scientists responded that they alone have the decisive influence on the discourse in and content of their research work. In the year 2001, 61% of all interviewed scientists responded that they alone have the decisive role in defining the content of their research work. Only 18% of all interviewed scientists answered that they defined the content of their research work considering also the demands of industrial firms in their regional environment. Next to industry influencing research, followed government (11%), international institutions (6%) and others (4%).

According to the new concept of ERA, regions may play the "motor" role in the overall context of economic growth based on research, technology and innovation. At a regional level, the public and private actors could establish synergies due to their partnership. Some successful cases in Europe could offer models of the innovative regions. Let us mention only Baden-Wuerttemberg in Germany, Rohne-Alpes in France, Lombardy in Italy and Catalonia in Spain, which are often taken as examples of "motor regions" in the EU (see for example: Third European Report on Science & Technology Indicators, 2003).

ERA encourages the development of regions that transcend national boundaries for the dual purpose of enhancing European unity and creating foci for knowledge-based economic development. Large scale policy interventions in R&D are no longer desirable. Policies have to be fine-tuned to regional innovation processes in order to develop the desirable network externalities. ERA takes into account the importance of embedding of research projects into regional economic and scientific structures, so as promote technological progress and economic growth (see fro example: COM 2001 (549)). Spatial proximity can help co-operation and networking aimed at transforming scientific knowledge into industrial applications within regions. In the recent times science-based technologies, such as nanotechnology and biotechnology are an areas that can especially benefit from regional approach. It is thus not surprising that at the European level a number of initiatives were triggered to encourages regionally based biotechnology networks which crossed the national borders. Several small and medium EU countries put as a key priority in their science and technology policy the fostering of biotechnology.

The regional dimension of research and innovation activities should be taken into consideration by the Candidate and other transitional countries as well. In the document titled "The Regional Dimension of the European Research Area" (COM, 201, 549 final) it is explicitly stated that in the ERA particular attention will be paid to the building of research and innovation capacities in the regions of candidate countries. In this part of the world, there is really coming to the awareness that with the growing globalization R&D itself has become more "spatially fluid". Benefits of research being undertaken in one locality are no longer necessarily remaining in that area. Therefore the efforts have to be made to integrate R&D capabilities with the local economy.

Notwithstanding, here is still the scarcity of R&D base at the regional level. The R&D systems in transitional countries mainly centers on capital cities, with weak and slow regional innovation performance (see more: Technology, Knowledge and Learning, 2001). Although institutional decentralization has been attempted in some countries (Hungary is considered the most advanced in this respect), these processes are still in the starting phase.

Let us take again the example of Slovenia. We have been faced, throughout the last ten years, with different normative acts and documents which put in the forefront the role of R&D as the main promoter of socio-economic development at the regional level. Unfortunately, reality showed us just the opposite. The main reasons for this situation were the following:

1. The R&D groups in Slovenia remained in the last ten years still mostly disciplinary and not problem-orientated (see for example: Mali, 2003).
2. The centre-dominated approach in the R&D policy have not been entirely abolished, in spite of the fact that the smallness of the country could have offered greater opportunities for achieving a more balanced regional development. (see for example: Bučar & Stare, 2003; Mali, 1997).
3. German experts who have analysed the innovation policy in Slovenia have stated that the minimum precondition for an innovation-oriented regional development is to establish an agency which can co-ordinate activities at the regional level and work out a strategic approach in collaboration with chambers of industry. There is still a lack of such "interface" institutions in Slovenia (see more: Phare Report, 1995; Walter, 1997).
4. An additional factor for deficiency is that representatives of the regional industrial sectors are not involved enough in the development of national R&D programmes (see more: Bučar & Stare, 2003).

The realisation of the strategic goal to create the regional innovation networks will be difficult in Candidate and other transitional countries also because of the high orientation of technical and natural scientists in this part of the world to the publicizing and not to the patenting. Unfortunately, in CEE – countries, the relative high publication productivity often does not correlate with technological performance.

Let us take the following example: if we compare the data about the publication productivity and citation impact of computer sciences which was one of the most rapidly growing scientific field in the second half of 90s and, undoubtedly, one of the most important field for the future knowledge based society, the position of some East-European transitional countries is still very good. Three of them belong to the group of thirty countries that score at least world average citation impact of 0,80. Concerning citation impact by country in computer sciences, Slovenia is ranked at the third place (Source: The Third European Report on S&T Indicators 2003).

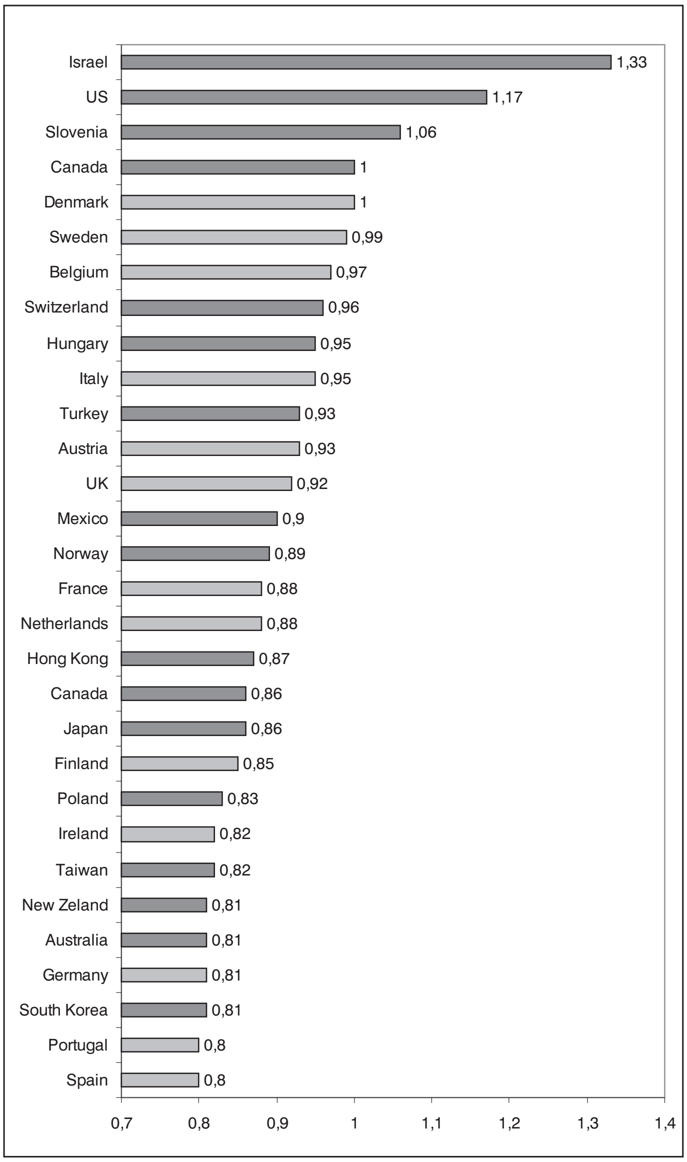

Figure 1
Citation impact by country in computer sciences (1993-1999)

Source: DG Research
Data: ISI, CVTS (treatments)
Third European Report on S&T Indicators, 2003

Unfortunately, the indicators about the internal scientific influence do not reveal much about the external utility of the research outcomes in filed of computer sciences. In Candidate and other transitional countries, there still exists low level of patenting in high-tech industry. That is opposite to the situation in EU Member States. Moreover, the figures from the above cited source (The Third Report on Science & Technology Indicators 2003) illustrate that the greatest dynamism in terms of both patenting and high-tech trade is presented in small EU Member States. Small EU Member States in particular have developed niche areas in which they perform well: Ireland in Computers, Finland in Telecommunications, Denmark in Pharmaceutics. The same is true for the dynamism in terms of patents. On the one hand, it is clear that large economies of Europe, the US and Japan have the dominant share of European and US patents. But the countries that have displayed the largest growth in patenting activity over the last ten years were smaller EU Member States, notably Finland and Denmark.

THE INTER-SECTOR MOBILITY OF SCIENTISTS

The concept of ERA triggers a greater mobility of researchers and the introduction of an European dimension to scientific careers. The mobility of European scientists is seen as an important instrument for the transfer of scientific knowledge throughout the world. As was pointed out in different EU documents, the mobility of human resources are now regarded as an essential factor for a high performance of the scientific system and the dissemination of scientific results to the broader social environment.

The mobility of scientists and research ideas is a more pronounced problem in the Candidate and other transitional countries. In an EU document titled "A Mobility Strategy for The European Research Area" (COM 2001,331 final), different sorts of reasons are identified which prevent a more efficient professional mobility of scientists in the Eastern part of Europe. These factors extend from the distorted career tracks of scientists to the blocked ways of intersectoral mobility, notably between academic institutions and industry.

In transitional countries, the "internal" brain drain is much more critical than the "external" brain drain. This is especially critical when there is a lack of highly educated and trained staff in industry and, at the same time, there is coming to the internal "brain drain" of young scientists. The most significant indicator that this form of domestic "brain drain" out of universities and institutes has not halted the economies of transitional countries is provided by data which show that during the 90s in which this mobility has strongly occurred, the amount of in-house industrial research in almost all transitional countries has dropped. An "internal" brain drain (that is, one which happens within the country) is worse than one in which talented scientists leave the country to find a job abroad. The loss of scientists in this way is painful to a country but it is understandable. Today the need for an openness of the scientific community towards the most developed parts of the world is high. The fact is that especially in small transitional countries, for purely objective reasons, the spirit of provincalism can threaten the development of R&D. The only way to overcome self-sufficiency and scientific inbreeding of a small scientific community is its openness towards world. Small transitional countries enter in an increasingly globalized environment which is constantly changing and which have a big winners, but also many losers.

It is interesting that in the context of mobility actions proposed by the promotors of the idea of ERA, there is not only a strong emphasis on the training of researchers from European countries abroad, but also on the mechanisms which could stimulate the return of the emigrated groups of scientists to their home countries and regions. To approach to the last mentioned goal, the Candidate and other transitional countries are still at the beginning. The R&D policy actors in these countries have to do much more to arrive at the so-called reverse brain drain.

CONCLUSION

At the European level the processes of globalization and commercialization of R&D are currently most tangibly influenced by the growing importance of European Research Area (ERA). In order to better understand what is the influence of ERA on the national innovation systems of small transitional countries, my interest was first of all to confront with the basic rationales of new Europe of knowledge. Of course, my intention was not to present all different theoretical and practical concepts including in ERA. I tried to stay at the presentation of the key structural issues which demand from Candidate and other transitional countries to accommodate their R&D policies and R&D systems to the main principles of new ERA as much as possible. The creation of Europe of knowledge is for national innovation systems in this part of world a source of opportunity, but also of major challenges. To be clear, it is not possible to insist on full imitation of procedures used in the near past in Western European countries. Every transfer of R&D policy concepts has to take in regard the different economic, social and political traditions of each country. The countries can not follow the model of full coping. Notwithstanding, they have to learn the experiences of each other through the transfer and diffusion of coded and un-coded experiences in the form of policy formulations, organizational arrangements, procedures, and similar measures.

FOOTNOTES

[1] Of course, Europe has also a lot of advantages. For that reason in all EU official documents is stressed that the advantages of Europe must be maintained, increased and fully exploited.

[2] About the driving political mechanisms leading to the consensus among stakeholders in the context of ERA see more in Jakob Edler's contribution to ESA conference in Murcia (Edler, 2003).

[3] In June 2003, there was organized in Slovenia a big strategic conferences dedicated to the realization of Action Plan 3%. The participants at the conference were coming from different social sectors: science, economy, politics, etc. After the presentation of Prime Minister's report, sever focus groups were formed to discuss in depth of particular aspect of ERA and national innovation strategy.

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II.

POTENTIALS AND OBSTACLES FOR KNOWLEDGE-BASED ECONOMY IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

Dr Slavo RADOŠEVIĆ

University College London
School of Slavonic and East European Studies
E-mail: s.radosevic@ucl.ac.uk

(MIS)MATCH BETWEEN DEMAND AND SUPPLY FOR TECHNOLOGY: INNOVATION, R&D AND GROWTH ISSUES IN COUNTRIES OF CENTRAL AND EASTERN EUROPE

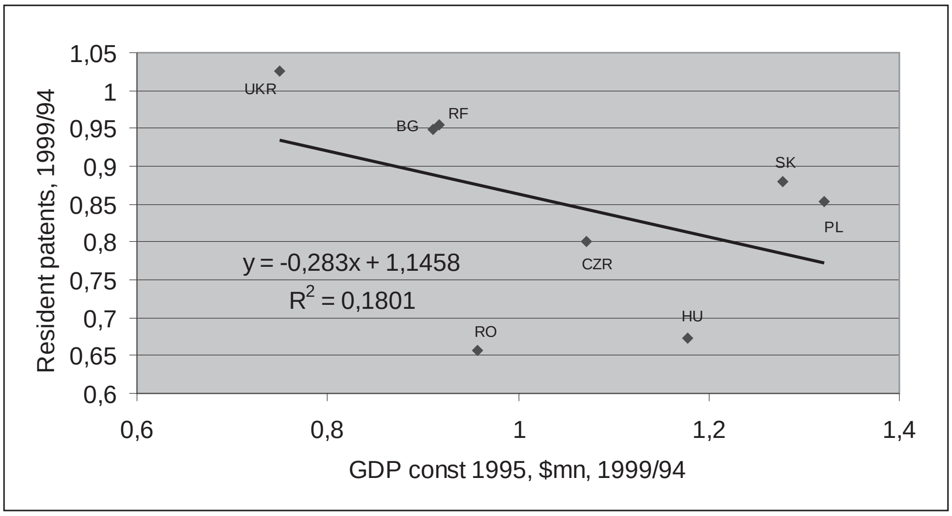
INTRODUCTION

So far, growth and recovery of post-socialist countries of central and east Europe (CEE) was based on efficiency gains from reallocations between sectors and firms, and on the firm level productivity improvements. Growth was not based on local R&D and extensive innovation activities. In order to grow further, CEECs will have to accumulate new knowledge and acquire new technology. In the core of this problem is the (mis)match between local demand and supply for technology which we explore in this paper. Economists are usually concerned with the issues of aggregate (mis)match between market demand and supply or supply and demand for products. However, demand and supply for products are not identical to demand and supply for technology (R&D and innovation). Technology is an intermediate input and output in economic process and in an increasingly knowledge intensive economy it has become essential for understanding the growth and its structural problems. In this paper, we explore this issue in the context of the CEECs using primarily statistical data, leaving theoretical issues aside and by developing policy relevant conclusions from data analysis. Our evidence on the gap between demand and supply of R&D and innovation and its determinants is not systematic. Nevertheless, we believe that even with this constraint our analysis contains empirically and policy relevant insights and conclusions.

The first part points to the emerging gap between lacking demand for technology and growth. Due to absent demand for technology, there has been sizeable downsizing of R&D in the CEECs. The second part analyses the relationship between R&D and innovation activities as well as the main sources of knowledge for innovation. This points to the (mis)match between current S&T system and changing sources of innovation. Conclusions draw policy implications.

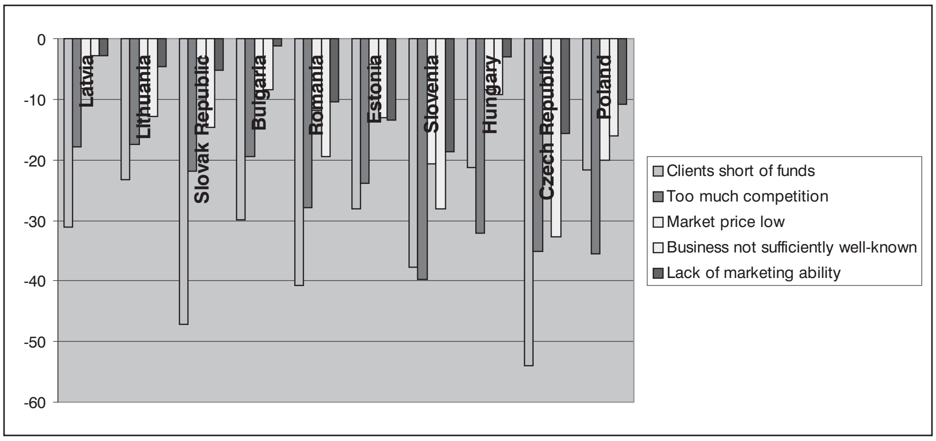
Growth and recovery in CEECs during the 1990s has not been linked to domestic R&D and technology effort. Moreover, recovery in demand has not been accompanied by recovery in demand for technology. Figure 1 shows that the relationship for eight CEECs has been slightly negative, i.e. countries that have grown faster in the period 1999-94 had relatively sharper fall in resident patent applications than economies that continued to decline. Although number of countries is far too limited to generalise the proposition on negative relationship, it is safe to conclude there seems to be not clear relationship between domestic technology activity and economic recovery. Recovery or decline are not strongly linked to domestic technological activity which seems to have its own autonomy. Elsewhere, we show that recovery and growth of Polish and decline in growth of Russia have led to similar decline of their R&D systems. This suggests that recovery of demand for local R&D and innovation may not emerge automatically with return of growth.

Figure 1
Index of GDP and resident patent applications in 1999-94 period



Source: World Bank Development Indicators, CDROM, 2002

Business surveys in CEECs suggest that there is clear easing of demand side difficulties in all CEECs for which survey data are available. Demand constraints were notable in the first half of the 1990s. Figure 2 shows that there has been significant decrease in demand side difficulties for "young" firms in CEECs. On that basis, we would expect that demand side improvements would be followed by an increasing demand for technology.

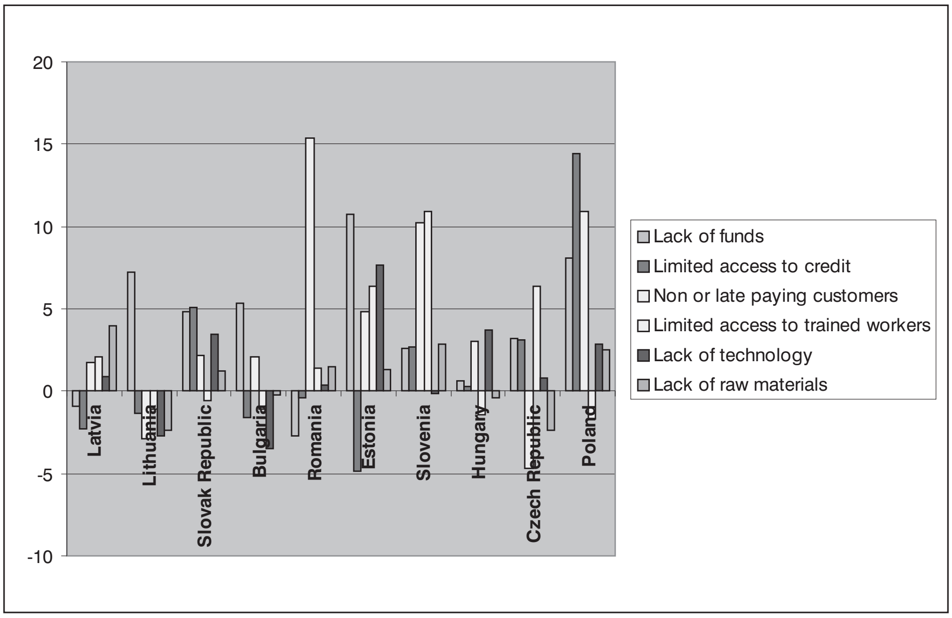


Source: Based on Eurostat, *New enterprises in candidate countries*, 2003

Figure 2

Change in proportion of demand side difficulties of enterprises today (2001) and at start up (established in 1998)

However, this improvement in demand side conditions has not been followed by equally strong improvement in supply side conditions. Figure 3 shows much more diversified picture regarding different supply side difficulties. Moreover, one of increasing constraints for new firms has been a lack of technology and limited access to trained workers.



Source: Based on Eurostat, *New enterprises in candidate countries*, 2003

Figure 3

Change in proportion of supply side difficulties of today (2001) and at start up (established in 1998)

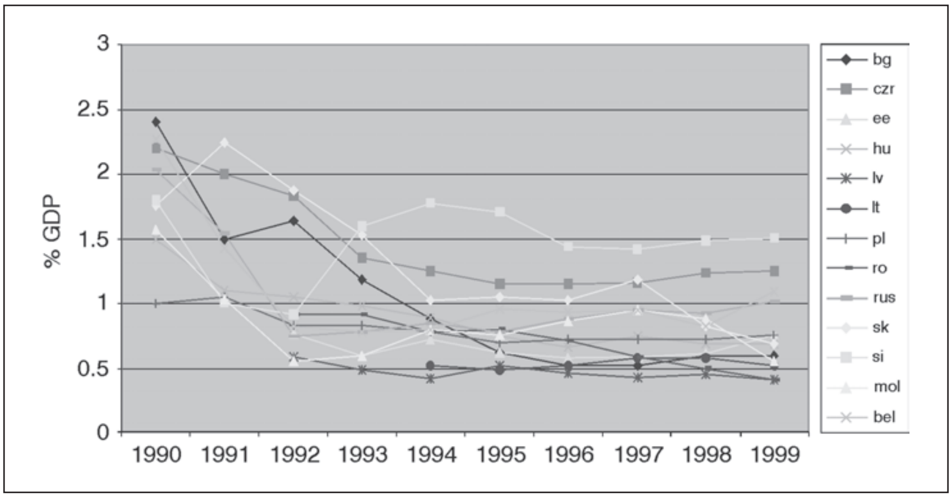
This has been coupled by the lack of funds and by worsening in liquidity (non or late paying customers) in all countries, except Czech R.

A clear improvements in demand side conditions suggest that the problems for innovators and entrepreneurs have now shifted to supply side, especially to issues of access to credit, own funds and liquidity of clients despite indications by companies that clients are now less financially constrained (see figure 2). This may suggest that the problem is not the general lack of liquidity but the mismatch between liquid supply and demand. In addition, firms are increasingly facing other supply side problems like trained workforce, and lack of technology. This is quite new phenomenon and suggests that the CEECs are entering into new stage of entrepreneurship where requirements for growth have become more variegated and related less to finance by itself but increasingly to the quality of supply and matching of supply and demand. From policy perspective, this points to the problem of weak financial systems, which are mediating between supply and demand, and to the importance of national innovation system.

R&D IN THE POST-SOCIALIST PERIOD

R&D system plays a relatively limited role in the current performance of the CEE economies. Given their income levels, the CEECs have still relatively large numbers of research scientist and engineers (RSE) while many of them have relatively favorable education structure of population. Both these factors should, according to new growth theory, produce much more robust growth than we have observed during the 1990s. Yet, recovery of the CEECs during the 1990s was unrelated to their R&D. Simple correlation coefficients between growth of GDP and share of GERD/GDP for 1992-1999 period are negative for six out of nine CEE economies.

However, we should not assess the importance of R&D system just based on its current role. Restructuring of R&D is one the key preconditions for further industrial upgrading. As figure 3 suggests, we observe for the first time that technology is seen as limiting factor for growth. During the 1990s, R&D has not been felt as constraint to growth. Growth has been generated from reallocations rather than from technology accumulation. Hence, demand for local R&D was quite limited. As a result, we have seen radical shrinking of R&D systems in all CEECs. Figure 4 shows the share of expenditures in R&D in GDP for CEECs.

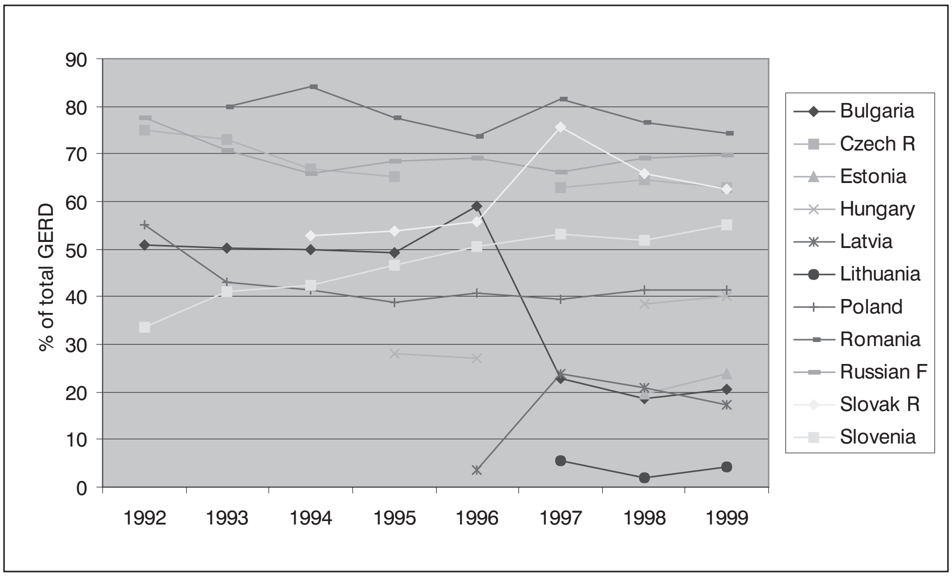


Source: EU (2002)
For Moldova and Belarus, DB of CIS Statistical Committee, data are not comparable to OECD definitions
For 1990-1991 OECD, Centre for Co-operation with Non-Memebers

Figure 4
Gross expenditures for R&D in GDP, 1990-99

From having very high shares of R&D expenditures at the end of the socialism, which ranged from 2.5% to 1% (1990) of GDP CEE economies investments in R&D fell to a range between 0.5% to 1.4% (1999) of GDP. This downfall can be disaggregated into three distinct periods. First, in the period between 1990 and 1993/94, with the falling GDPs the share of expenditures for R&D also declined sharply leading to a very high absolute declines in funding of large R&D systems. This was followed by the period of stabilisation (1993/94 to 1996) in which decline continued but at significantly lower rate. From 1996, signs of recovery in some economies, in both absolute and relative funding of R&D, have emerged. However, in some CEECs, like Romania R&D decline continued uninterrupted. Overall, after average annual decrease of 13% in 1991-96 period, the relative share of R&D on average grew by 3.2% annually in 1997-1999 period.

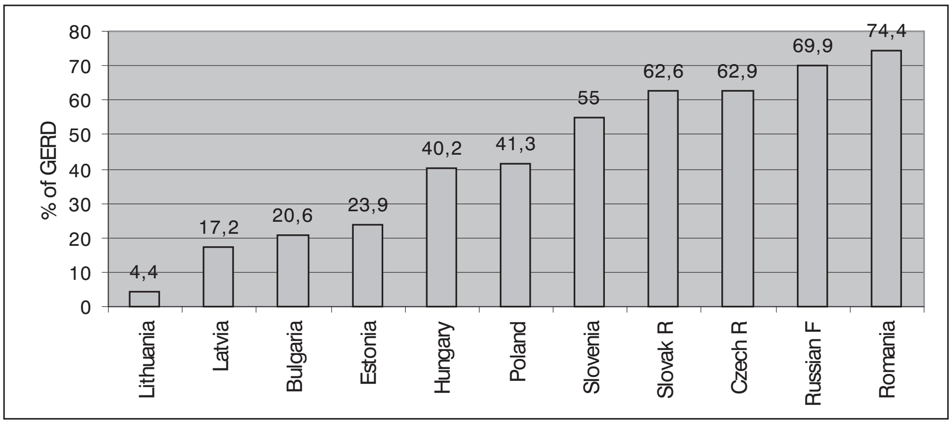
From perspective of growth and restructuring, it is important what has happened to business enterprise sector R&D. Data show that the shares of R&D funded by business enterprise sector in CEECs have remained relatively stable over the whole period. In other words, business enterprise sector has shared the destiny of the overall decline, absolute and relative, of R&D sector. (See figure 5.)



Source: EU (2002)

Figure 5
Share of R&D performed by business enterprise sector, 1992-1999

National differences in the share of R&D funded by business have remained suggesting that the transition could not change strong structural and nationally specific features in R&D systems. A high shares of R&D funding by business sector in Czech Republic and Slovakia and very low in Baltic states are the result of differences in industry structure, especially in terms of the role of large firms as well as of neglect of R&D in Baltic states during the early 1990s. A high share of R&D *performed* by business enterprise sector in Russia and Romania indicates primarily unreformed R&D sector which is dominated by extra-mural industrial R&D institutes rather than strong in-house R&D. At the same time, in both countries there is a low share of R&D *funding* by industry and high share of government funding of business sector R&D. This situation is generally rare in market economies and can be taken as an indicator of the slow restructuring in R&D. Our research (see Radošević, 1999) suggests that the Russian innovation system is moving towards a situation where the in-house R&D activities of enterprises are playing a more important role than the extra-mural R&D activities. However, the role of extra-mural R&D activities still continues to be significant suggesting that some elements of the Soviet R&D model as described by Gokhberg (1997) are still operating.



Source: EU (2002)

Figure 6
Share of R&D performed by business enterprise sector, 1999

A simultaneous fall in government funding and weak demand for R&D from industry have blocked sectoral structural change within R&D systems which adjusted to lacking demand by overall shrinking. As we analyzed elsewhere, (Radošević and Auriol, 1999) downsizing of the R&D systems in CEE was not systematically linked to a specific individual factor on the demand or supply side. Probably, it is the combination of demand side factors (annual changes in GDP and investments) and supply side policies (budgetary R&D policy) that in the end have shaped trends in R&D spending. Neither government nor market demand for R&D could buffer this fall. However, this does not mean that there was not change at micro-level in R&D system. For analysis of Russian situation in S&T from this perspective see Radošević (2003).

BUSINESS R&D AND INNOVATION

The supply of R&D is only a part of the overall process of innovation that leads to a finished product being placed on the market or to economic growth at national level. The fall in aggregate R&D spending hides the changing nature of innovation and its sources. So, if we want to understand why there has been decrease in demand for R&D we should look beyond R&D sector to the nature of innovation process.

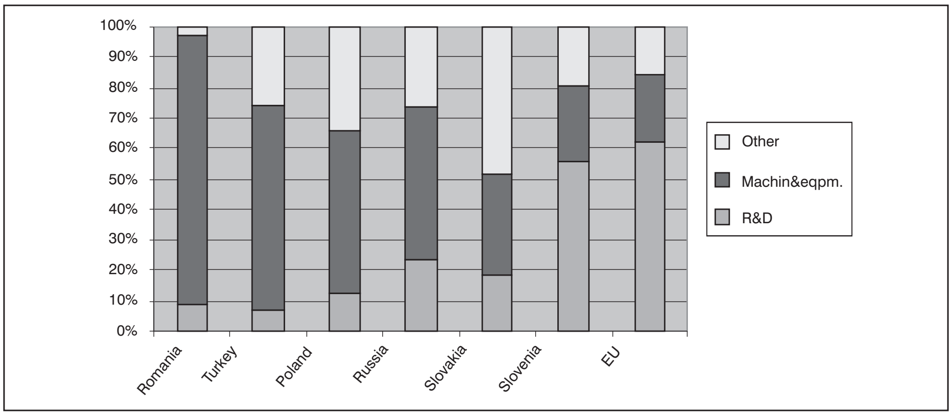
Research and development data measure the size of institutionalized knowledge generation activities. Small and discontinuous R&D activities usually closely linked to production are not covered by R&D surveys (Sirrili, 1998). Moreover, continuous and institutionalised research activities are not necessarily used as input into innovation process. This is especially apparent in 'catching-up' economies where behind the frontier R&D work is usually much less integrated with innovation activities than in economies at the world technology frontier.

The differences in the structure of innovation expenditures should indicate differences in the main types of innovation activities. Taking into account differences in developmental levels between the EU and the CEE we would expect that the structure of innovation expenditures should be significantly different. Countries that are behind the technology frontier should spent relatively more on embodied technologies and on downstream innovation activities like reverse engineering, product and process imitation than on R&D.

The analysis of the innovation expenditures by Evangelista et al. (1997a) shows that, first, the distribution of innovation costs is relatively coherent over all EU countries. If innovation costs reflect the scope of different innovation activities than the mix of innovative activities appears rather similar across EU. The second conclusion based on the EU innovation survey is that the industrial innovative process consists, first and foremost, of the purchase and use of "embodied" technologies (innovative machinery and plants), which account for 50% of total expenditures on innovation (ibid.). Third, among the "intangible" innovation expenditures R&D activities are confirmed to be a central component of the technological activities of firms (see Evangelista et al., 1997b, fig 2, p. 529). Fourth, across all European countries expenditure-wise, the acquisition of "disembodied" technology through patent and licences emerges as a secondary innovation component when compared to the technological sources (ibid.).

Figure 7

Innovation expenditures in manufacturing, in %



Source: R&D and innovation statistics in candidate countries and the Russian Federation Data 1996-97, EC, Theme 9, R&D, 2000

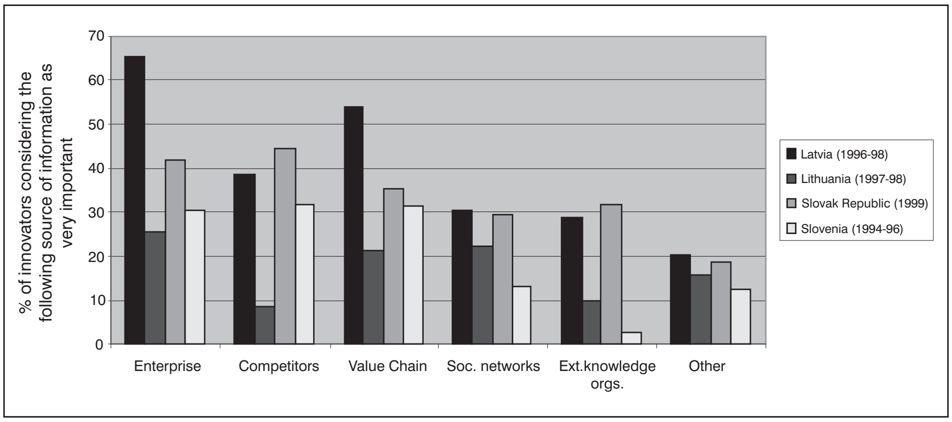
For Slovakia, Slovak Statistical Office. For Turkey, Turkish Statistics Institute

For EU (2000) Statistics of Innovation in Europe, Eurostat, Luxembourg

A comparison of structure of innovation expenditures for the group of non-EU countries in figure 7 shows that there are significant differences as compared with the EU costs structure. R&D cost amount to smaller share of innovation expenditures than in the EU. Only Slovenia, which is the most developed CEECs, has a share of R&D similar to the EU. Acquisition of machinery and equipment amounts to the biggest item among innovation expenditures. In particular, in Romania, innovation activity is essentially about installing new equipment. This cost structure reflects the nature of innovation in CEECs, which is primarily based around new equipment, most often imported.

Enterprises do not innovate on their own. Their technological upgrading is dependent on the supply chain (suppliers and buyers) within which they operate, on degree of competition and on 'social networks' on which they can rely. Figure 5 shows the main sources of information for innovation in four CEECs. Data confirm the importance of direct business environment of firms as the main source of knowledge for innovation. Quality of clients, competitors, buyers, and of social networks within which enterprises operate are the key to their innovation. Universities, consultants and R&D institutes are not the source of direct knowledge or at least seem to be a secondary source. This is not surprising and corresponds to EU innovation surveys. Universities serve as sources of skilled professionals i.e. as indirect knowledge providers rather than as direct sources of knowledge for information.

Figure 8
Sources of information for innovation in manufacturing *(% of innovators considering the following sources of information as very important)*



Source: R&D and innovation statistics in candidate countries and the Russian Federation 1990-1999, Eurostat

Note: External knowledge organisations (average of importance for universities, consultants and R&D institutes)

Value chain (average importance between clients and suppliers)

Social networks (average importance of professional conferences, meetings, fairs, exhibitions, electronic networks)

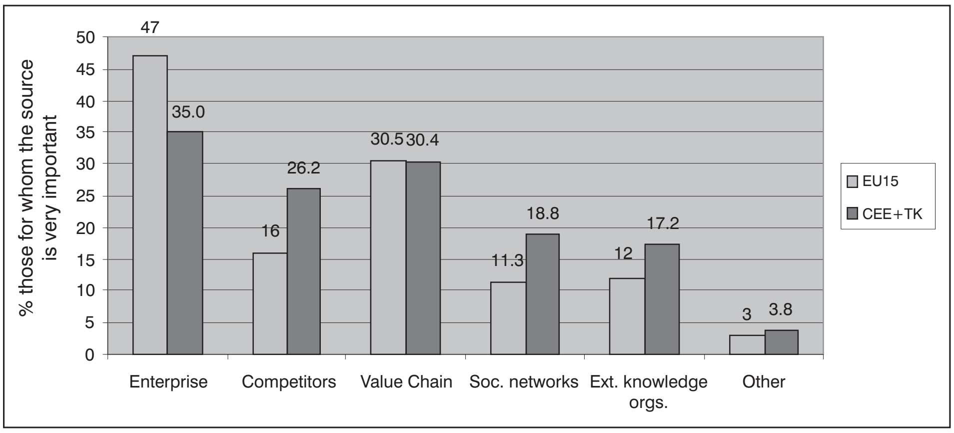
Other (patents)

However, when we compare the importance of external vs. internal sources of information for innovation between EU and the average of four CEECs and Turkey we observe that in less developed economies the external sources of knowledge are more important than knowledge within enterprise[1].

Figure 9 shows that competitors, social networks and external knowledge organisations all play more important role for innovators in than in the EU. One the other hand, own sources of knowledge for innovation are more important in more developed context than in less developed CEEs and Turkey.

Figure 9

External and internal sources of information for innovation between EU and four CEECs and Turkey *(% of innovators considering the following sources of information as very important)*



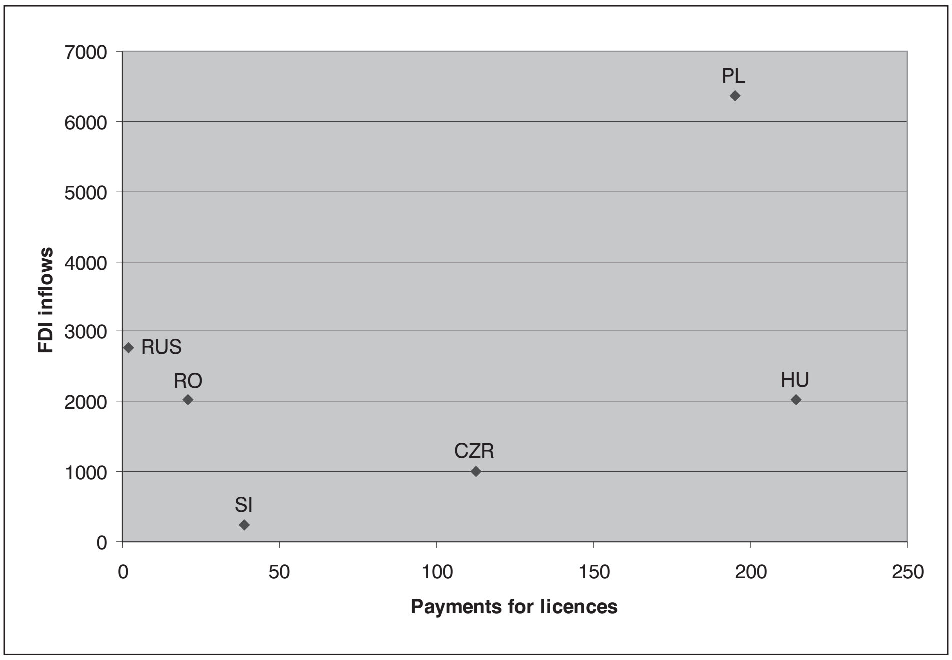
Source: R&D and innovation statistics in candidate countries and the Russian Federation 1990-1999, Eurostat; Turkish National Statistical Office and EU (2002)

Notes: see figure 8

Value chain (suppliers and buyers) play similarly important role in both groups of countries. This finding has important policy implications. First, it points to the relatively bigger importance of national system of innovation (competitors, social networks, external knowledge organisations) for innovators in the CEECs. Their innovation capabilities are dependent on systemic features of external environment in which they operate. Secondm weak innovation capability of local firms, which are not able to generate new knowledge within their own R&D activities, points a need to support firm level R&D or to induce demand for internal knowledge.

Relatively bigger dependence on external sources of knowledge in less developed environments suggests that CEECs are dependent on FDI for new knowledge. Weak innovation capabilities of local firms and the gap between 'old' S&T system and new sources of knowledge for enterprises led to increasing reliance on foreign technologies.

Limited data for the CEECs suggest that the FDI is an important channel for inflow of new knowledge as expressed through payments for licences. Correlation coefficient between payments for licences and FDI inflows for the six CEECs for which data are available is positive and moderate $(0.455)^2$ (figure 10).



Source: UNCTAD, World Investment Report, 2003, Geneva

Figure 10
Payments for licences and FDI inflows, 1998, $mn

This suggests that local firms have to rely on FDI in order to gain new knowledge. A comparatively high presence of FDI in some CEECs like Poland, Hungary and Czech shows that they have been relatively successful in that respect. This is the strength but also the weakness of innovation in the CEECs. Exclusive reliance on knowledge from abroad as well as on weak national system of innovation, coupled with very weak innovation capability of domestic firms represent the most vulnerable aspect of the CEE economies. In short and medium term, the exclusive reliance on FDI leads to quick productivity improvements. However, in a long-term, this creates fragile economies whose narrow specialisations in FDI related activities and weak national system of innovation may become obstacle to further upgrading. Trade off between short term efficiency and long-term strategic orientation and flexibility are the key emerging issues for frontrunner economies of central Europe, like Hungary, Czech R and Poland. Other

CEECs, in particular east European economies (Romania, Bulgaria, Russia, Ukraine) will have to reply on FDI as the way to gain quick access to new technologies. However, in both groups of countries the key long-term issue is how to achieve complementarity between domestic and foreign sources of knowledge.

CONCLUSIONS

Our analysis has several important implications for the development policy in the CEECs.

First, recovery and growth will be not automatically followed by recovery of demand for domestic R&D and innovation. In fact, some CEE countries may exhaust sources of growth which come from reallocations, closures and lay-offs and face structural problems of further upgrading. This new threshold levels for upgrading will not be exclusively related to the institutional system of market economy which has been addressed through transition related policies but will be related to weakness of national systems of innovation and its integration with FDI. Any national system of innovation is a system based on public – private and local – global interfaces and interactions. It is the challenge for policy makers to facilitate the emergence of public – private interfaces, which are essential to market economy.

Transformation of the CEECs during the 1990s shows that innovation does take place even with ineffective innovation policy. Slovenia, Poland and Hungary are clear examples of this. If so, is innovation policy indispensable? Indeed, impact of innovation policy should not be overestimated. However, we should bear in mind that the sources of growth in CEECs are changing. During most of the ten years of transition growth has been unrelated to domestic technology accumulation. Large-scale reallocations from unproductive parts of industry to services, from less to more efficient firms have ensured growth for some period. However, there are signs that the sources of productivity growth, which have been mainly in realm of 'reallocations', are now coming to an end and that the CEECs will have to grow based on technology accumulation. For example, Kubielas (2003), in case of Poland, argues that Ricardian adjustment based on reallocations has been exhausted and that Polish growth is now dependent on imported technology. Since Poland has lost chance that it had during the 1990s to strengthen absorptive capacity of its R&D system it is now entirely dependent on FDI to ensure continuous technology accumulation.

It may happen that innovation will continue to develop in some CEECs entirely based on local or export demand. However, if growth is to depend on the strength of national innovation system than innovation policy is one of important factors to facilitate domestic technology accumulation and diffusion. National systems are everywhere hybrid systems and require public – private co-operation. CEECs may still grow for some time unrelated to domestic R&D and without innovation policy. However, they may soon reach limits to this type of growth and face structural barrier or threshold level, which will require new national system of innovation and policies to be overcome. Innovation policy is not a quick fix. In order to be successful it requires a broader consensus of various stakeholders. As CEECs show this policy is easier to establish in periods of growth rather than depression. However, this also reduces pressure for its development. In addition, its long-term nature does not ensure clear benefits in 4-year cycle politics. All this suggest that demand for innovation policy is not articulated easy and that we should not be too optimistic regarding its establishment in CEECs.

Second, high tech seems to be the dominant paradigm in innovation policy in CEECs despite data which suggest that innovation in these countries is very much linked to equipment and with limited R&D component. As pointed in example by Nauwelaers and Reid (2003) this leads to narrow client base of 50 large companies for Estonian innovation policy. In other countries this means that attracting high tech through S&T parks actually functions as substitute for innovation policy. In the best case, this route can create isolated pockets of competencies in new technology but will leave untouched majority of local firms. This is not to argue that this route should not be pursued but only that it should not serve as substitute for innovation policy.

The relevance of this policy can best be seen when comparing marginal relative position of CEECs in US or EPO patenting. On the other hand, innovation surveys and R&D data, which show gradual increase in BERD, suggest that innovative firms are increasingly involved in technology activities but these are not necessary high tech. This points to increasing wedge between R&D and innovation policy, (see Kubielas, 2003, for the case of Poland). CEECs will have to close the gap, which currently exist between dominant R&D policy and subservient innovation policy. As CEECs increasingly try to emulate EU policies and try to restructure towards knowledge-based activities this gap will become unviable. Shift towards knowledge based economy in CEECs will mean (i) shift towards diffusion oriented activities within R&D system, and (ii) transformation towards enterprises based R&D system.

As interactive innovation model suggest this will not mean irrelevance of R&D but integration of R&D and innovation activities. While this may sound simple in conceptual terms this shift is very difficult to make in policy terms. How to move form current situation where "science" and "innovation" are seen in policy terms as zero sum game between science establishment and weak "innovation community" towards positive sum game situation or situation where reorientation of both areas will be of mutual benefit.

Third, policy should assist transformation of the S&T system into market oriented technology or knowledge infrastructure. For this transformation to take place it is essential to develop explicit innovation policy.

After ten years of implementation of transition-based policies, central European economies have started to introduce innovation policy measures. The emergence of innovation policy in these economies shows that there are important changes taking place in their political philosophies. From being reduced to building the institutional framework of "open market economy" and promotion of, at least rhetorically, minimalist role of the state we observe the shift towards more pro-active role of the state. However, innovation policy should be squared with the specific context in which it has to operate.

Innovation surveys show that direct market and social environment of enterprise is the main source of information for innovation[3]. Yet, this aspect is not taken into account by innovation policy, which is rarely sector specific or technology specific. Innovation surveys show that sector and technology specific measures could matter more for innovativeness of enterprises when compared to general measures like tax incentives or horizontal measures like innovation centres and S&T parks.

As innovation surveys in CEECs suggest innovation links are value chain based, i.e. they are the strongest with suppliers and buyers immediately after intra-firm sources. This is the strength but also the weakness of innovation systems in CEECs. Production integration through FDI led value chains ensures high productivity, innovation linkages and regular sales to local firms. However, in the long-term, product and technology upgrading does not necessary follow value chain logic, especially when value chains are changing or breaking-up. Again, this means that innovation policy will have to strike balance between supporting integration of local firms into global value chains (FDI, subcontracting) and domestic linkages with universities, S&T parks, cooperative centers, etc. Integration of local firms through value chains and FDI is policy which has been relatively undeveloped in CEECs. Hungary and Czech Republic are the only two candidate countries which have developed elements of this policy which goes beyond marketing of country as production location. There has been much more policy focus on linkage mechanisms like S&T parks, innovation centers, etc. i.e on linkages for which weak and dependent local firms may not have immediate demand rather than on value chain linkages. This explains their irrelevance to local firms and their innovation activities, which are, primarily value chain driven. A challenge for CEECs is how to integrate FDI and innovation policy.

FOOTNOTES

[1] We compare weighted EU average with the unweighted average of five countries. This makes sense as our EU indicator becomes biased towards bigger and technology developed countries like Germany, France and UK. In addition, we do not have data for the CEECs and Turkey to calculate weighted average.

[2] Identical correlation coefficient for 10 "catching up" economic (China, India, South Africa, east Asian and Latin American economies) is low (0.122) suggesting that channels of technology inflows are not confined only on FDI.

[3] This is what interactive model of Kline and Rosenberg would suggest to be the typical situation.

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Devrim GÖKTEPE

PhD student, Division of Innovation
Department of Design Sciences, Lund Institute of Technology-LTH
Lund University, Lund, Sweden
Phone: +46 46 222-3930, Fax: +46 46 222-8060
Homepage: http://www.innovation.lth.se/devrim.goktepe

A NETWORK PERSPECTIVE ON EU ENLARGEMENT: THE ANALYSIS OF SIX-EUROPEAN NATIONAL INNOVATION PROGRAMS AND IMPLICATIONS FOR TRANSITION ECONOMIES*

INTRODUCTION

In today's global world of innovation, knowledge and learning have become strategically important factors that foster competitiveness and socioeconomic growth. Globalization, international information exchange, and strong competition impel all stakeholders of society to participate actively and promote the role of knowledge within the socioeconomic system as early as possible. Therefore, the timely possession or non-possession of knowledge and skills and the full utilization of the knowledge capacity of partners will determine national welfare and prosperity.

"Deficits and backlogs, especially if they concern the structure of the system, lead to heavy burdens and can only be remedied at the highest expense" (Tubke, A., 1999, p. 1). This has been observed recently in the Eastern European countries. After the decline of Eastern Bloc, many Eastern European Countries were characterized by the disappearance of organizational and institutional frameworks that systemize economic, political and social affairs. Therefore they have been obliged to restructure their legislative, executive and market mechanisms. However this new organizational and institutional formation, which is rather weak or embryonic, prohibits the establishment of successful economies and limits the prospects of innovation and growth.

Networking between the users and producers of knowledge has been proposed as a way to remedy the systemic structural problems and to generate more power from the synergy of participants. Consequently, networking approaches for innovation have been widely used in different levels such as initially at national (Lundvall, 1992; Nelson, 1993; Edquist 1997), and regional or sub-regional (Cooke, 1992 in Bracky et al., 1997). These approaches are also applied in different contexts like in *industrial and technological sectors* (Pavitt, 1984; Carlsson, 1995; Malerba, 1997), *scientific networks* (Pavitt, 1997; Steinmuller, 1994), structural and cluster analysis (Porter,

1995) and Triple Helix analysis of university-industry and government networks (Etzkowitz and Leydesdorff, 1996).

However networking approaches have not been utilized sufficiently at the international levels such as in the enlargement of European Union and integration of new countries. Against this background I argue while the international frameworks eliminate the national boundaries for science and technology; the widespread application of similar networking policies not only expedites this process, but also it standardizes and harmonizes international innovation system. In analogy to the international cooperation, which is more attainable and successful among the countries that have similar ideologies and aims, it can be argued that international innovation cooperation can be more attainable among the countries whose R&D programs and institutions that are incorporating the features of the Triple Helix Model.

Although non-linear models of innovation and Mode 2 state importance of networking as well, a "Triple Helix" of academia, industry, government relations and a spiral model of innovation diffusion likely to be a key component of any national or multinational innovation strategy of the twenty-first century. Thus despite different historical patterns, Triple Helix based innovation strategies can be admitted as the most viable method for both industrialized and industrializing world of twenty-first century (Gulbrandsen in Etzkowitz and Leydesdorff, 1997).

Simultaneously, the extensive use of information communication technologies, transition to knowledge-based society and increasing relations among states have accelerated the internationalization and globalization of industrial and economic activities. This transition caused national innovation policies to be shaped and mediated at the international frameworks such as EU and OECD. This paradigmatic shift provides an opportunity for the transition countries to cleanse, and set their institutional frameworks according to the true time[1].

This paper argues the idea of the replacement of traditional understanding of science & technology generation with the features of Triple Helix renders the elimination of dichotomy both at national and international levels. Such as in the case of dichotomy between the ***producers of knowledge: "academy and developed countries"*- and *users of knowledge: "industry and developing countries"***. Accordingly, the paper claims the recursive modeling of these indicators by the transition countries would help the elimination of the structural and cultural mismatches among these two groups of countries and thus speeds up the formation of a larger European innovation area. Therefore the paper claims the transition to knowledge-based economy has brought about opportunities; both to the accession countries for the adjustment of institutional settings and socio-economic models in accordance with the EU requirements and to EU to become a much bigger harmonious economy rather than a challenge that can not be contended with.

In line with these arguments, the paper makes a comparative analysis of six national programs, -which have been designed for innovation networking between university, industry and government, – of the late industrializing countries of 1990s namely "Denmark, Finland, Ireland, the Netherlands, Norway and Sweden". It deliberately stays away from detailed country descriptions to lift analysis from country levels to cross-country trends towards Triple Helix. The paper finds out eleven features, behind these programs, which can be a driving force and organizational tools for innovation frameworks for transition countries both at the national level and integration to the European Union system.

Accordingly these determinants which can be utilized by the transition countries in the eve of the integration to the EU are analyzed. The general perspective on the current situation of transition economies and how does it relate to the European innovation networking system are analyzed. In order to tackle the all the elements of Triple Helix and Innovation System models, the transition economies are presented from these following dimensions[2]:

(i) *Role and power of government*
(ii) *Characteristics of the science and innovation system in transition;*
(iii) *Education and training system,*
(iv) *Industrial relations and inter-company relations*

Even though these specific network programs can be criticized as they can not represent the whole national innovation systems, their organizational philosophies become the backbones of the whole innovation systems. By the comparative analysis of the six different European national measures and the examination of the changes and developments of the systems in the transition countries and their adaptability / compatibility and convergence to the European Union science, innovation and production system will become visible. In developing this argument, this paper contributes to the existing literature as deriving policy suggestions to the connecting networking perspective to the international levels and national institutional building.

In the remainder of this paper, I present the comparative analysis in section 2; and the indicators for the establishment of innovation networks fruitfully in these six countries. Subsequently, sections 4 and 5 deal with the current situation of the transition economies in general and appropriation of these indicators in the transition economies, respectively. These analyses then lead me to describe the institutionalization of national innovation networks and the possible impact of institutional changes on the enlargement of EU. Section 6 concludes the arguments presented in this paper.

A NETWORK PERSPECTIVE ON THE 6-EUROPEAN COUNTRY INNOVATION PROGRAMS

The relationships between science and industry and growth have been shifted from linear models of innovation of 1960s to non-linear models and systemic approaches over the last two decades, as a result of increasing recognition of the fundamental role of knowledge and innovation for economic growth, technological performance and international competitiveness. Correspondingly, non-linear innovation network formulation and interactive innovation systems have been acclaimed as effective models for innovation generation and management (Kline and Rosenberg, 1986; Rullani and Zanfei, 1988; Metcalfe, 1990; DeBresson and Amesse, 1991; Lundvall, 1992; Gibbons et al., 1994; Skyrme, 1992; Dodgson and Rotwell, 1994; Etzkowitz and Leydesdorff, 1995; Porter, 1998; Gilbert et al., 1999; Kim, 1999; Jacob et al., 2000).

On the other hand, there is a widespread belief that each nation has experienced a unique pattern in the transition to knowledge-based economy – on account of different capacities and traditions in science and technology systems, economic and cultural patterns (Göktepe; 2003). However, there is still the possibility of mutual learning from successes and failures in addressing the common objectives (OECD, 1999). Therefore the transition economies can benefit from the experiences of these six countries which have high innovation performance – to a certain extent – due to their innovation networking programs.

CASE STUDIES

i. Data Collection & Methodology for Country Selection

The data for the contextual framework are complied from the OECD figures and statistics, European Trend Chart of

Innovation, Internet sources for the national science & technology programs. Statistical and comparative analyses are done in order to figure out the uniqueness and/or similarities of these models and hence state the general tendencies and features of innovation networks at the national levels.

In order to state the basis of the selection of the countries and their programs for the comparison, the indisputable facts of R&D inputs:

(i) Percentages of gross domestic expenditure on civilian R&D (GERD);
(ii) Financing sectors like governments (GOVERD), higher education (HERD) and business sector (BERD);
(iii) GERD in real terms and per capita;
(iv) R&D personnel per capita of the countries are examined as the initial classification method;

As the main aim of the comparative study is to figure out the achievement of industry-science cooperation the ranking of countries in terms of company-company and company-university cooperation are also used for the fifth classification item (Dodgson 2000)[3].

(v) The University-company, company-company ranking

Consequently, these five main items "national expenditure on R&D, allocation of R&D financing among the private/public sectors, level of industry-science cooperation and the amount researchers" indicates the level and success of countries in R&D and innovation, thus it guides distinguishing the countries. At first off, the selection revolves around top ten countries in terms of science-industry interaction. Among these countries though the success of East Asian countries are not deniable the European Union countries are chosen from Table A.1. Among them, the countries with a higher GERD between 2 and 3,5 are picked out from the Table A.2[4].

Most of these countries have national innovation systems with many good policies that cover a wide range of areas and demonstrate favorable development. However they go beyond the scope of this research, thus the selection criteria of the programs for this comparative research based on:

(i) Non-defense related public funding mechanisms that aim to strengthen academia and industry cooperation and clustering;
(ii) Nation wide programs, which aim wide spread dissemination of knowledge;
(iii) Center on pre-competitive research, with an interdisciplinary focus;

(iv) Cooperative generic R&D in High-Tech industry;
(v) Involving relatively high number of network participant from all concerned sectors especially universities and / or knowledge centers;
(vi) Having a central national funding from government and public domains, thus exclusion of supranational funding mechanisms.

However, concerning the last consideration, it is difficult to find sole national funding within the European context, since most of the programs are built on to benefit from EU sources. As a matter of fact, this singularity implies the necessity of the integration of Eastern European countries to the EU innovation framework. Ultimately Denmark's Competence Center Contract Program (Agency for Trade and Industry), Finland's Centers of Expertise Program (TEKES), Ireland's Advanced Technologies Research Program (Enterprise in Ireland), Netherlands's BIT and Technological Cooperation Program (SENTER), Norway's BRIDGE program (The Research Council of Norway) have been selected as case studies.[5]

ii. International Comparison

After having selected the countries and national programs towards the academy-industry cooperation, this section presents the comparative analysis among these programs. It scrutinizes the cases in as much as fulfilling a Triple Helix model. It addresses to the ***factors for achievement of successful partnership and satisfaction from the program. "reasons of the program, target groups, the organizational, financial, management structures; project proposal & eligibility criterion, intellectual property rights regimes, and socio-economic implications"*** as of important parameters to compare and contrast national measures for innovation networking and comprehend the university-government-industry relations in an innovation network system. The lack of precise empirical data in the financial benefits, exact allocation of patents, or increase in the export rates are not considered as disadvantages for the composition of innovation typology policies.

R&D Inputs

When the R&D inputs of these seven countries are examined as in the Table 1, Sweden and Finland. Have outstandingly high GERD in absolute terms. However in the case of Ireland the investment on R&D is relatively lower due to the foreign investments. The critical point that is drawn from these cases is the identification of priorities, though transition countries have lower GDP per capita, they are all advised to redefine their priorities. This should not prevent them to allocate a competitive amount of resources on R&D.

Table 1
R&D inputs

Input / country	DK	FI	IE	NL	NO	SE
GDP per capita	26,300	22,800	25,200	25,100	27,600	23,000
GERD per capita	521	701	269	462	464	732
GERD %	2.%	3.1%	1.40%	2.00%	1.6%	3.5%
GOVERD %	36.1%	30%	22.20%	37.90%	42.9%	25.6%
BERD %	53.4%	63.9%	69.1%	48.6%	49.4%	68.8%
Population	5,368,854	5,183,545	3,883,159	16,067,754	4,525,116	8,876,744
Total Researchers	18,438	25.398	7,825	40,623	18,625	39,921

Goals and Objectives

Table 2 presents the objectives of the programs; the main motivations of the programs are to render the competitiveness, industrial growth and innovation capacity of countries by way of increasing the interaction between industrial bases and academic bases of the countries. Generally, the aims of the measures are the promotion of joint innovation projects between industry and universities in order to improve and continue the industrial competitiveness of the countries.

Table 2
Program Objectives

Objectives/country	DK	FI	IE	NL	NO	SE
Commercialization of knowledge	√	√	–	√	√	√
Increasing competitiveness	√	√	√	√	√	√
Increasing innovation	√	√	√	√	√	√
Start-up of high-techs	–	–	√	–	√	√

Beyond these motivations while the Norwegian, Sweden programs are giving emphasis to the factor or necessity of "absorption of new technologies by SMEs" the other measures have not specifically address this issue. Second, the Finnish and Dutch programs explicitly underline the importance of strengthening the innovation capacity of companies.

The Organizational Administrative Structure

All of the programs are initiated by governmental initiatives, they are organized according to top-down approach of innovation networking, and the governments' agencies provide the institutional, legal and financial structures necessary for innovation networks. The governments primarily undertake the following roles.

Table 3
Role of Government

Role of Government / Country	DK	FI	IE	NL	NO	SE
Administrator	√	√	√	–	√	√
Catalyser	√	√	√	–	–	√
Facilitator / Coordinator	√	√	√	√	√	√
Funder / Investor	√	√	√	√	√	√
Launcher / Initiator	–	–	–	√	√	√
Networker	√	√	√	√	√	√

This classification is reflecting the statement of Triple Helix model as the changing role of governments according to the country patterns. None of these countries has left their R&D, innovation facilities and thus industrial competitiveness into the hands of market mechanisms; instead they are involving in the innovation process in a reasonable mode with the market tendencies. They are acting on a limited but essential level that renders the propitious conditions for innovation partnership.

Intermediary/Bridging Agencies

Prevalently, all of the measures are operating under the umbrella of a governmental body. This body is bridging the business sector, industrial research institutes, higher education institutes with the concerned ministries, recurrently such as ministries of industry, trade, economics, education or national agencies for research and technology. These agencies are acting as intermediaries between the funding/policy level and performers.

Table 4
Intermediary Bodies

Type of Intermediary Body / country	DK AGTI	FI Tekes	IE Enterprise Ireland	NL Senter	NO RCN	SE Vinnova
Advisory Councils	–	–	–	–	√	–
Dedicated Organizations	√	√	√	√	–	√
General Organizations	√	√	√	√	√	√

The literature on the types of organizations argues that for an effective management of innovation partnership, the intermediary bodies need to have some considerable role in directing the way of ST&I policies and executive power in the implementation of these policies rather than just providing independent advice at arm's length.

Therefore, the cross-country analysis correspondingly shows that these national measures are generally managed by active decision-makers, rather than people appointed on ad hoc basis. Thus this kind of exclusive bodies can be considered as a more viable method for the developing countries in the management of innovation networks. The integral existence and importance of these intermediary bodies are also reflecting another characteristic of Triple Helix.

Stakeholders / Participants: These programs try to comprise of all of the participants and stakeholders of innovation networks. The main target groups of these programs are as follows.

Table 5
Target Groups

Target Group / country	DK	FI	IE	NL	NO	SE
Large Industrial	√	√	√	√	–	–
(Non-industrial) Companies	√	√	√	√	–	–
Industrial SMEs	√	√	√	√	√	√
(Non-industrial) SMEs	√	√	√	√	√	√
Universities	√	√	√	√	√	√
Research Institutes	√	√	√	√	√	√
Foreign Partners	–	–	–	√	–	–

Albeit the governments are funding and initiating the networking programs among the similar target groups, how they are organized and managed varies from country to country. As a reflection to the point in terms of company-company cooperation Ireland, Norway and Netherlands are ranked 17^{th}, 15^{th} and 11^{th} respectively and there is a need for higher business participation, qualifying the SMEs with R&D capacities and strengthening the competitiveness of industry, hence the emphasis is given to industrial participants. On the other side, Denmark is ranked 10^{th} in university-company cooperation, there is relatively more need for strengthening the industry-oriented capabilities of research institutes; consequently they introduced bridging organizations such as GTS and other measures to facilitate the transfer of basic knowledge to industrial utilization. Thus all of these countries try to remedy their "major relative weaknesses" in terms of innovation generation. (ETCI, Innovation Scoreboard, 2001, p. 12). The different tendencies or preferences according to the country needs explicitly reinforce the arguments of Triple Helix in terms of country specific projection patterns. However it should be kept in mind that none of the countries have only these measures, they have several complementary policies and programs that work within the scope of national innovation systems. Thus in each of these programs the role of the government and the target groups may vary, or overlap.

Implementation

As for the attainment of Triple Helix model, definitely, these programs are designed for the interactive innovation process between universities and industry. There are central requirements in al of these programs such as the establishment a team of project, in an active cooperation of certain number of universities and research institutes. Second, it needs to be comprised of large number of industrial participants and should be open to the new comers as well. The programs considered to be legally binding agreements between the participants. They are acting under the terms of these measures; this causes them to be the one department of a big firm working mutually for the same objective. The coordination of this "big firm" is realized generally by a committee, which represents the ministries of industry, economics and science and technology councils. They also include representatives from industry and academy. These committees are responsible for the financial and administrative relations of the partners.

Management of Intellectual Property Rights

Concerning the management of intellectual property rights, Danish Case states the actors who participated in the development of the project, has equal rights over the IPR. However the dissemination of new knowledge outside the project teams are given great importance. Among the other programs, the general tendency is to leave the final decision to the members of the consortium. They execute their own method about IPR management. This is literally coincides with the Triple Helix attribute for the management of IPR.

Delivery Measure (Financing)

The governments financially support the programs. The percentages and the budget allocations, the possibility of additional funds varies from country to country. The common point is while the governments undertake the highest burden, the participants are supposed to contribute to the development of the project. The Table shows that the details of budget allocations.

Mode of Delivery / country	DK	FIN	IE	NL	NO	SE
% Of Government Funds	50%	50%	100%	Min. 50%	–	50%
Overall Budget	NA	NA	Eu5,725bn	–	–	–
Expenditure / year (2000)	13	Eu5M to dozens of Million	P. 100,000 –400,000	Eu50M	Eu15.8M	Eu 650,000–900,000
Industry Share	25%	50%	–	–	√	50%
Research Inst. Share	–	–	√	–	√	Vinnova
Higher Education Share	–	–	No	–	–	Vinnova
Additional funding	√	√	No	Mx. 50%	NA	EU
Duration of Partnership	C	C	3yr	4yr / C	C	3yr

Eu: EURO, M: million, C: The duration of the project depends on the completion on the project. P: UK Pound.

Table 6
Financing of the Program

According to the Table 6, the governments are providing the higher shares of the program budgets from at least 50 to 80 percentages, even in Ireland the government covers the whole budget. In most of these countries additional financing, especially benefits from the EU programs are very influential in these programs funds. Moreover, according to the European Trend Chart on Innovation under the heading of cooperation for innovation between industry and university the number of the programs in this field is definitely higher than this research (ETCI, 2000).

The classification on the financial management of the programs evidently reflects the requirement of innovation networks regarding cost and risk sharing among the participants. Although it is difficult to enumerate them in an ascending order from the best application to the least one, there are still some conjectures for a late coming country. Concretely, while the governments undertake the higher burden, they need to make the business to contribute at the utmost possible level, and finance their own costs, while the participation of research institutes and universities should be financed by the (conjectural) program. The Table 6 does not show detailed data on the overall budget allocated for the measure (except Ireland). This tendency can be calculated as a positive indicator for developing countries, since generally they have instabilities in budget allocations for the longer-terms, thereupon they do not need to be concerned so much with the details of overall budget allocations. On the contrary, for a successful functioning of the measure, it needs to have a stable and increasing budget allocation at the optimum level it needs to be refrained from any macro-economic instability, which seems to be very difficult for the developing countries to achieve.

Criteria for Eligibility

The application to participate in these measures can be realized via a research institute or it can be done by individual researchers, or group of organizations. While a beforehand partnership between academy and industry provides an expeditious initiation, the program committee can act like a matchmaker and bridges the partner. Extensively, whether they are prior partnerships or joined under the framework of the measure, they are subjected to the rules of the program. The following table shows the different types applicants. Under the conditions of a developing country, the beforehand partnership seems to be difficult to achieve, thus this programs should be designed to bridge and administer these two settings.

Table 7

Applicants for the Programs

Type of Applicant / country	DK	FIN	IE	NL	NO	SE
Group of Companies	√	√	√	√	X	√
Individual researcher	√	√	√	√	√	X
Industry & Academy	√	√	√	√	√	√
Industry/business	√	√	√	√	X	X
Research Institutes	√	√	√	√	√	√
Universities	√	√	√	√	√	NA

In addition to the sort of participants for application, the committees of the programs apply similar or different criteria to decide the eligibility of the project propositions from these applicants. These criteria are by nature reflects the requirements of knowledge-based economy and objectives of a successful Triple Helix system. This table classifies the governments' industrial priorities, in initiating these programs. This classification is based on the programs' frameworks it should not be considered that there are sharp lines among the program objectives, and some points are totally neglected.

It should be kept in mind that though there are national variations, by and large the critical points in accepting or rejecting the proposals are how much they are promising to bridge the producers and users of knowledge and how much it contributes to the industrial competitiveness of the country. The Table 8 tries to itemize each programs specific and overlapping criteria and it aims to show the omnipresence of the arguments of a successful innovation partnership in these national partnership programs.

Criteria/Country	IL	DK	FIN	IE	NL	NO	SE
Active participation	√	√	√	–	√	√	√
Basic Science → Applied Science	√	√	√	√	√	√	√
Concrete solution	–	√	–	√	√	–	–
Cost/Risk reducing	√	–	√	√	√	√	√
Dissemination of technology outside	√	√	√	√	√	√	√
Employment oriented	√	√	√	√	–	√	–
Export oriented	√	√	√	√	–	√	–
Financing Requirements	–	√	–	–	√	–	√
Generic technology	√	–	√	–	–	–	–
Initiate/useful for SMEs	–	–	√	√	–	√	√
Knowledge pooling	√	√	√	√	√	√	√
Large # of Participants	√	–	–	–	–	–	√
Open to newcomers	√	–	–	√	√	–	–
Targeted at priority areas	–	–	√	√	√	–	√
Technological innovation	√	–	√	–	√	√	–

Table 8
Project Evaluation Criteria

The classification of the criteria of eligibility of in details underlines the utilization of the aims of innovation networks by each of the program. Hence it can be concluded that as higher as these items are taken into account in the assessment of project proposals, the higher the success rate of the programs. The Table 8 also reflects the objectives of the national programs.

It is necessary to emphasize that the criterion of "concrete solution" is only employed by three measures Denmark, Ireland and Netherlands. Accordingly it can be stated the main aim of the networks is not to end in results but to provide the necessary conditions for production and any kind of problem solving. In order to clarify for developing countries, these items can be grouped under four main headings to be applied as eligibility criteria: ***"success in technological innovation, high results of economic benefits, commercial potential and active cooperation of participants from industry and science".*** These factors should be taken into account in assessing the project propositions.

Results / Implications of the Measures

Definitely, this is the most difficult part to discuss since primarily there is not enough official data on the results of the programs; or no unequivocal indicator to figure out them. Second, the net results of these programs are difficult to be distinguished; since at the national level all of these measures are working in cooperation with other national and international programs. Moreover, even though all these countries have high innovation performance, the variations make a national comparison on strictly defined item difficult. Therefore, in each of the country reports the achievement of the project criteria, the general positive observations on the programs, or at least continuation of the programs and increase in their budget are considered as programs' positive implications and achievements'. Table 9 shows the indicators of success, rather than net profits of the program. Still and all, any unchecked indicator does not mean a total failure at or ignorance of that factor, rather this is due to the lack of data or a complementary connection.

Table 9
Indicators of Success

Implications/country	DK	FIN	IE	NL	NO	SE
Accomplishment of Targets	√	√	√	√	√	√
Budget increase	√	√	NA	√	√	NA
Efficiency in Gov. role	√	NA	√	NA	NA	NA
Enhancement of R&D	NA	√	NA	√	NA	NA
Extension of program/projects/consortia	√	√	√	√	NA	√
Increase in competitiveness	√	√	√	√	√	√
Increase of U&I partnership	√	√	√	√	√	√
New companies & jobs	√	√	√	NA	√	NA
Superior achievements	NA	NA	NA	√	NA	√

By and large, the programs are considered to fulfill their initiation targets, and contribute to the intensification of university-industry interaction, which is very instrumental for further innovation. Another success sign is the extension of these programs, reflecting the acceptance and effectiveness of these programs nationwide. The countries experience an increase in their competitiveness, and in the availability of employment opportunities. It can be concluded that at different levels and on different items, these measures indicate that a successful Triple Helix modeled innovation system results in such impacts.

The measures are designed to achieve the targets of a fruitful university, industry and government cooperation, which Triple Helix model expound to incite. The Table 9 rates the success of programs in the accomplishment of a trilateral networking.

POST-COMMUNIST ERA SITUATION OF UNIVERSITY- GOVERNMENT AND INDUSTRY (UGI) RELATIONS IN COUNTRIES IN TRANSITION

As a result of many historical experiences[6], which had still adverse effects on the economic growth, the Central and Eastern European Countries had followed a different path of economic and social development. Democratic capitalism in western countries led better and more dynamic environment for interaction of economy, technology and science (Koslowski, 2000). Concerning the research administration there has been lack of efficiency, order and connection to the environment. In the absence of well-defined economic and social development programs, science, technology and innovation programs have subsequently became vague and unresponsive to the needs of industrial and economic development. Public institutions have no missions or plans, its functioning rules were formed in the communist era. As a rule, ministries in CEE countries acted as organizations created to manage relatively uncomplicated and routine matters using relatively passive staff (Koslowski, 2000). Despite some reforms these public bodies are still tend to repeat the same routine behavior and far from forming a web of coordination within the whole system.

The secret and golden thing in the efficiency of the public administration in western countries is the fact that both officials and politicians apply certain basic reasoning just like scientific researchers or scientific process. Policy plan for innovation or innovativeness – which is the main concern of this paper – includes phases of: *preparation, identification of the problem, implementation, monitoring and assessment.* These phases are all actualized in the implicit or explicit form of trilateral relations of UGI.

Concerning the other organizations for innovation, such as universities, technology agencies, research councils and research organizations there are also diversity and lack of coordination within these organizations. There are no institutional framework bridging the knowledge centers to the industrial level.

LESSONS LEARNED IN DEVELOPED COUNTRY PROGRAMS: READINESS FOR INTERNATIONAL COLLABORATION

In this section, some of the indicators and guidelines for a successful international cooperation analogous to the Triple Helix based UGI relations are identified. This helps the elimination of the dichotomy between technology producers – developed countries – and technology users – developing countries. The appropriation of these features would help transition countries to become a part of global production system as well. While the level of economic development, ideological similarities are used to be factors for the collaboration between states, recently the culture and philosophies for the management and generation of innovation becomes another important determinant of international cooperation. Beyond the percentages of GERD or total number of researchers, currently different indicators have been utilized as to measure the readiness for international cooperation in R&D and innovation programs. These indicators are gathered from a comparative perspective on the general indicators derived from innovation programs in developed countries the current University-Government and Industry (UGI) relations in countries in transition.

Governmental Indicator: "An active participant government"

As international cooperation starts at the governmental or institutional levels, a developed country (S&T body) seeks out the facilitator bodies that operate on similar basis. Successful country cases and Israel reveal the existence of administrations by which science base and productive base are integrated. They have absolutely identified ST&I bodies that are dedicated to the management of UGI relations. Thus after having an administrative reform and restructuring the S&T bodies these countries will become a more eligible partner for cooperation.

Academic Indicator: "entrepreneurial university"

The existence of a history of highly qualified academic culture and more strikingly the entrepreneurial academy of 21st Century, with the mission of economic development is the general indicators that initiate a propitious cooperation at the domestic and international levels. On the other hand, it would be imaginary to expect an attainable relation between a university with a number of independent interdisciplinary centers, and programs where the staff following the latest developments, and a university where faculty assumes basic research and education on traditional areas as its exclusive mission and can not follow the recent scientific developments. As a second point, EEC needs to reform its higher education system not only to have more industry-oriented universities but also to have internationally attractive higher education institutions.

Industrial Indicator: "science-based industry"

A significant number of technology-based industries that have the ability to integrate internal R&D, production and commercialization process with external partners are the preferable business types of knowledge-based economy. Therefore in order to be an eligible partner in international programs, CEE urgently needs to initiate a framework that encourages its industry to generate technological innovation via networking and partnership.

Work Force: "skilled human resources"

Well-educated human resources capable of developing and implementing innovation are critical national assets that attract other nations for cooperation. The CEE on the other hand with their younger and educated society demonstrates some advantages as to make cooperation since most of the European countries are suffering from ageing population and declining birth rates.

Stability of Program: "Research missions & plans"

Rather than the amount of R&D expenditure, the financial and political stability of the program are more positive indicators to initiate a successful cooperation. Additionally, if can not expand its GERD, CEE needs to convince the international participants about the stability and commitment to the measure. Innovation policy must be immune from the short-term political and interest considerations. It must be embedded into the national system and culture.

Well-defined Market: "rich consumers"

All of these programs are aimed at producing goods that have the potential for commercialization; even they may have existing markets. The forecasts of future consumer trends and needs decrease the risks of marketing. Moreover, existence of sufficient market-pull with increasing demands for the application of technology in the products is also important incentives for collaboration. While with its large young and demanding population CEE represents a good market, however the low-income rates and life standards are fading the purchasing power and people are forced to consume less technology intensive products. Therefore, CEE also needs to increase average income level, as indicated in the previous sections.

Trust-Building in Networks: "Social network"

As the literature survey and the case studies elucidate the mechanisms of innovation networks, more specifically Triple Helix system works on an evolutionary selection mechanism that is enacted by its members. In the system there is no central control dictating them what to do or not to do. Since the participants are linked through the elements of trust, cooperation and close interaction, they prefer to select those with whom they can achieve these elements and have mutual benefit. Thus assuredly, while they have inclination to select the ones who has the qualification of a beneficial partnership they have disinclination to cooperate with the ones who does not carry the characteristics that are defined as indicators for collaboration.

Network is the forum for collective learning, communication, and synergy creation. The analysis on the cases bears out that the main success of networks is based on the achievement of energy of ***critical mass***[7], establishment of trust among the members. Involvement of end-users, customers and potential networkers enable the system to have the understanding of their customers' needs (SPRU, SAPPHO Study, in WAMP, 2001). Pertaining to conditions of catch up countries the trust and reliance between neither within the industrialists nor between industry and university even to state sector is difficult to achieve. Thus the governments are obliged to assure trust among the partners and their commitment to the system; they must pledge to continue the system despite of the political instabilities.

Generally, networks are the virtual, symbolic places of cooperation embody the image of a big company. In as much as the management of a big company is hard the administration of networks is arduous and requiring concessions, trust endurance and determination. Thus, the catch-up country should persuade the potential partners based on Luzt's[8] assertion for consortia as none of the partner is calculating individual gains, but this is a matter of belief and devotion for the national competitiveness and development. It is not a win and lose individual competition, but achievement of exceptional R&D results. The impacts of networks are greater than the sum of its parts, because they are benefiting from the synergy of the system.

Historically, while capitalists-liberal economies used to cooperate between themselves, communists-socialist states used to form their networks on the other hand. Currently, however studies reveal that cross-cutting arrangements like the Triple Helix are becoming the mode of cooperation. Thus it is not illogical to assume the foundation of cooperation between countries now have the characteristics of Triple Helix in their innovation or more generally in their production system. International networking can be successfully achieved among states whose R&D programs are designed on similar base and whose potential partners not only seek the opportunities to gain, but also contribute to the system.

The aim of international cooperation is to co-development of technology rather than establishment of multinational companies or transfer of technology from one company to another. Analogous to national level, international cooperation aims the pooling of multinational resources either industrial, academic or human resources. The aim is also similar endogenization of knowledge production into the system and reduction of technology transfer costs and applicability risks of new technology products. On the other hand, not only developing countries are in need of cooperation, but also developed world needs cooperation since even if they can generate innovation endlessly, they will not be able to find innovation demanding young and rich consumers to sell their products. As a case to the point while Finland is considered the center of ICTs and cell-phones, the consumers of cell-phone are mainly from developing countries with their larger population.

CONCLUDING REMARKS

Building upon the argument presented in this paper, innovativeness and hence the economic success of enlargement of the European Union will depend on the extent and the way in which the transition countries are adapting their innovation structure to well-balanced, value added trilateral relations of university-government and industry. The EU is neither nation state nor a federation of nation states. The enlargement process should have a networking perspective. It should be achieved on the network of relations among national governments, industries and knowledge centers. The new institutional framework can be constructed on the networking principles rather than big expectation of an enlarged harmonious system. However it is my belief that the if national programs complement and compatible to each other, the achievement of networking will be much more promising than the integration of completely diversified policy plans. Therefore the knowledge-based economy provides a paradigmatic shift and opportunity for both countries in transition to harmonize their institutional structures with the European Union, and for the EU to develop a network systems against the competition coming from the US, Japan and East Asia.

FOOTNOTES

* The concept of transition countries are synonymously used with Central and East European Countries or accession countries for European Union.

[1] Laws and institutions are constantly tending to gravitate. Like clocks, they must be occasionally cleansed, and wound up and set to true time (Henry Ward Beecher life Thoughts, 1858).

[2] These features have not covered enough due to the lack of data. It is the hope of author to complete that part soon.

[3] The ranking of these countries are taken from the World Competitiveness Handbook in Dodgson, 2000. The list is attained through the national and international surveys in which the respondents were asked whether technology transfer between companies and universities are sufficient, and whether technological cooperation between firms is common or lacking.

The complete lists of Tables showing all these cross national data are attached as appendix.

[4] For a further qualification for eligibility, as while higher rates of BERD and lower rates of GOVERD signify the trends of developed countries (OECD, 1999) the countries with relatively higher BERD and lower GOVERD are preferred over the others as to underline the developed country trends.

[5] The selection and classification of these countries and their programs are based on authors' previous and current research on the comparative analysis of national innovation systems.

[6] i.e. The "Second serfdom, stagnation, weak bourgeoisie, having no state of their own or independence, having to survive communism" and Roman Catholic, Greek Catholic and Orthodox which showed greater passivity, fatalism, distrust towards change and focus on religious made CEE countries follow a different path.

[7] The amount of substance that is needed for a nuclear chain reaction to take place.

[8] Chief of Crysler and partner of Crysler-Ford-General Motors consortium.

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APPENDICES

Table A.1

Country	GERD $	% of GDP on R&D	% of GOVERD	% of BERD
Israel	–	3.6	30.40	60.40
Australia	N.A	1.4	47.80	45.00
Belgium	5,025.4	1.8	24.90	69.40
Canada	14,727.0	1.6	31.20	49.30
Czech Rep.	1,751.0	1.2	42.60	52.60
Denmark	2,968.9	2.0	36.10	53.40
Finland	3,752.0	3.1	30.00	63.90
France	29,239.9	2.0	40.20	50.30
Germany	47,573.6	2.3	33.80	63.60
Greece	1,084.3	0.5	53.50	21.60
Iceland	170.0	1.9	51.20	41.70
Ireland	1,083.8*	1.4	22.20	69.10
Italy	13,830.0	1.0	51.10	43.90
Japan	95,084.0	3.0	19.30	72.50
Korea	18,543.0	2.4	22.90	72.50
Netherlands	8,394.8	2.0	37.90	48.60
New Zealand	752.1	1.1	52.30	30.50
Norway	2,140.2	1.6	42.90	49.40
Portugal	1,268.7	0.6	68.30	21.20
Spain	6,375.1	0.9	38.70	49.80
Sweden	7,755.5	3.5	25.60	68.80
Switzerland**	4,867.6	2.7	26.90	67.50
Turkey	2,635.9	0.49	53.70	41.80
U.S.	197,830.0	2.3	29.20	66.80
UK	22,467.0	1.6	375.60	47.30
EU-15	157,641.0	1.82*	36.9	54.1

Table A.2

Company-University Cooperation		Company-Company Cooperation
Country	Ranking	Country
Finland	1	Finland
Singapore	2	Israel
Israel	3	Japan
Netherlands	4	Germany
Switzerland	5	Denmark
Sweden	6	Singapore
USA	7	Sweden
Canada	8	Canada
Ireland	9	Iceland
Denmark	10	Taiwan
Australia	11	Netherlands
Taiwan	12	Switzerland
Germany	13	USA
Norway	14	Luxembourg
Iceland	15	Norway
Belgium	16	Australia
Colombia	17	Ireland
New Zealand	18	New Zealand
Austria	19	Belgium
United Kingdom	20	Austria
Hungary	21	Malaysia
Hong Kong	22	France
China	23	Hong Kong
Malaysia	24	Hungary
South Africa	25	China
Japan	26	United Kingdom
France	27	Russia
Russia	28	Spain
Luxembourg	29	Slovenia
Philippines	30	Poland
Chile	31	Czech Republic
Spain	32	Greece
Czech Republic	33	Italy
Greece	34	Philippines
Brazil	35	South Africa
Turkey	36	Brazil

Table A.2
(nastavak)

Company-University Cooperation		Company-Company Cooperation
Country	Ranking	Country
Korea	37	Chile
Portugal	38	India
Italy	39	Turkey
Thailand	40	Argentina
Poland	41	Mexico
Argentina	42	Venezuela
Mexico	43	Portugal
India	44	Korea
Indonesia	45	Thailand
Slovenia	46	Indonesia
Venezuela	47	Colombia

Dr Željka ŠPORER

Senior Research Fellow
Centre for Innovation and Development
University of South Australia
E-mail: zeljka.sporer@unisa.edu.au

KNOWLEDGE-BASED ECONOMY AND SOCIAL CAPITAL IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

INTRODUCTION

Daniel Bell (1973) developed the concept of the post-industrial society. His notion was that after modernisation and industrialisation, the most developed societies would move into the next stage of development. This next stage is characterised by a change in the basic production structure, from industry to the tertiary sector, or a so-called process of de-industrialization. The main empirical indicator for the transition from one stage to another, used by Bell, is the employment structure. When employment in the service sector outnumbers employment in industry sector, the economy is seen to be entering the post-industrial stage. In such a system, knowledge is replacing capital, innovation is replacing tradition, and ideas are replacing manual work as the main sources of power and economic growth. The notion that capital is replaced by knowledge as the main source of growth and power gave rise to the idea of the "knowledge based economy". This is an economy where knowledge is the predominant resource, much in the same way that capital previously replaced land as the power source in the transition from the pre-industrial to industrial phase; knowledge is now replacing capital in the transition from the industrial to post-industrial. In his later works, Bell speaks of the "information society" instead of the post-industrial society, but the basic idea remains essentially the same. The reason why the concept of information society is now so widespread lies in the phenomenal expansion and economic importance of information technology and its application in all sectors of the economy and society.

The information society means, not only a shift in the dominant sector, but also a change in the demand for workers who are highly skilled and well educated. The majority of newly created jobs in developed economies are knowledge based and most of them are in the service sector. Green et al. (1998) found that in the UK, between 1986 and 1997, the average levels of work skills required had increased, as had the usage of skill. Consequently, the proportion of jobs that required only short training periods decreased. The structure of labour demand (Gera, 1996) has shifted in favour of skilled workers and workers with higher skills enjoy higher employment rates. Employment growth is increasingly related to the use and production of knowledge (Gera, 1996) and the direction of employment in all sectors is shifting toward knowledge.

The other significant change is happening in the labour market and in the nature of employment. There is a tendency towards increased part-time, casual employment and a loss of job security in general. Globalisation and competitiveness are placing increasing pressure on businesses, which spills-over into pressure for a more flexible workforce. The nature of these tendencies was not predicted by the theories of post-industrialism and the information society. These theories reflected the optimism of a liberal ideology and its belief in continuous progress. The change in labour market is acknowledged as the key argument behind the claim that post-industrial and information societies are only a new stage of the capitalist development. Knowledge is not a new power resource but simply a new element in the production for profit. Although the neo-Marxist theorists did not develop their own theories of post-industrialism (post-Fordism comes closest to it), they insist that we cannot speak about a new type of society and economy, only about a new stage of capitalist development. The best framework for understanding the changes in the labour market, and the changes in the nature of work, are still profit maximization and labour-capital relations.

The information economy is changing the predominant content of work (Won-Ki, 2001). The life cycle of jobs is shortening and the demand for permanent learning becomes required. In addition, higher-level skills such as problem-solving capabilities, communication, social skills and computer skills are increasingly required in contemporary organizations (Green et al., 1998). These skills, as well as capabilities for permanent learning, rely heavily on the educational system for support. The general educational level of a society is becoming an important element of that society's human capital.

Consequently, other institutions have responded to the demand emanating from the economy. Of course, the feedback mechanism is also present because when educational institutions started to expand they started to create demand for education in its own right. Educational institutions started to expand the number of programs offered on all levels, and the number of students enrolled increased significantly. Permanent learning and training programs have become a constituent part of business organisation and educational institutions. Educational institutions promote knowledge and push towards a more knowledge-based society. Business organisations rely on knowledge and also advance the creation of the knowledge-based society. We are now facing an explosive increase in knowledge emanating from the educational and research institutions, from corporations and businesses, and from their joint cooperation. This knowledge base has a tendency to double in a shorter and shorter time (Won-Ki, 2001).

Universities and R&D are basic institutions for knowledge production and innovation through scientific research, transmitted through education and training, and disseminated through information and communication technology. In an economic context Evans, Carter and Koop (1990) defined innovations as the transformation of existing knowledge and ideas (inventions) into new or better commercial products that add value to the customer. Consequently, the basic institutions for knowledge implementation and commercialisations are businesses. The relationship between universities, R&D, and businesses has been described in the context of the western market economy as a balance between science-push and market-pull factors (Muller and Etzkowitz, 2000). In economic terms, it is a market model based on forces of supply and demand. The traditional separation of the institutions of higher education and business has started to change. Relationships between businesses on one side, and universities on other side, are becoming closer and more interdependent. Universities, once the citadel of the detached and abstract research, who scorned mundane business activities, are becoming more and more entrepreneurial (Etzkowitz, 2000, 2003). On the other hand, businesses have started to educate their labour force and conduct their own research. The third partner in this relationship is government, the resulting triangle has been described as a triple helix model (Leydesdorff and Etzkowitz, 2001) in which all three institutions reinforce each other in an effort to promote knowledge and innovation and stimulate economic growth.

It has become obvious that knowledge and skills are central and that economic growth and value-adding activities increasingly rely on innovative capabilities. Knowledge and innovation are becoming critical for job creation. From an economic perspective, it can be said that a *knowl-*

edge-based society is a system where knowledge capital and innovation starts to play a dominant role in the national economy.

DRIVING FORCES IN THE KNOWLEDGE-BASED SOCIETY

The main forces driving a knowledge-based society are the interaction of two main processes. On the one hand, there is a contextual change for the operation of modern societies and economies, commonly called globalisation. The process of globalisation and on the other hand the new information and communication technology operates as a drivers for the full utilisation of the innovation of our age.

Globalisation, in general, is a concept that reflects societal change in the modern world, from the isolation of human societies towards a prevalence of interaction among them. Globalisation, from an economic perspective, can be defined as a process of converting the relatively separated (sometimes isolated) national economy into a more integrated, more open world economy. Although the process of globalisation can be observed through history, it has accelerated immensely in recent times. The historical dimension of globalisation is emphasised by some authors who speak of "globalisation waves". Goran Therborn (2000) thinks that the first wave of globalisation started with the spread of global religions and then continued through European colonisation, intra-European power struggles resulting in warfare for global domination, continuing further through imperialism based on bulk trade, trans-oceanic migrations and faster means of transport and communication. The fifth wave of globalization started after WWII and was based on the declining costs of transport and communication but was impeded by the global rivalry expressed in the Cold War. The last and present wave of globalization is the result of the nexus and mutual reinforcement of the rise in information and communication technologies, and the removal of obstacles based on the capitalist-communist divisions. This process intensified competition among businesses on a local, national and global level. It boosted trade export orientation by offering attractive conditions for foreign direct investment, and by promoting privatisation, rationalisation and global freedom of enterprise (McMichael, 1996). It has opened borders for all types of interactions. This openness stimulates more creativity and innovation. The operations of global markets are restricting inherent tendencies for monopolistic behaviour. The prevailing culture of neo-liberalism is encouraging anti-trust actions on the side of governments that further erode the capacity of the big players in monopolistic behaviour, as is evidenced in the current developments around Microsoft.

New information and communication technology (ICT) is regarded as a major source of economic and social change in recent years, and it has made globalisation possible in every respect. It has allowed companies to operate (produce and trade) globally. One dimension has been the opening of global financial markets, thereby creating the possibility of instantaneous transfer of funds around the world. This new technology has opened the flow of information, enabling a tremendous increase in the speed and transfer of all types of information, knowledge and innovation. (National Science Foundation, 1999) Electronic commerce has tremendous impact on how firms do business. Increased use of information technology (IT) is not only limited to the business enterprises, but also to government, science and technology, R&D, innovation, higher education, and the general public. A good deal of government information and activities are being made available on-line. The implications of IT for science and engineering are tremendous. Most notably, its potential can be seen in its capability to use more modelling and simulation in experimentation, the management of large databases that help improve performance in all area of research, electronic version of journals, and more collaboration between scientists, rapid innovation, and distance learning. Knowledge-innovation backed up with ICT has become the driving force of economic growth and job creation. Because ICT has played such a central part in the debate on the new knowledge-based economy, an immense effort has gone into the development of measurement indicators of these new phenomena.

COMPARATIVE ANALYSIS BETWEEN SOME CEEC AND EU COUNTRIES

This paper focuses on Central and Eastern European Countries (CEEC) or former communist countries. Its first aim is to do a "diagnostic study" to find out how much CEECs are lagging behind in the key dimensions that constitute knowledge-based societies. Our purpose is to diagnose the main aspects, and the size of the existing gap between CEECs and the Western economies, whose standards and practices they want to emulate.

CEECs have suffered in varying degrees from isolation from the globalising trends of the Western economies. Isolation, and the self-contained nature of the centrally planed economies of this region, has prevented them from participating in the global process of economic integration. Globalisation processes, that first accelerated in the 1970s when international corporations started to relocate their factories to areas of low wages (Frobel, Heinrichs and Kreye, 1980) around the world and contributed to the international division of labour, left those countries out of this process.

We witnessed the disparate processes in the Western and CEEC economies after the fall of communism in the late eighties. The speed of change resulting from globalization trends and increases in living standards accelerated in the Western economies. The same could not be said for the CEECs. Expectations about the full and speedy "catch up" with the West were not fulfilled. The aging industries and non-existing institutional infrastructure did not allow these economies to start successful integration without a slow, erratic and painful restructuring process. The collapse of the COMECON structure, for example, left these economies without foreign markets and because of the shabby quality of their products, they were not able to reorient themselves within the Western markets.

The previous institutional structure was inadequate; it did not support the transformation toward markets and openness, even in the relatively more open economies. The goal of building the new institutions was imperative amidst the deep transformation crisis. The problem was also that the "end of the tunnel" was, and is not, quite visible. The period of "building of communism", where the present sacrifices were made in the name of a better distant future, has been replaced with the "building of capitalism", where again the present sacrifices are made in expectation of a better distant future. The generations to whom the better future was promised, for their whole lives, are now again faced with the same promises. In such situations a political backlash is inevitable. The situation has been aggravated by wars in some of these countries including the former Yugoslavia and the Caucasus region of the former USSR.

We can summarise that the CEECs are faced with the legacies of their isolation from the globalising trends of the world economy. They are also, to a large extent, unable to fully participate in present developments because of their preoccupation with institutional restructuring. The big question is whether the technological gaps that have existed are closing, or whether they are continuing to widen as the result of all of these processes.

We can argue that some of the peculiar characteristics of communist industrialisation are not automatically an impediment for the transformation into market and open economies. Furthermore, some of these characteristics could be seen as assets in the transition process. Compulsory education resulting in high enrolment rates and policies aimed at equal positioning of women has created a labour force with great potential for fulfilling the requirements of a knowledge based economy. At the same time, the much lower technological sophistication of these economies is a constant obstacle for the more complete adoption of the standards and operational methods of Western economies.

In this study, a sample of EU countries and CEECs is used for comparative purposes. However, within the EU countries there is also a different level of development. Northern Europe is more developed than southern Europe. Taking the dimension of the macro-region (north-south) and the political-economic legacy (CEEC and EU) the sample of the countries compared in this study is as follows:

	CEEC[1]	EU
Southern Europe	Croatia Slovenia	Greece Spain
Northern Europe	Hungary Poland Slovakia Russian Fed. Estonia	France Ireland Denmark Finland

Five groups of indicators that identify the level of development of the knowledge-based economy and society are examined:

- The first is employment: by major economic sectors, employment changes over previous year, unemployment levels, particularly youth unemployment.
- The second group of indicators are: higher education enrolment, higher education graduates, and share of GDP going towards education. EU member-states aim to spend at least 5% of GDP of public expenditure on education in general (Commission of the European Community, 2003). It is important to examine whether CEECs match this standard.
- The third group are indicators of R&D capabilities: the number of researchers, investment in R&D (R&D expenditure as percentage of gross national product), source of funding for R&D, and performance of R&D measured by the number of patents and publications.

The last two indicator groups directly reflect the characteristics of the knowledge-based economy:

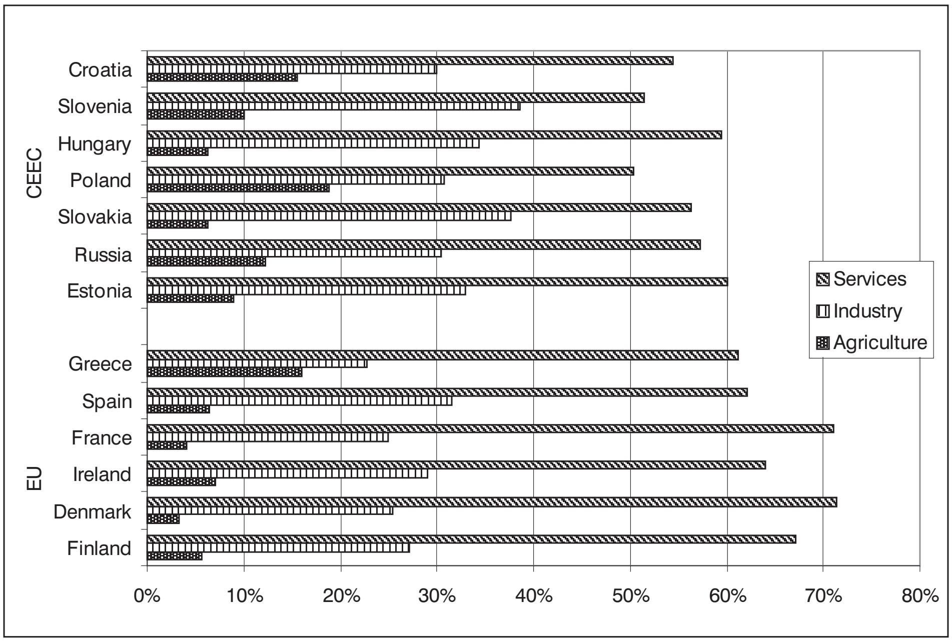
- Globalisation can be measured through indicators such as imports, exports, (particularly high tech exports), foreign direct investment, membership of international organisations, and migration rates. These indicators measure the involvement of each country in the global economy and its participation in international institutions. In the open economy, trade involves the trading of goods and services and also the free migration of people.
- Communication and information technology is a key dimension because it opens up an economy and society to new influences and information flows. This can be measured using indicators such as the number of phone lines, penetration of mobile phones, numbers of personal computers per capita, and Internet usage.

Model of analysing Knowledge-based society

The 17 indicators can first, reveal the differences that exist between the developed north and less developed south of Europe, as well as between EU countries and CEECs, which is our primary aim. Second, and probably more important, they can reveal the extent to which these countries reflect the shape of a new knowledge based economy or whether they are retaining characteristics of the old economy. "In the New Economy, a state's economic success will increasingly be determined by how effectively it can spur technological innovation, entrepreneurship, education, specialized skills, and the transition of all organizations, both public and private, from bureaucratic hierarchies to learning networks" (Atkinson, Court and Ward, 1999:4).

Employment structure

Graph 1 show that the employment structure in CEECs is similar to EU countries. Most employees work in the service sector, rather than in industry, and only a small minority are employed in agriculture. However, the relationship between these three sectors is different: in EU countries, a higher percentage of employees work in the service sector (on average 66.1%) and in CEECs the average is 55.6%. In industry, EU countries have less than 26.8% of the employed population and CEECs more than 33.54% are employed in industry %. In agriculture, EU countries employ only 7.06% of the workforce, whilst CEECs employ 11.1%.



Source: UNECE Statistics. Trends in Europe and North America 2003 Statistical Yearbook of the UN/ECE, http://www.unece.org/stats/trend/trend_h.htm

Graph 1
Employment structure

Average employment by major economic sector in 2001

	Agriculture	Industry	Services
CEEC	11.1%	33.5%	55.6%
EU	7.1%	26.8%	66.1%

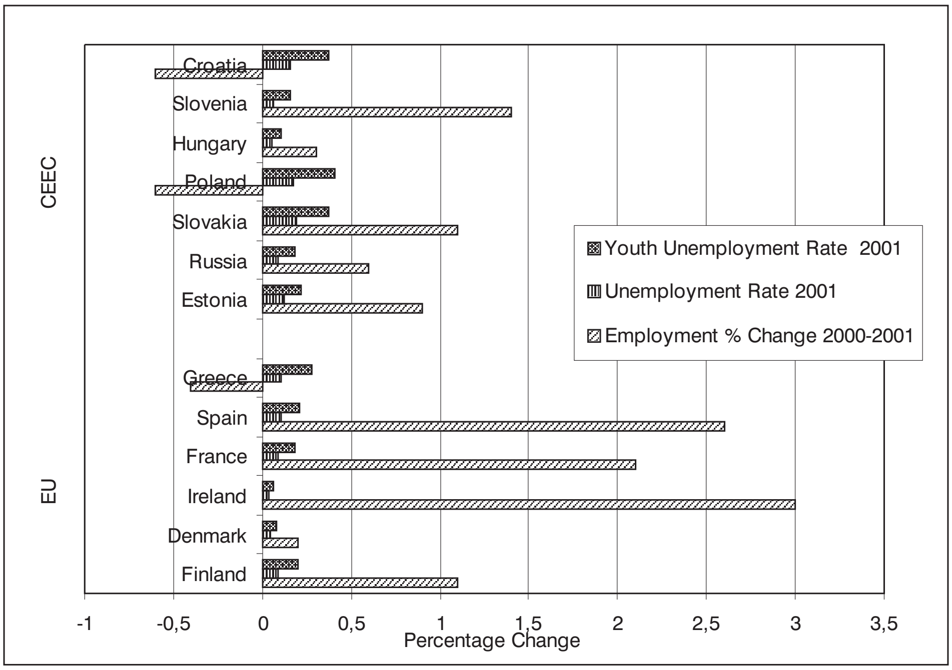
The relationship between sectors of production is the same in EU countries and in CEECs. The CEECs have an employment structure with relatively stronger representation of industry and a more modest shift toward services. EU countries show an employment structure with services more represented, which is typical for a post-industrial economy. From this we can conclude that the employment structure indicates a modest gap between CEECs and Western Europe. All of the employment structural indicators are pointing toward a post-industrial structure with Western Europe being "a step" ahead.

Employment – unemployment indicators

Employment indicators show the dynamic and the direction of change within economies. They indicate whether an economy is growing steadily and generating new jobs, if it has a slow rate of growth, or is stagnating.

Ireland shows the healthiest picture of economic development among EU countries with the highest relative creation of new jobs, lowest unemployment rate and lowest youth unemployment. Greece and Spain are showing higher than EU average unemployment rates and higher youth unemployment rates. The CEECs closest to the EU averages are Hungary and Slovenia, while Croatia and Poland are showing negative to slow employment growth, very high unemployment rates and extremely high levels of youth unemployment.

Graph 2
Employment indicators



Source: UNECE Statistics. Trends in Europe and North America 2003 Statistical Yearbook of the UN/ECE, http://www.unece.org/stats/trend/trend_h.htm

Employment-unemployment indicators average for CEEC and EU

	Employment % change over previous year 2001	Unemployment rate (%, 2001)	Youth unemployment (%, 2001)
CEEC +	0.44%	12.2%	26.1%
EU +	1.43%	6.2%	18.2%

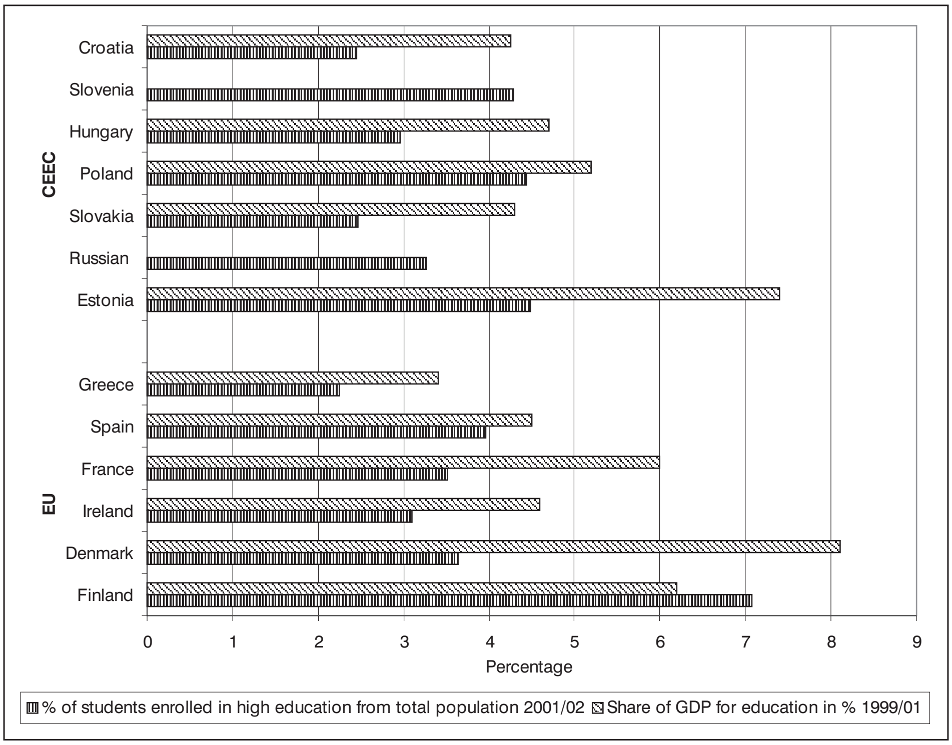
CEECs have, on average, 0.44% higher employment rate than in the previous year, a 12.21% unemployment rate that is twice as much as EU countries and a 26.07% youth unemployment rate. EU countries have an employment growth rate of 1.43% that is almost three times the highest of the rates for CEECs and a 6.21% unemployment rate with a rate of 18.18% for youth unemployment.

It is clear from this data that the EU countries are showing much higher economic dynamics, and are significantly outperforming CEECs.

Educational indicators

Educational structure is certainly one of the most important indicators of a knowledge-based society. One of the indicators telling us most about the shift of the economy in the direction of the knowledge base is the number of students enrolled in higher education. Only an educated population with a high knowledge capability can respond to future economic challenges and be innovative. In the EU, one quarter of all those aged 30-34 had a tertiary education qualification in 2000 (European Commission, 2002), which represents significant human capital. The more students we have now, the more knowledge based the society will be in the future.

Graph 3
High education enrolement and share of GDP for education



Source: See sources in Appendix Table 2

Graph 3 shows that in CEECs, enrolment in higher education ranges from 2.45% of total population (in Croatia) to 4.49% (in Estonia). In EU countries the range is from 2.25% (in Greece) to 7.06% (in Finland). On average, the rate of student enrolment in higher education is similar for both groups of countries: 3.47% for CEEC and 3.92% in the EU. Similar ranges can also be seen on the financial side. The shares of GNP spent on public education are, on average, CEECs 5.15%, and EU 5.45%.

Average higher education enrolment and share of GDP spent on education

	% of population enrolled in higher education	% of GDP for higher education
CEEC	3.47%	5.17%
EU	3.92%	5.46%

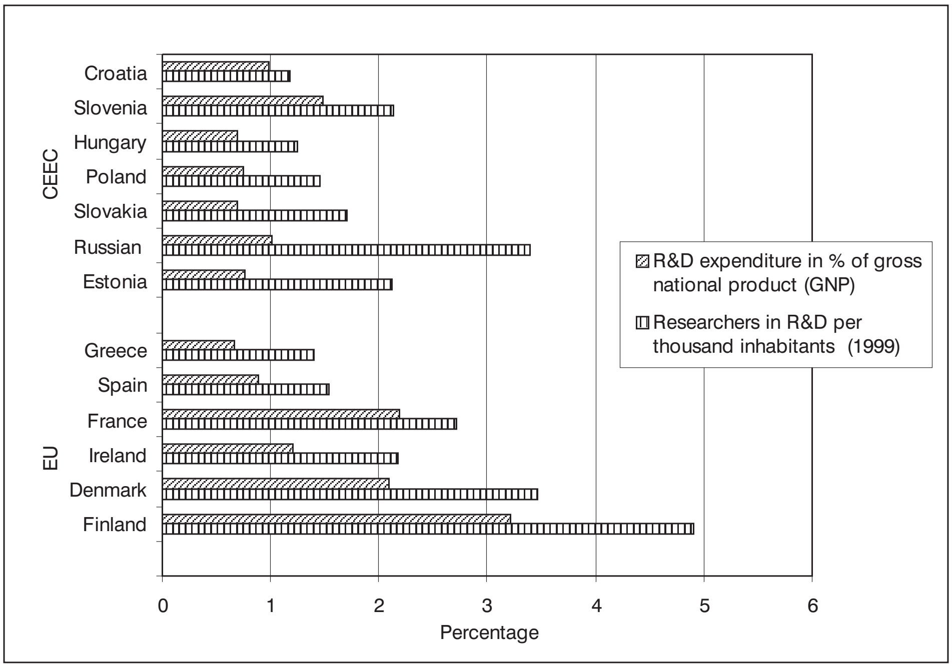
In this respect, the difference between the European north and south is bigger than the difference between EU and CEEC. Furthermore, these findings support the hypothesis that communist systems have emphasised the importance of education and that these efforts have left residual effects, even today. As a consequence, the CEECs are not lagging behind EU countries in respect to educational indicators. These findings tell us that a number of prerequisites for the introduction of a knowledge-based economy are present in the CEECs and that not everything needs to be built from scratch. Although these indicators do not tell us much about the quality of that education, the quantitative base is present and ready to be used in any economic transformation.

Research indicators

Research capabilities

Research capabilities are the engine for producing new knowledge, implementing it, and in general, pushing the boundaries of innovation further. Creation of new jobs depends more than ever on innovation processes. The numbers of researchers (per thousand inhabitants) in R&D organisations and the proportion of GNP spent on R&D indicate the capacity of a nation to innovate.

In CEECs the number of researchers per 1000 inhabitants is between 1.25 in Hungary and 3.39 in the Russian Federation. The Russian Federation inherited huge number of scientists and researchers from S&T institutes and that number still shapes its research structure. In the EU countries, the lowest number of researchers per 1000 people is in Greece (1.40) and the highest is in Finland with 4.91 per 1000.



Source: Institute for Statistics, UNESCO, http://portal.unesco.org/uis/ev.php?URL_ID=5218&URL_DO=DO_TOPIC&URL_SECTION=201

Graph 4
Research indicators

Average researchers and expenditure on R&D in 1999

	Researchers in R&D per thousand inhabitants	R&D expenditure, % of GDP
CEEC	1.89	0.90
EU	2.70	1.71

On average, the ratio of researchers per 1000 inhabitants in EU countries is higher than in CEECs (2.70: 1.89). We can assume that this higher ratio does not reflect any deliberate government policy but rather, that it is largely a reflection of the market forces of supply and demand. The fact that businesses see the usefulness of R&D means that they more readily finance it. In this way, the high ratio reflects the "nature" of the knowledge based society, where spontaneous market forces produce such a high representation of researches. On the other hand, the number of researchers in the planned economies of the CEECs reflects the priorities of the planning centres, rather than emanating from the direct needs of the economy.

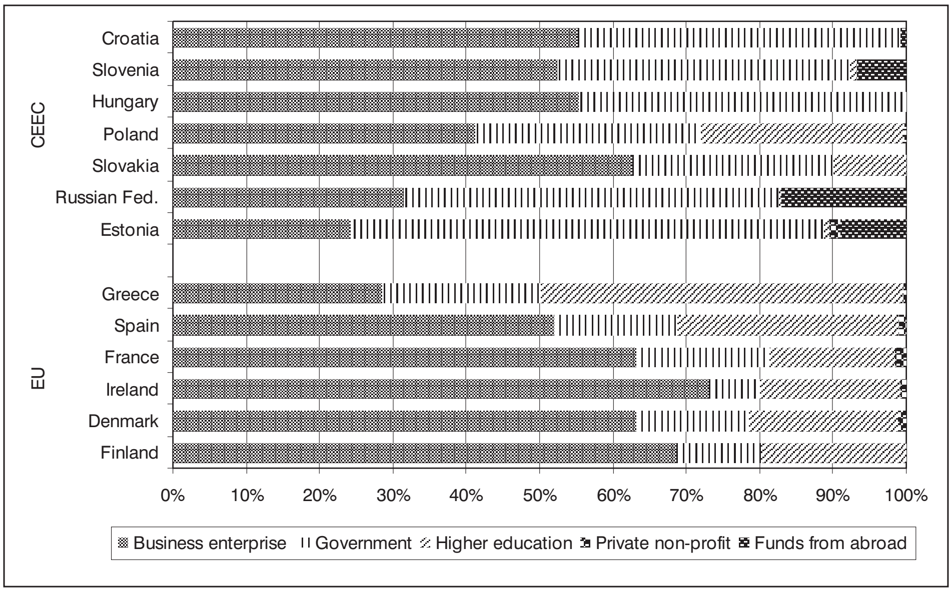
The proportion of GNP spent on R&D in CEECs ranges from 0.69% in Hungary to 1.48% in Slovenia. In EU countries, the range is from 0.67% in Greece to 3.22% in Finland. Within the EU there is a large difference in investment and number of researchers. "The Nordic countries Finland, Sweden and Denmark are best prepared and rapidly turning their economies into knowledge-based economies" (European Commission Research 2002:10). At the other extreme are Greece and Spain which have much lower spending on R&D than is the EU average. The average investment for CEECs is 0.90% of GNP compared to 1.71% in the EU. These findings indicate that there is potential for widening the gap between the EU, and that EU countries have higher development capabilities than their CEEC counterparts. Despite this, it must be noted that EU countries themselves are lagging significantly behind the USA and Japan.

Research funding

The next important question is who finances R&D. The source of R&D funding can come from business, government, higher education, private non-profit organisations, and funds from abroad. The way in which R&D is financed indicates the role that different actors play in society and the type of relationships between them. The dominant actors are the triangle of government, business, and higher education; the relationship between them is described in the form of the triple helix model (Leydesdorff and Etzkowitz, 1998).

In the context of this model, we shall try to identify any differences between the EU countries and the CEECs. The main characteristic of the CEECs is in the dominant role of the government in shaping every activity in society and the absence of market forces and business initiatives. It can be expected that in these countries the government is still the primary source of financing for R&D activities.

Graph 5 unveils different funding patterns for R&D activities. In the majority of CEECs analysed here, the business sector is the dominant player in R&D investment. In Croatia, Slovenia, Hungary, Poland and Slovakia, business investment is greater than government funding. In the Russian Federation, as well as in Estonia, governments invest in R&D substantially more than the business sector. The legacy in these countries is a strong S&T system traditionally financed by the government. This pattern still exists, and combined with the large number of researchers and scientists in these countries, means that it will take time and a huge effort to reorient these human resources (Muller and Etzkowitz, 2000), with the accumulated scientific knowledge, into an entrepreneurial force. They were traditionally oriented toward the government and not towards market demand.



Source: Institute for Statistics, UNESCO, http://portal.unesco.org/uis/ev.php?URL_ID=5218&URL_DO=DO_TOPIC&URL_SECTION=201

Graph 5
Sources of R&D funding

The only CEECs where the higher education sector invests significantly in R&D are Poland and Slovakia. Funding from abroad is substantially present especially in Russia and Estonia, and on a smaller scale in Slovenia and Croatia.

In the EU countries, the pattern of R&D is different. In all EU countries (except Greece) business enterprises are by far the most dominant investors in R&D. They are then followed by higher education, and to a lesser degree government investment. Private non-profit organisations do invest, but on very small scale.

The sources of funding indicate the existence of at least three financing models. The first model begins with business enterprises as major investors in R&D, followed by higher education, and the government. Countries having this model spend a higher percentage of GNP on R&D than countries practising other models. We can hypothesise that this model emphasizes or reflects the close connection of industry and research, and that this research is directly oriented to serving industry, producing innovations and focused toward the commercialisation of knowledge. Countries that practise this model are Spain, Ireland, Denmark, and Finland. The average spending on R&D is 1.85 % of GNP. Obviously, this model is practised in the most developed knowledge-based economies. This means that we can expect that with development, the emphasis in financing R&D will shift more and more toward the business sector and higher education, and the role of the government will diminish in importance.

The second model is where the dominant actors are business and the government. This model is characteristic of societies where governments traditionally played an important role, and continue to support and invest in R&D, but where business enterprises are also becoming increasingly important. The countries practising this model include Croatia, Slovenia, Hungary, Poland and Slovakia. The average spending on R&D is 0.91% of GNP.

The third model is characterised by government domination of investment in R&D. The gap between the government and business is large, with business lagging far behind government investment. This pattern is vivid in the countries with a heavy legacy of central planning and direct government control over all activities. Although countries using this model have a relatively high number of researchers, they are heavily dependent on government funding. Therefore it is difficult to expect that the business sector can replace the government any time soon. The average spending on R&D in these countries is 0.88% of GNP.

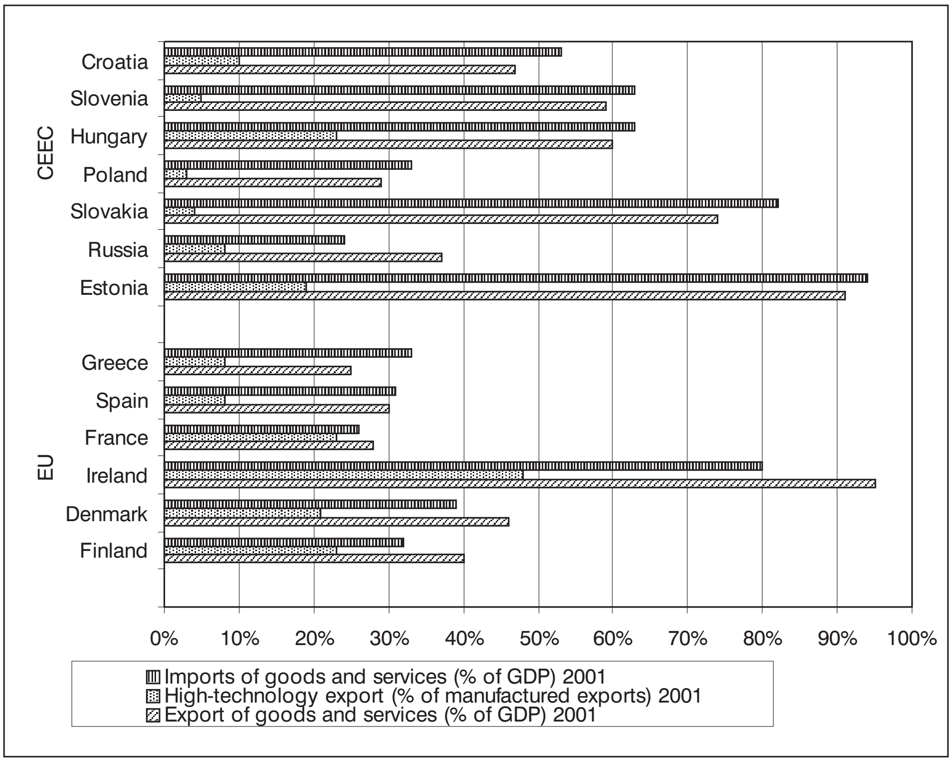
Economic globalisation indicators

Trade

Economic globalisation means openness measured by tariff reduction and removal of trade barriers for goods and services, free flows of investment, speculative capital and people. Greater openness for trade indicates a country's increased integration into the world economy, and consequently its participation in the globalization process.

Graph 6 reveals several important features of trade patterns. It is obvious that different countries within both groups have different volumes of trade. Russia and Poland trade less than other CEECs, which indicate that they are less open and less integrated into the world economy. Russia exports more than it imports, whereas in Poland the reverse applies. The other CEECs trade significantly more and their main characteristic is that they import more than they export.

The trade level of EU countries is generally lower that that of CEECs. Only Ireland matches the trade levels of Estonia, Slovakia, Hungary, Slovenia and Croatia. Other EU countries have lower levels, similar to Russia and Poland. Greece and Spain trade less, and import more than they export, while other EU countries are exporting more than they are importing.



Sources: World Development Indicators Database

Graph 6
Trade indicators

Combining two dimensions; level of trade and the import/export ratio, we produce four major types. Trade level is measured by exports and imports in relationship to GDP where high indicates that imports and exports comprise more than 50% of GDP and low indicates a ratio of less than 50%. The second dimension is based on the relationship between the levels of export in relationship to the level of imports.

Import-export balance by level of trade

		Exporting more than importing	Importing more than exporting
TRADE	*High*	Ireland	Estonia, Slovakia, Hungary, Slovenia, Croatia
	Low	Denmark, Finland, France, Russian	Greece, Spain, Poland

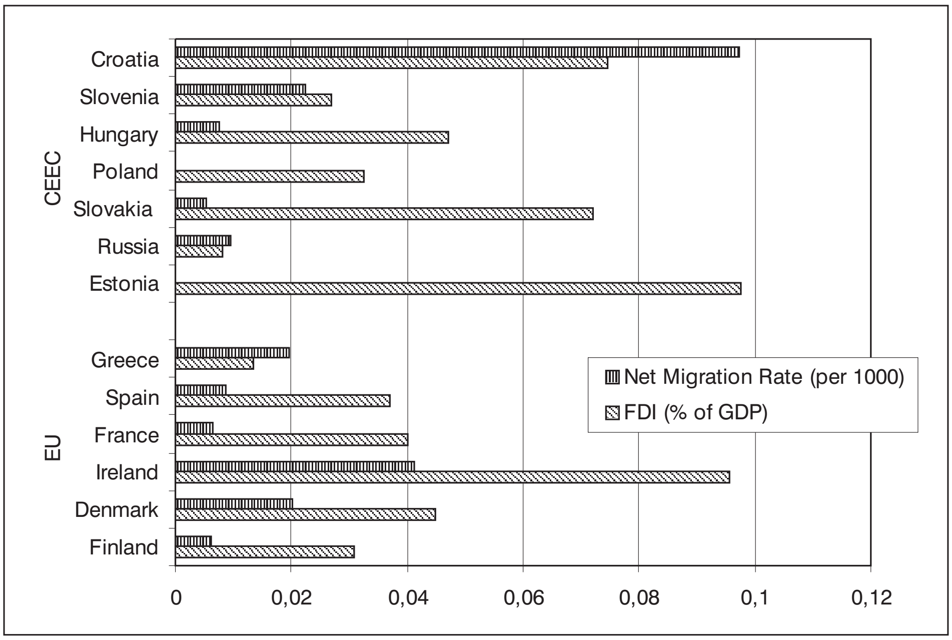
Surprisingly, most of the CEECs have a high trade level, which indicates that they have high openness toward the world market. But this openness is more in the direction of dependency because they import more than they export. The only exception is Russia, which continues its trend from the communist period of high exports but remains relatively closed against world markets. This has been possible because of the size of the Russian economy and its heavy reliance on the export of raw materials.

Foreign direct investment

Countries with a high FDI as a percentage of GDP are Estonia, Ireland, Croatia and Slovakia. All of these countries also have also high levels of trade. The countries with lower FDI rates are the Russian Federation, Greece, Slovenia and Finland. These countries also have lower rates of trade. The other countries are located in the middle with a modest FDI.

Foreign trade and FDI are obviously correlated. All of the CEECs have successfully opened their economies and are becoming attractive destinations for investors. The FDI Confidence Index (A. T. Kearney, 2003) reveals that Central and Eastern Europe achieved higher levels of FDI in 2002, and in the first quarter in 2003. Countries like Slovenia, Romania, Baltic States and Croatia are "little tigers" of Europe because investors are increasingly optimistic about investing there. The problem is that they are still not fully participating in the world economy, which is clearly indicated by their heavy import dependency. The extent to which this is just a transitional phase remains to be seen.

Graph 7
FDI and migration indicators



Source: World Development Indicators Database, CIA – The World Factbook 2002

Migration

A constituent element of openness is the free flow of people and a flexible labour market. Both of these elements are prerequisites for a healthy economy and economic growth. One of the main advantages of the US economy is its openness and high level of immigration, combined with a flexible labour market and the willingness of people to move to where jobs are available. Europe has a rigid labour market, and much more limited openness toward immigration. The reasons for a much more limited intra-European migration may be the language differences combined with lack of co-recognition of education qualifications. All of this, combined with strong nationalistic feelings, means that national borders play an important role. Those problems are well recognised in the EU (Commission of the European Communities, 2003) and policies toward openness are recognized as a necessary precondition for the creation of a future European knowledge based society.

The data in Table 4 (see Appendix), which are the estimates for 2002, indicate that Croatia has the highest migration rate: 9.72 per 1000 inhabitants. High migration is a consequence of political and economic conditions in neighbouring Bosnia, combined with the legacies of nationalist policies and war. It is not the result of a healthy economy or the markets demand for a workforce. Croatia has a very high unemployment rate. It is important to note that there is no language barrier, nor problems with recognition of educational qualifications between Croatia and Bosnia. The migration of Croats and Muslims from Bosnia and Herzegovina has been easy and was, on the one hand forced by the war, and on the other encouraged by the nationalist policies of the former government. Countries relatively open to migration are Ireland (4.12%), Slovenia (2.24%), Denmark (2.01%) and Greece (1.96%). Other countries have migration rates below 1%. Poland and Estonia have negative migration rates because more people are moving out than in.

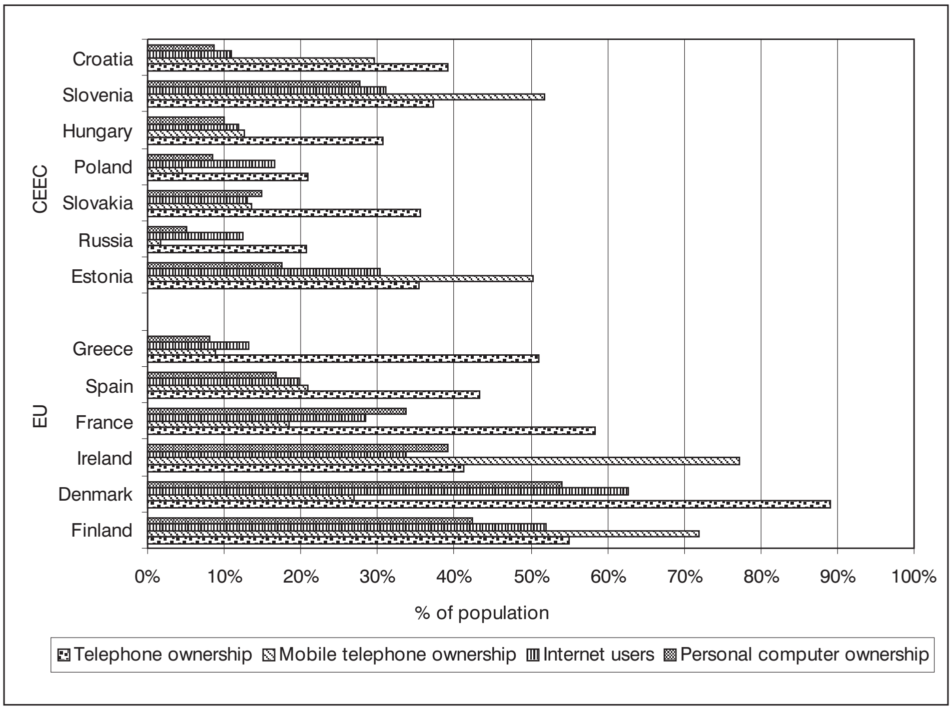
Membership in international organisations

Globalisation is not limited to the economic sphere it also has a political dimension. Today we are witnessing a mushrooming of the number of international organizations with more and more spheres of governance penetrated by them. Formal membership in these international organizations is one important indicator of the level of participation, by a particular country, in globalization. The data uncovers some simple membership patterns (see table 4 in Appendix). The countries that emerged as successor states from the disintegrating federations such as the Soviet Union, or Yugoslavia, are less present as members of international organisation, than the countries that have had continuous independence recognized internationally. Consequently, Slovakia, Slovenia, Croatia and Estonia have lower membership rates of international organisations than other countries. However, we should not read too much into this information. Presumably, in due course, these countries will "catch up" and achieve the same membership rate as the most established independent countries. There is no reason to believe that this information tells us anything other than the longer period of the existence as independent actors in the international system mean higher membership.

Information and communication technology indicators

Graph 8
Information and communication technology indicators

The other dynamic forces of change in contemporary societies are the development of information and communication technologies.



Sources: World Development Indicators Database, CIA – The World Factbook 2002

Every EU country has more telephone lines per person than any of the CEECs. The percentage of population connected to the traditional phone lines ranges from Denmark's 89.13% to Ireland's 41.20%. The average for EU countries is 56.31%. CEECs have a significantly lower rate of population connection. The highest is in Croatia (39.2%) and the lowest in Russian Federation with 20.69%. The average rate is 31.42%. The data in this field could be misleading because of the rapid increase in the number of people connected since 2001. The most recent data for different countries is not available for the same year, this alone could account for some observed differences.

The fastest expansion in communication is in the area of mobile phones. Because of the low infrastructural requirements and high market demand, their expansion has been extremely fast. The highest percentage of people having mobile phones occurs in Ireland (77.26%) and Finland (71.93%) followed by two CEECs, Slovenia (51.74%), and Estonia (50.22%). The Russian Federation (1.72%) and Poland (4.61%) are seriously lagging behind other CEECs and EU countries.

Ownership of personal computers per 1000 people uncovers a two-way difference between north and south, and east and west of Europe. The top countries for the highest level of personal computer usage are Denmark, Finland, Ireland, France and some distance behind them, Slovenia. The rest of the CEECs and EU countries are far behind.

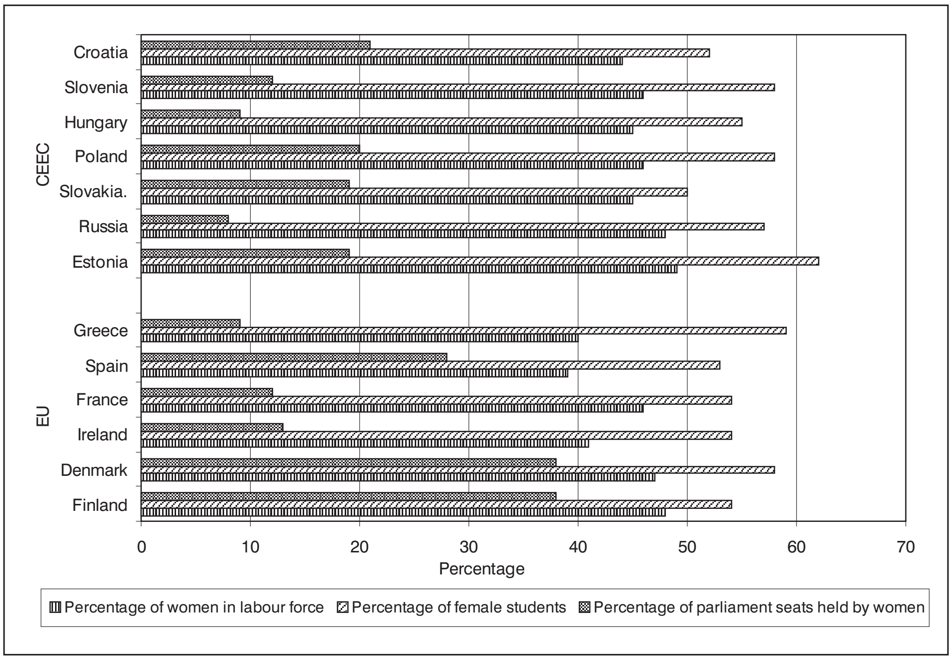
Finally, the number of Internet users as a percentage of total population shows the same pattern as personal computer ownership. In general, countries that have more personal computers have more people connected to the Internet. Consequently, the first three countries are Denmark, Finland, Ireland, followed by Slovenia and Estonia.

If we want to summarize high-tech indicators, we can conclude that the countries leading in the implementation of new technologies are Finland, Denmark, Ireland, Slovenia, and Estonia, with France some distance behind. The rest of the CEECs and the EU countries are substantially further behind. Obviously there is a great difference in the uptake of this technology among countries. When taking into account the importance of these indicators for a knowledge-based growth, it is clear that some of these countries are significantly lagging behind. In these countries, the basic infrastructure necessary for developing a knowledge-based economy, as the growth engine, is lacking.

Female participation indicators

One of the dimensions mentioned at the beginning of the paper was the ideological emphasis of the former communist countries on women's participation in education, politics, and the labour force. Similar goals were expressed in western societies as a result of general social and cultural change, and the influence of the feminist movement. The female participation rate in these three areas is indicative of a modern values orientation, and full usage of human capital as prerequisite for the development of a knowledge-based society. Although these parameters are not economic indicators of development per se, they are important because of their broader indication of the usage of human capital.

Graph 9
Female participations indicators



Source: UNECE Statistics. Trends in Europe and North America 2003 Statistical Yearbook of the UN/ECE, http://www.unece.org/stats/trend/trend_h.htm

The participation of women in the workforce is almost the same in CEECs as it is in EU countries. The significantly higher participation of women in the labour force existing in the former socialist countries 20 years ago has almost disappeared (Šporer, 1985). The average percentage of women in the labour force in CEECs is 46.2% and in EU countries 43.5%.

The new trend characterizing all developed countries is that of high female participation in higher education.

What should be specially emphasized is that this trend is equally valid for CEECs as well as EU countries.

There is still a visible gap in female participation in politics. However, the gap is much smaller in the parliaments of EU countries (average female representation 23%) than in the CEECs (average representation 15.4%). Almost equal participation in the workforce and in higher education has translated into political representation being much less in the CEECs than in their EU counterparts. A possible explanation for this phenomenon lies in the way women's emancipation was introduced in the first place. In the former socialist countries, women's emancipation was part of the official ideology and the policies to achieve this goal were implemented in a "top down" fashion. In the EU countries, female emancipation was more the result of the general social modernization and the spontaneous feminist movement in a "bottom up" manner. The consequence is that female participation has spread more evenly through all spheres of social life in the countries characterized by the "bottom up" model, rather than in the countries with the "top down" model.

From this part of the analysis, we can conclude that CEECs have the capability of faster development than that which they show now. These countries had different historical development patterns and it is impossible to describe them using a "one size fits all" model. However, we can argue that they emulate the development pattern of the earlier phase of EU countries. In this sense, we can imply a certain evolutionary model in describing the patterns of development.

The present picture of the CEECs is in some dimensions repeating an "earlier phase" of development of the EU countries. From this standpoint, we can argue that they are on the same track as EU countries, and therefore will repeat the same development pattern. The open question is the speed of development. That is, if changes in the "right direction" are implemented fast enough, meaningful development will deliver an increase in the standard of living in the not too distant future. The capabilities related to their human capital, such as high education enrolment rates, high investment in the educational sectors (not much below the EU average), and the relatively high numbers of researchers, are all good starting points for the creation of knowledge-based economies.

The case of Croatia

The aim of this section is to describe the extent of Croatia's lag behind other CEECs. In order to make the comparison clear, we can assess Croatia's position on each of the indicators analysed according to whether Croatia's standing is below, at, or above the average of other CEECs.

Table 1
Croatia

Indicators	Low	Medium	High
Economic structure			
Sectors of production		√	
Employment rate	√		
Education			
Enrolment in higher education	√		
Spending on education	√		
R&D			
Number of researchers		√	
Investment in R&D		√	
Source of funding		√	
Globalisation		√	
Trade			
FDI			√
Migration			√
ICT			
Phone			√
Mobile		√	
PC	√		
Internet	√		
Female participation		√	
Female labour force			
Female students		√	
Females in parliament			√

Table 1 clearly shows, not only that Croatia is below the EU average, but on many dimensions is also below the CEEC average. Croatia is clearly lagging behind in the job creation area and in the area of higher education, where Croatia is below EU and CEEC averages. Croatia is also below the CEEC average in PC ownership and the number of Internet users. On all of these indicators, Croatia is well below the EU average. Low spending on education and a low presence of information and communication technology indicates a significant lack of some of the basic prerequisites for the development of a knowledge-based economy.

In other dimensions such as the sectoral distribution of the labour force, the number of researchers, investment in R&D and type of funding sources of R&D, Croatia falls within the average range for CEECs. The same holds for trade, mobile phone presence, proportion of female participation in the labour force and proportion of female students.

Finally, there are some dimensions where Croatia is among the leaders in the CEEC group. These dimensions are the above average levels of FDI, migration rate, telephone connections, and female representation in parliament.

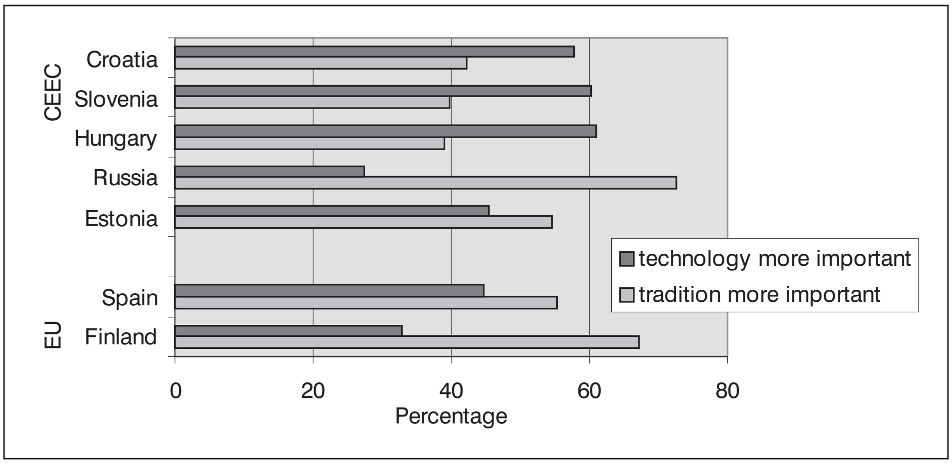
SOCIAL CAPITAL

Adam Smith argues that the economy is deeply imbedded in social life and it cannot be divorced from culture. Successful economic activities (Fukuyama, 1999) are based on a variety of norms, values, rules and regulations that profoundly shape every society. Coleman (1988) argues that in addition to skills and knowledge an important part of human capital is people's ability to associate with each other. This ability is based on shared norms and values, and willingness to subordinate individual interest to the interest of a large group. Putnam (1995, and Putnam and Gross, 2002) reinvented the idea of importance of culture for economics in the concept of "social capital". They defined social capital as a "feature of social life – network, norms and trusts – that enable participants to act together more effectively to pursue shared objectives." Putnam's intention was to apply this concept specifically to the functioning of democratic institutions. In this vision the "right" social capital as a characteristic of the particular society is a precondition for efficient functioning of democratic institutions. In an extension of the original Putnam's and Fukuyama's work, Lundvall (2002) defined social capital as tradition of cooperation with others outside the narrow circle of the family, in the pursuit of solving common problems.

Social capital as a value system

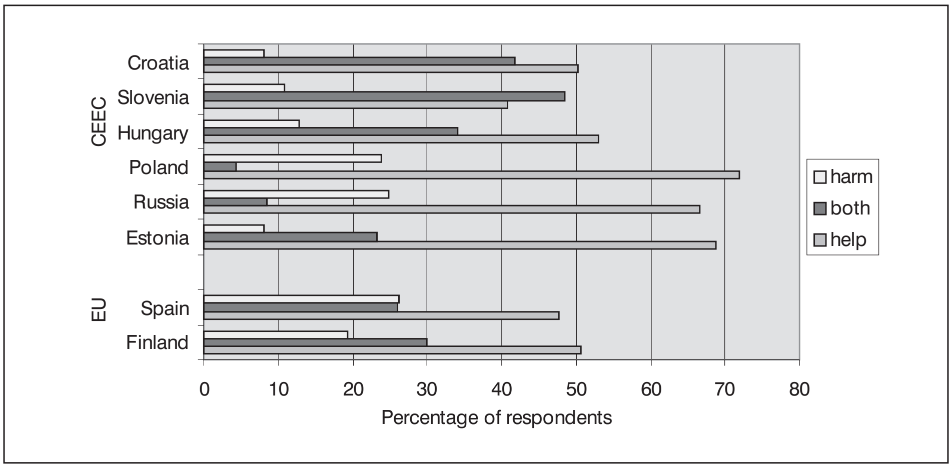
What are the characteristics of social capital in CEECs? Can it be assumed that social capital in CEECs, due to the historical circumstances of their development is of a "different kind" from the one prevailing in the EU and other Western countries? Is it of the "kind" that presents a barrier for faster development toward a knowledge-based society and democracy? Is the legacy of the communist ideology and institutional structure also adding to these negative characteristics of the prevailing social capital? The communist systems were development oriented and they transformed the predominantly agricultural societies into industrial ones. In that process the role of natural science and technology was strongly emphasised. Education was compulsory and effort was made to involve women in the labour force. The importance of work was emphasised, as in the old slogan "those who do not work do not need to eat." Work was the essence of the ideology and it was regarded as much more important than family or leisure. Although the market, competition and openness were not so much present, work, development, and science and technology were positively valued. The World Values Survey conducted in 1995-6 (http://wvs.isr.umich.edu/) reveals that technology, science and work are more positively valued (see graph 10) in CEECs than in EU countries.

Graph 10
What is more important: tradition or technology?



Source: World Value Survey 1995-96

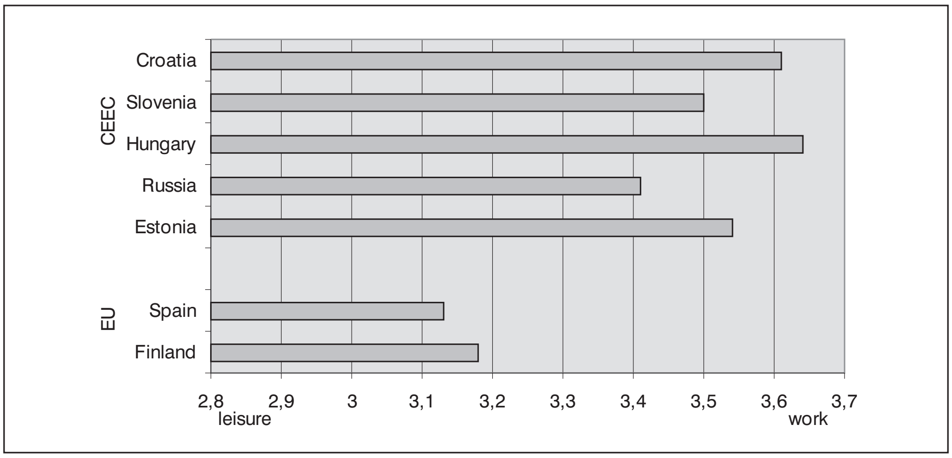
On the question "What is more important; tradition or technology?" respondents in Hungary, Slovenia and Croatia were more in favour of technology than of tradition. In other CEECs as well as in EU countries, the respondents favoured tradition more than technology.



Source: World Value Survey 1995-96

Graph 11
Does advance of science help or harm?

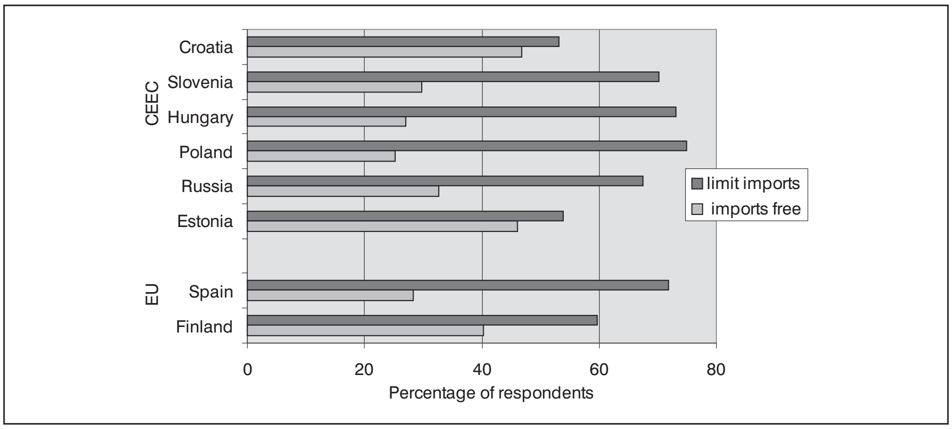
Advancement in science (graph 11) was positively regarded in all countries and was seen as a process that in general was more helpful than harmful. On that basis we can assume that the introduction of communication and information technology will not be impeded by personal values.



Source: World Value Survey 1995-96

Graph 12
Importance of leisure or work on the scale 1-5

The relative priorities of work and leisure (graph 12) show that respondents in CEECs stressed work more than was the case in EU countries. These values are certainly not obstacles for a knowledge-based society. Quite the contrary, they are instrumental for social transformations that lead in that direction. In this respect EU countries are more post-modernist and the importance of leisure is seen as being higher.

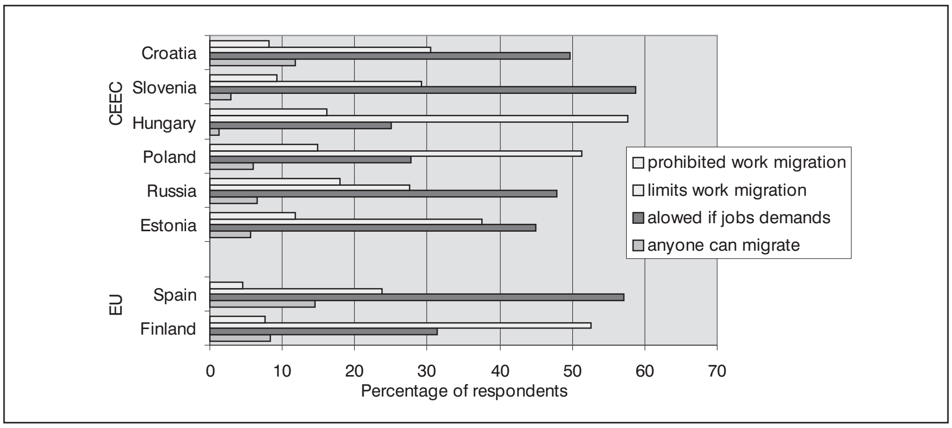


Source: World Value Survey 1995-96

Graph 13
Atitudes towards free trade

Graph 14
What is your opinion in relation with the foreign workers?

Openness is a basic feature of the globalised world. Attitudes toward free trade show that (graph 13) people in Croatia and Estonia, although preferring some limitations of imports over completely free imports, at the same time show greater openness toward free trade than in other countries. Taking into account the fact that Croatia already is a significant importer and trader, this can be a good signal regarding popular support for participation in the world market and open economy. We may say that the Croatian policy of openness has relatively wide popular support, and has not been imposed unilaterally by the political elite.



Source: World Value Survey 1995-96

The attitude toward free movement of foreign workers (graph 14) shows large differences between countries, regardless of whether they are CEECs or EU members. Spain has the most positive attitude toward foreign workers, followed by Croatia and Slovenia. The countries that are more negative and prefer more control of labour migration are Hungary, Poland and Finland, all of which have very low immigration rates. Regarding the causal relationship between the attitudes and migration rates, we can argue that higher migration (due to geographical and economic circumstances) leads to more positive attitudes toward migration.

Social capital as a network and relationship

Social capital as a system of values is usually measured on the individual level, but it is also understood as the property of a group to build networks and relationships that make cooperation more successful. Societal institutional arrangements are built on and supported by the system of networks and relationships that exist among groups and individuals. An analogy can be drawn between organisations and society. In organisational theory, distinctions are made between formal and informal organisations. When a formal organisation becomes dysfunctional, the informal structure of that organisation helps the organisation to function. The informal organisation helps to overcome the obstacles caused by the formal structure. It can be assumed that the same mechanisms operated in the former communist societies. Social capital as a system of networks and relationships helped communist societies to function, in spite of the obstacles coming from the centralised system and nonexistent or distorted markets.

Can we assume that the same social capital that helped people to survive rapid industrialisation, a centralised economy, the one party system and other features associated with communism is now an obstacle for democracy and a knowledge-based economy? Because the communist system was dysfunctional, especially in relation to markets and democracy, party social ties and social networks replaced market forces. Market forces were replaced by command (the extent to which markets were operating varied among the communist countries), and the institutional structure necessary for the operation of a market economy (like consumer protection, private property and security of contracts) was underdeveloped. The system was dysfunctional especially because it suppressed entrepreneurial behaviour. Because of this, social capital was compensating for the imperfections of the formal system, and social network and trust became more important than the law and regulatory institutional systems. Consequently, the first people responding to market incentives were those who were not only ready to take risks (just as most of them did when this type of behaviour was considered criminal activity) but also the people with already created network of predominantly illegal activities. When "Big Brother" was controlling everything, distorting markets and undermining democracy, the unintended consequence was the development of the type of social capital that relied extensively on social networking, and undermining law, regulation and the legal system.

Social capital as norms and trust

According to the World Bank "social capital refers to the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions... Social capital is not just the sum of the institutions which underpin a society – it is the glue that holds them together." (Office of the National Statistics, 2001) The main characteristics of the communist system were that its institutions were built from the "top down". The system designers expected that the imposed institutions would work as designed. The answer to the manifestations of dysfunction of the imposed institutions was to impose new institutional designs. In that way, society was caught in the endless process of change that did not evolve as a gradual adaptation, but which emanated from the ideological designs very often at odds with social reality. Instead of a gradual institutional change reflecting the processes of economic, technological and social change there was a constant "revolutionizing" process, imposing new institutional designs. The population regarded this process as something that should be avoided as much as possible. The institutions were not perceived as something that helped society to solve problems, but as something that was imposed from "outside". In order to solve the problems, "ways around" had to be found.

First, the communist elites introduced a new institutional system, and through it destroyed the previous system. Because the new system did not work as designed (as it couldn't, because of the utopian premises on which it was built) the institutions were changed very often. (Yugoslavia was introducing new constitutions every 10 years.) The consequence was instability of institutional systems, because institutions were not perceived as permanent. The norms were often ignored because they were perceived as unrealistic and ideologically driven. Trust in institutions was very low, and stability and permanence were found only in informal networks and relationships. The question of whether this social network was positive or negative for development in the direction introduced in 1990 is highly debatable. The social network facilitates performance, but it is not always certain whether it is done legally or illegally, whether it benefits society or individuals against the society, or whether it produces social conflict and disintegration of the new institutional system.

Social capital becomes also an important issue in post-modernist Western societies because the individualistic spirit of capitalism has been destroying the social bonds of community, which are vital as the social glue that holds society together. The problem is certainly different in the CEECs. The absence of stable institutions and the lack of trust in the institutional system is the crucial problem. Fixing institutional systems in a way to enable the functioning of markets and democracy, and at the same time to control negative elements of the previous social networks, is the most important goal of the societal policy.

CONCLUSIONS AND RECOMMENDATIONS

The comparative analyses of the economic indicators between EU and CEEC reveals a complex picture of similarities and differences due to historically different pattern of development. In the sectors of production, CEECs have a structure resembling characteristics of industrial society while EU is more a prototype of the post-industrial type. The capabilities of human capital, such as high educational enrolment rates, or investment in education, and the number of researches, show that on average CEECs do not lag behind the EU (with the exception of Croatia which is behind other CEECs in spending on education).

The indicators of the drivers of social and economic change such as globalisation show that some of the CEECs are more open toward the world economy than many of the EU countries. This openness is not universal but varies from country to country. In countries open for foreign trade, the FDI rate is also high and conversely, in countries less open to trade the FDI rate is lower.

The dimensions in which CEECs are lagging far behind EU countries are several. CEECs have a different pattern of **research funding** and they are lagging behind in overall research funding. On average, CEECs invest less in research, and the government is still heavily involved in research funding. Business enterprise involvement in R&D funding is low, and that reflects an absence of relationships between industry and research institutions. Research activities are not directly oriented to serve industry or to produce innovation, and are not focusing on the commercialisation of knowledge. On the other hand business enterprises are not using the knowledge and innovative capabilities of R&D. *That is certainly one major problem that needs to be addressed by the government. The government should aim to facilitate such stimulative policy for business enterprises and R&D to promote closer relationships, commercialisation of knowledge, and entrepreneurial behaviour.* Bridging that gap between businesses and R&D is the focus of government policy around the world because it becomes extremely important to use knowledge capabilities to solve the problems and produce more innovations in knowledge-based society. Knowledge and innovation are becoming critical for job creation. An example of successful government policy in this area policy is tax relief for the businesses that invest in R&D. Another is when research projects funded by businesses receive additional funding from government. The main role of the government is to ensure a stimulative environment and to **foster collaboration** between those agents.

Whenever radical technological innovation was introduced the consequence was a spiral effect, or a new economic cycle. The last big wave of innovations began in the 1990s and is based on digital networks, software and new materials. (*The Economist*, February 20th 1999) That brings economic growth, and its associated social change. What is essential for every economy is to introduce that new technology as soon as possible and ride the economic growth from the peak of this new innovation wave. CEECs (and Croatia particularly) are substantial lagging behind EU countries in **implementing new technology** (ICT). That means that these countries are not taking advantage of the new cycle of innovation, and the gap is widening. Government policies should be based on activities that promote technological diffusion: by increasing competitiveness in telecommunications technology, building confidence and making e-government a priority. Through these activities government should be an example to other sectors in using the high technology.

Investment in ICT will stimulate demand for new technology. The large organisations are in the process of rationalisation, specialisation and outsourcing certain activities. Those processes combined with the privatisation process in CEECs will create more small businesses. Bojnec (2001) found that most of the newly created firms in Slovenia arose out of necessity because people lost their jobs or had difficulties in finding new jobs. Few firms were created based on an entrepreneurial motivation to start up new business, and most of them are outgrowing on the family-based entrepreneurial tradition. CEECs with their high human capital capabilities combined with the aggressive introduction of ICT can stimulate creation of small **high tech firms** that are attractive for venture capital.

The ability to implement and adapt to change depends on human capital and institutional arrangements, but also on social capital. Social capital defined as a value system indicates a prevalence of modernistic orientation in CEECs (and particularly in Croatia), which are certainly positive bases for building knowledge-based society.

However, social capital is also a characteristic of the group, to build networks, relationships, and trust in institutions. In that dimension, unintended negative consequences of the previous system are still shaping the way that people do business. In the relation to this negative effect of social capital, the main function of the government policy in CEECs is to create stable institutional systems, impose a rule of law, and to implement stimulative and non-restrictive regulation. In the long run, that will produce trust in the institutions and stability of the market and democracy.

FOOTNOTE

[1] A distinction between EU candidate countries and CEECs has not been made, because candidate countries differ in many respects, e.g. Norway, Iceland, Turkey, Malta, and Cyprus. Furthermore, CEECs share the same recent history that ultimately influences the structure of society and economy, and makes them more similar in the dimensions that are important for a knowledge-based economy.

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APPENDIX

Table 1
Employment structure

		Employment by major economic sectors (2001) % of labour force			Employment (% change over previous year 2001)	Unemployment (%, 2001)	Youth unemployment (%, 2001)
	Countries	Agriculture	Industry	Services			
CEEC	Croatia	15.5	30.0	54.5	–0.6	15.8	37.3
	Slovenia	10.0	38.6	51.4	1.4	5.9	16.1
	Hungary	6.2	34.4	59.4	0.3	5.7	10.8
	Poland	18.8	30.8	50.4	–0.6	17.4	41.0
	Slovakia	6.2	37.6	56.3	1.1	19.2	37.3
	Russian Fed.	12.3	30.4	57.3	0.6	8.9	18.0
	Estonia	8.9	33.0	60.1	0.9	12.6	22.0
EU	Greece	16.0	22.8	61.2	–0.4	10.2	28.0
	Spain	6.4	31.5	62.1	2.6	10.5	20.8
	France	4.0	25.0	71.0	2.1	8.5	18.7
	Ireland	7.0	29.0	64.0	3.0	3.7	6.2
	Denmark	3.3	25.4	71.3	0.2	4.3	8.3
	Finland	5.7	27.2	67.1	1.1	9.1	19.9

Source: UNECE Statistics. Trends in Europe and North America 2003 Statistical Yearbook of the UN/ECE. http://www.unece.org/stats/trend/trend_h.htm

Table 2

Enrolment in high education and graduates in CEEC and EU countries 2001/02

	Countries	% of students enrolled in high education from total population 2001/02	% of high education graduate from total population 2001/02[1]	Share of GDP for education in % 1999/01[2]
CEEC	Croatia	2.45[3]	0.31	4.26
	Slovenia	4.28[4]		
	Hungary	2.96[5]		4.7
	Poland	4.44[6]	0.78	5.2
	Slovakia	2.46[7]		4.3
	Russian Fed.	3.27[8]		
	Estonia	4.49[9]	0.62	7.4
EU	Greece	2.25[10]	0.29	3.4
	Spain	3.96[11]	0.52	4.5
	France	3.51[12]		6.0
	Ireland	3.09[13]		4.6
	Denmark	3.64[14]	0.73	8.1
	Finland	7.08[15]	0.81	6.2

[1] European Commission: Key Data on Education in Europe, Tertiary Education

[2] European Commission; Key data of Education in Europe 2002, Financing of Education pp3

[3] Central Bureau of Statistics of the Republic of Croatia, http://www.dzs.hr/ljetopis2002/24podat.htm

[4] National Statistical Office of the Republic of Slovenia, http://www.sigov.si/zrs/eng/index.html

[5] European Centre for Higher Education, http://www.cepes.ro/information_services/statistics.htm

[6] Polska Statystyka Publiczna [Statistical Office], http://www.stat.gov.pl/english/index.htm

[7] Statistical Office of the Slovak Republic, http://www.statistics.sk/webdata/english/index2_a.htm

[8] European Centre for Higher Education, http://www.cepes.ro/information_services/statistics.htm

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Table 3

R&D structure and expenditure in 1999

	Countries	Researchers in R&D per thousand inhabitants (1999)	R&D expenditure in % of gross national product (GNP)	Source of funds				
				Business enterprise in %	Gover-nment in %	High education in %	Private non-profit in %	Funds from abroad in%
CEEC	Croatia	1.18	0.98	53.3	42.3			0.8
	Slovenia	2.14*	1.48*	52.5	39.9	0.8		6.8
	Hungary	1.25	0.69	40.2	32.3			
	Poland	1.46	0.75	41.3	30.8	27.8	0.1	
	Slovakia	1.70	0.69	62.6	27.5	9.9		
	Russian Fed.	3.39	1.01	31.6	51.1	0.4		16.9
	Estonia	2.12	0.76	24.3	64.6	0.7	1.6	8.9
EU	Greece	1.40	0.67	28.5	21.7	49.5	0.3	
	Spain	1.54	0.88	52.0	16.9	30.1	1.0	
	France	2.71	2.19	63.2	18.1	17.2	1.5	
	Ireland	2.18	1.21	73.1	7.0	19.2	0.7	
	Denmark	3.47	2.09	63.4	15.2	20.3	1.2	
	Finland	4.91	3.22	68.2	11.4	19.7		

Source: Institute for Statistics, UNESCO,
http://portal.unesco.org/uis/ev.php?URL_ID=5218&URL_DO=DO_TOPIC&URL_SECTION=201
* Data for 1998

Table 4

Globalisation indicators

	Countries	Imports of goods and services (% of GDP) 2001	Export of goods and services (% of GDP) 2001	High-techno-logy export (% of manufactured exports) 2001	FDI as % of GDP in (US$) 2001	Net migration rate per 1 000 (2002 est.)[1]	Membership in international organisations[2]
CEEC	Croatia	53	47	10	7.46	9.72	45
	Slovenia	63*	59*	5	2.68	2.24	48
	Hungary	63	60	23	4.70	0.76	63
	Poland	33	29	3	3.24	–0.49	68
	Slovakia	82	74	4	7.21	0.53	56
	Russian Fed.	24	37	8*	0.80	0.94	69
	Estonia	94	91	19	9.76	–0.73	40
EU	Greece	33*	25*	8	1.35	1.96	63
	Spain	31	30	8*	3.70	0.87	64
	France	26	28	23	4.01	0.64	90
	Ireland	80	95	48	9.55	4.12	64
	Denmark	39	46	21	4.48	2.01	71
	Finland	32	40	23	3.09	0.62	72

Source: World Development Indicators Database
* Data for 2000
1 CIA – The World Factbook 2002
2 CIA – The World Factbook 2002

Table 5
Indicators for information and communication technology

	Countries	Phone (as % of total population)	Mobile (as % of total population)	Personal computers (per 1000 people) 2001	Internet users (as % of total population)
CEEC	Croatia	39.20 (2000)	29.61 (2001)	86	10.93 (2001)
	Slovenia	37.35 (1997)	51.74 (2000)	276	31.04 (2001)
	Hungary	30.72 (1997)	12.60 (1999)	100	11.91 (2001)
	Poland	20.89 (1998)	4.61 (1998)	85	16.57 (2001)
	Slovakia	35.68 (1998)	13.59 (1999)	148	12.91 (2000)
	Russian Fed.	20.69 (1998)	1.72 (2000)	50	12.42 (2002)
	Estonia	35.44 (2000)	50.22 (2001)	175	30.35 (2002)
EU	Greece	51.02 (1997)	8.81 (1997)	81	13.15 (2002)
	Spain	43.26 (1999)	20.94 (1999)	168	19.69 (2002)
	France	58.33 (1998)	18.54 (1998)	337	28.39 (2002)
	Ireland	41.20 (2002)	77.26 (2002)	391	33.74 (2002)
	Denmark	89.13 (1997)	26.90 (1997)	540	62.77 (2002)
	Finland	54.94 (2001)	71.93 (2001)	423	51.89 (2002)

Table 6
Female Participation Indicators

	Countries	Percentage of Women in Labour Force (2001)	Percentage of female students 2001	Percentage of parliament seats held by women 2001
CEEC	Croatia	44	52	21
	Slovenia	46	58	12
	Hungary	45	55	9
	Poland	46	58	20
	Slovakia	45	50	19
	Russian Fed.	48	57	8
	Estonia	49	62	19
EU	Greece	40	59	9
	Spain	39	53	28
	France	46	54	12
	Ireland	41	54	13
	Denmark	47	58	38
	Finland	48	54	38

Source: UNECE Statistics. Trends in Europe and North America 2003 Statistical Yearbook of the UN/ECE. http://www.unece.org/stats/trend/trend_h.htm

III.

TOWARDS KNOWLEDGE-BASED ECONOMY: CASE STUDIES

Jadranka ŠVARC

Ministry of Science and Technology, Republic of Croatia
Trg J. J. Strossmayera 4, 10000 Zagreb, Croatia
E-mail: jadranka.svarc@mzos.hr

Jasminka LAŽNJAK

University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering
Pierottijeva 6, 10000 Zagreb, Croatia
E-mail: jlaznjak@rgn.hr

WHY HAVEN'T THE EU ACCESSION COUNTRIES YET ACCESSED KNOWLEDGE-BASED SOCIETY: WHAT CAN SOCIAL SCIENCES DO ABOUT IT? THE CASE OF CROATIA

INTRODUCTION: REALITY OR MYTH

In the countries of the developed West the concept of knowledge-based economy (KBE) has been recently (at the beginning of the third millennium) subjected to the critical examination prompted by the slowdown of information and communication technologies (ICT) and dot.com economy in the USA. The new economy has been proclaimed "in part an old story" (OECD, 2001; OECD, 2003), a myth and not a reality born by ICT and other new technologies that, by the end of the 1990s (OECD, 2001), were the drivers of the productivity growth. However, it can not be denied that a new pattern of economic growth has emerged bringing forth the new factors strongly influencing economic growth and catch-up processes between countries. While the developed as well as some of the fast growing small economies (e.g. Finland, Ireland) are already analyzing the consequences of the "knowledge based growth" they have experienced during the last quarter of the 20th century, in some of the EU candidate[1] and pre-accession countries[2] the knowledge based economy is far from being either the reality or a myth.

The reality of these countries, judging from the example of Croatia as a typical pre-accession country is torn by internal and external political interventions, "realpolitics" which has little to do with knowledge production, human and social capital, technology development, networking and other specific elements which constitute the new economy. Therefore, the knowledge-economy in these countries is neither a "negative" myth which should be reassessed and overcome nor a "positive" myth, a desirable goal, a better future worth aspiring to. Still, the typical dilemma that disturbs the policy makers all over the world, regardless of the scale and power of their economy is almost the same:

- in the **advanced countries** scholars are concerned with why have the USA and some smaller economies like Australia, Ireland, the Netherlands (OECD, 2003) or

Finland grown so fast while many big European countries like Germany or non-European countries like Japan have decreasing growth rates;

- Similarly, the **developing CEEC** countries scholars have concluded that "we have, on average, seen increasing divergence rather than convergence across Europe "while (...) "catching up has been restricted to just a few of restructuring CEE countries" (Gristock, 2003)
- The same question is relevant for **pre-accession** countries as well. Why, for example, hasn't Croatia joined the EU club together with Slovenia, Poland, and Hungary? In the 1970s it was one of the most advanced countries in the region. All of the necessary pre-requisites like technology base, scientific base, educated labor, openness to international markets and such did exist in Croatia. Nevertheless, taken together they haven't been a very successful combination.

The recent analysis of the growth performance of different countries corroborates the common belief that the divergence in growth can not be easily explained by investment in fixed assets (machinery, plants, equipment), or even by investments in the new technology and knowledge itself. (...) "Although they have pervasive effects on economy and society, they alone can not explain why some economies are growing while others are downsizing" (for more, see OECD, 2001; OECD, 2003). Much more important are the factors that put physical investments as well as investments in intangible assets to work.

Starting from this new assumption, we will try to demonstrate, using Croatia as an example, that the failure in economic growth in the developed and developing countries is deeply socially and politically rooted. The future of any country is produced by its historical heritage, business ethics, moral values, political attitudes. In the case of Croatia historical heritage has produced the state of semi-modernism which prevents the structural adjustment to the global changes and deters the knowledge-based economy. The Croatian society is a mixture of modern and traditional elements that create the state of semi-modernism, a term coined and defined by the famous Croatian sociologist Josip Županov (2001). Semi-modernism marked the last decade of the 20th century and is dominated by so-called de-industrializing political elite. These political elite dragged some aspects of social and economic life into the pre-industrial era which caused:

- basic failure to understand of the role of innovation, knowledge and technology capability in the knowledge based-economy including

– failure to implement the national innovation system (NIS) as a framework for connecting research and business facilitated by proper policy measures and environment needed for accelerating technology development.

Since the establishments of NIS and technology development are considered to be fundamentally social processes, the paper will explain how social sciences imbedded in the specific theory of Triple Helix (TH) can contribute to NIS, economic growth and entering knowledge-based economy.

WHAT DOES IT MEAN TO BECOME THE KNOWLEDGE-BASED SOCIETY?

The term knowledge based-economy was coined by OECD (1996) and defined as an economy which is directly based on the production, distribution and use of knowledge and information (Trewin, 2002). By analogy, the knowledge based society (KBS), could be defined, lacking the empirical analysis as well as theoretical reflections, as a new economic and social structure that is designed to support and stimulate technological change and innovation as well as R&D and education as its driving forces in all aspects of society: organizational, institutional, cultural, political, legal, ethical, etc.

Moving towards KBE is usually expressed in statistical indicators that measure or numerically express the strength of the selected factors or dimensions recognized as the most characteristic or influential for knowledge-based growth.

Some components such as knowledge investment, ICT, innovation and entrepreneurship, human capital and social capital are common for all indicators of entering KBE. The strength of these dimensions in a specific country is usually taken as a measure of moving towards KBE.

For example, by investing in knowledge, as one of the most important dimension of KBE,[3] Sweden, The USA, Korea and Finland became the four most knowledge-based economies, as their investment in knowledge amounts to 5.2 – 6.5% of GDP (OECD, 2001a). In addition, the majority of OECD countries, especially the Nordic countries, Ireland and Australia are moving towards knowledge-based economy because during the 1990s they invested more resources in the knowledge production (annual investments increase of 3.4%) than in gross fixed capital (annual investments increase of 2.2%).

However, the statistical evidence of strength of these selected components like knowledge investments does not explain why some countries are strong, or better yet: why did they decide to become strong in these components, when others didn't.

WHY IS NIS IMPORTANT FOR BECOMING KBE

No matter how we put it, the essence is in the creation of an environment that stimulates the knowledge-driven factors. Contextual dimension incorporates a number of background elements such as economic, social, cultural, legal, political, environmental and global factors which act as preconditions for successful KBE (more in: Trewin, 2002).

In other words, economic growth and technological development could be accelerated by creating a socio-economic system which encourages the commercialization of knowledge through innovations and new technologies, namely by creating a national innovation system (NIS). Therefore, the concept of NIS could be defined as the integration of the science, educational, industrial, and technology policies into the new strategic policy of development as a model for achieving knowledge based growth.

For the development of small economies with scarce R&D and technology resources like Croatia, it is extremely important to understand that economic growth and technology development are complex social phenomena primarily based on the ability of a society to get organized in a way that stimulates technological change and innovations as the main driving forces of growth.

Still, in countries like Croatia innovation policy has never been a priority. Quite the contrary, it has always been marginal in comparison to the politically and socially accepted priorities like macro-economic stabilization, privatization, and the reconstruction of the regions devastated during the war, etc.

NIS as a national consensus on innovation hasn't been established and a technology policy has never become a national development priority. The fundamental question is why?

THE SOCIAL ASPECTS OF LEGGING BEHIND IN TECHNOLOGY DEVELOPMENT AND THE ABSENCE OF A PROPER NIS

The inability of Croatian ruling elites to recognize knowledge and innovation as the driving forces of growth and to comprehend that NIS is the environment that would put these forces to work is deeply rooted in socio-economic system and therefore depends on cultural values, historical heritage, political will-power and social recognition. The socio-economic system in Croatia is in a state of "semi-modernism" (Županov, 2001) that marked the last decade of the 20th century. It is dominated by the so-called de-industrializing political elite which have brought some aspects of social life back to the pre-industrial era. Croatia is one of the countries which have been going through the 50 years long transition process, also described as the state of "Purgatory". The first phase of the process was the period of socialism as a transition between capitalism and communism, and the present, second phase is "political capitalism" as a transition from socialism to liberal democracy and market economy.

There are three main aspects of semi- modernism:

1. The first is **re-traditionalization** – the process of de-secularization and the so called "moral and social renewal" back to the ethical values of the 19th century. This social type of "Gemeinschaft" which was believed to have disappeared in migration and urbanization has raised surprisingly well as new normative integration. National homogenization which was very welcome during the war for independence has afterwards not been transformed into functional integration. Just the opposite, some kind of "Hobbesian incivility" and anomie have become quite visible because the old norms and values in business and politics were destroyed and the new ones have been based on a different process, the process of de-industrialization.

2. **De-industrialization** – is the process of devastation of industrial firms by the way of "the empty shell model". The model marks the process of the privatization of the previously state owned companies the substance of which was sucked out by the tycoons and corrupted or irresponsible managers. Privatization regularly ended with companies loosing their competencies in technology, skills, fixed assets, market competitiveness, etc. These companies were nothing but the empty shells dependent again on the state support. The wrong model of privatization entitled political "capitalism" lacking in fresh financial input and skilled managers, has had, instead of the healthy profit seekers, the rent-seekers, a new class of businessmen, who earned themselves the profits by selling the property accumulated by the previous generations.

3. The third process, **de-scientization,** a process of the marginalization of science and the creation of the atmosphere of anti- intellectualism, proves that the political elite just did not recognize science and education as necessary for development. The results were devastating and familiar: "brain drain", the migration of scientists, the financial starvation of research, the destruction of industrial R&D and the loss of technological competence.

These three processes are the social and political roots of legging behind in technology, slow growth and the lack of the structural adjustment to the knowledge-based economy.

THE STATE OF THE ART OF THE KEY NIS ELEMENTS IN CROATIA: ITS SHORTCOMINGS AND ITS SOCIAL ROOTS

The four main characteristics of the Croatian NIS are selected to illustrate the presented social and political roots of the failure in development. These are as follows:

A. Insufficient technological capabilities of companies
B. Inadequate structure of R&D sector
C. Unsatisfactory science- industry cooperation
D. Inappropriate environment

A. The Insufficient technological capabilities of companies

The technological capability of companies, which, by definition, comprises the ability to innovate and the ability for innovation diffusion (transfer, absorption, application, modification) is the factor of differentiation between technology leaders and technology followers, the so-called "technology changing" and "technology-using" countries (for more see: Bell & Pavitt, 1993).

The "technological capability" in contrast to the "production capability" has emerged as one of the major factors that are used to explain growth differences among the developed and the developing countries because it implies the ability to create and modify new technologies while the production capability incorporates the production and efficiency ***at a given*** level of inputs (technology, skills, equipment, etc.) (Bell & Pavitt, 1993).

The examples of Japan and Korea in the past and Finland or Ireland in the present are the evidence that technology accumulation enables the less developed countries to transform the low-technology and labor intensive sectors (textile, wood) into complex technology systems (food, chemical, automotive industries) and finally enter the knowledge intensive sectors (pharmacy, biotechnology, services). In practice it means that in the 1980s these countries made some structural adjustments to fit the new economy.

The importance of the technology capability for making the structural adjustments in accordance with the global changes is poorly understood in Croatia. Since the structural adjustments of economy have not been recognized as a priority goal of national development, neither the state nor the private business have made any efforts to introduce new technology sectors or to modernize the exiting ones that would be worth mentioning.

It is, on the macro-economic level, illustrated by the fact that, for more than 25 years, the economy as well as the export has been dominated by the "traditional Croatian industries" like wood and textile industry, fishery, tobacco and shipbuilding (Jurlina-Alibegović, 2002). However, there is also some statistical evidence that the export of high-tech products is quite significant, amounting to 8% of the total exports of the manufacturing sector.

On the micro- level of companies, the technology capability is, again, rather low (Table 1). The comparison of some selected indicators like the number of patents, ISO standards 9000 and Internet hosts reveals that Croatia lags not only behind the developed countries, but also behind the European accession countries we like to compare to. For example, the number of patents is 6 times lower than in the Czech Republic and Poland and 26 times lower than in the EU countries.

The number of ISO 9000 is 7 times lower than in Slovenia and 16 times lower than in England, while the number of Internet hosts is 3 times lower than in Hungary, Poland, or Slovenia and 20 times lower than in Denmark.

As is the case with the technological capability, the innovation capacity and national competitiveness are rather low in comparison not only with the developed but also with the EU candidate countries we like to compare to (Table 2).

Table 1
Diffusion of Internet Hosts, ISO 9000 and patenting activities in 2000

		No. of Internet hosts per 10.000 inhabitants	No. of patents per Mio. inhabitants	No. of ISO 9000 per Mio inhabitants
Accession Countries	Cyprus	30		369
	Czech Republic	209	60	375
	Estonia	357		126
	Poland	127	60	54
	Slovenia	148		424
High Income Countries	Denmark	1.045		424
	Germany	294		396
	Netherlands	1.634		696
	UK	371		1.073
	EU 15		260	
	Croatia	47	10	65
	Hungary	168	70	469

Source: EPO 2003, OECD S&T Indicators, 200172, ITU 2002, World Bank 2001

It is obvious that in Croatia the management of the technological change and the accumulation of the technological capability of firms have, in reaction to the decades of the state planned economy, been being approached from the newly introduced neo-liberal point of view. When technology policy is considered, the power of market was obviously overestimated. However, the possibility for political and business elites to intervene to accelerate technology accumulation has been completely blocked from the fear of any kind of state interference.

B. The inadequate structure of R&D sector

Although the total investments in R&D (GERD) in Croatia are quite satisfactory (since it amounts to 1.2% of GDP in the year 2000) and Croatia is at the top of the list of theEuropean accession countries (still below Slovenia with 1.5% of GDP, but above Slovak Republic and Hungary with 0.68% of GDP, or Poland with 0.75% of GDP), the industrial R&D sector, the driving force of economic development, has almost disappeared during the transition period while the public R&D sector, the national pool of knowledge, has been seriously weakened. The general diagnosis would be that the problems are not so much in "inputs" but in "outputs" – the so called "Croatian research paradox"

Table 2
R&D and innovation indicators for selected countries in 1999 (Or the most recent available year)

Indicators	Croatia	EU	OECD	Finland	Nordic countries	Poland	Hungary	Slovenia
The Global Competitiveness report								
– Rank of GDP per capita (2001)	44			14		38	30	25
– Rank of national competitiveness	58			2		51	29	28
– Rank of technology index	58			3		36	21	25
– Rank of innovation capacity	42			3		35	28	25
GERD	1,19	1,85	2,21	3,19	--	0,75	0,68	1,51
% of GERD performed by business	44,4	65,6	72,4	70,0	69,2	41,4	45,4	55,0
% of GERD performed HE and public labs	51,2	34,4	27,6	26,0	30,8	58,6	54,6	45,0
% of GERD financed by business	44,5	54,7	63,2	65,0	62,8	38,1	38,5	56,9
% of GERD financed by the State	52,7	36,0	29,8	30,0	30,0	58,5	53,2	56,9
BERD	0,43	1,20	1,54	2,18	–	0,31	0,28	0,84
Public expenditures on R&D as % of GDP (GOV+HE)	0,55	0,64	0,61	0,99	–	0,44	0,37	-
R&D expenditures per capita (USD)	70	415	500	–	690	60	90	220
Researcher is business sector (%)	17,3	49,8	64,9	–	50,5	18,3	25,9	18,3
Researchers in public sector (%)	82,7	50,2	35,1		49,5	81,7	74,1	63,6
Researchers per 1000 labor force	3,2	5,2	6,1		8,1	3,3	2,9	4,6
PhD in science and technology (aged 25-34)	0,17	0,55	0,47 (USA)	0,97	–	–	–	–

Source: Radas 2003; Strategy of Development, "Croatia in 21st century – Science", (Official Gazette, 108/2003), The Global Competitiveness Report, 2002-2003, Annual Competitiveness Report of Croatia, 2002, NVK, 2003

This paradox is rooted in the inadequate structure of R&D sector which is not harmonized with the requirements of the modern research system for "catching up" and adjusting to knowledge-based economy. In the developed countries industry dominates the science system since it funds nearly 63% and conducts about 72% of the total R&D. It employs the majority of researchers and scientists – from 50% in the EU to 65% in OECD countries.

But Croatian R&D system is still dominated by the public sector since the state funds about 53% of R&D and employs about 83% of researchers (53% at universities and 30% in the public labs).

Business sector finances about 44% of total R&D and employs only 17% of researchers. It is obvious that the vast majority of R&D potentials heavily depends on the scarce budget resources, which amount to only 0.55% of GDP.

In addition, the total investment of business sector in R&D is extremely low and amounts to 0.43% of GDP while in the developed countries business sectors invests more than 1% of GDP and in the fast growing countries like Finland more then 2% of GDP.

Both the government and the industry in Croatia have a very good reason for alarm. Therefore, the urgent task of NIS in Croatia is to strengthen the industrial R&D sector towards its domination of R&D system.

The devastation of industrial production and industrial R&D sector is a most severe shortcoming of the Croatian innovation system, as insofar both the major supply and the strong demand for R&D and technological development have disappeared.

Thus, to build up and support R&D and innovative activities in the business sector should be a common goal both for the government policy and the business sector.

At the moment, the institutional and policy environment is neither conductive nor encouraging for entrepreneurial activities and technology development. It, also, isn't attractive for international / export oriented economic activities.

The prerequisite for such change in R&D system would be a social and political recognition of the business sector as the place of commercialization of research through innovations and new technologies. However, during the transition period, the political and business elites applied the "shock" therapy (Radošević, 1996) on industrial R&D sector driven by the neo-liberal belief in the perfect market. The business philosophy of the new business elite was driven by "rent-seeking" through privatization and not by "profit-seeking" through industrialization and technology accumulation.

C. The unsatisfactory science-industry cooperation

The strengthening of the industrial R&D sector largely depends on the science industry cooperation, a mechanism which is widely used in the developed countries for the translation of R&D potentials into new marketable technologies.

In Croatia is the cooperation between public R&D organizations and business sector quite unsatisfactory. The research institutes earn only about 10% and the universities earn meager 6% of their revenues from the contracts with the industry (Švarc et al., 1996). There is no market for scientific research and services, since the Croatian industry has, in time, lost the need for R&D services, and the research institutions traditionally play a passive role in this interaction. The close cooperation exists only between the large industrial companies in technology intensive fields and their corporate institutes established for the purposes of the in-house research (e.g. "Tesla – Ericsson" (telecommunication), "Pliva" (pharmacy)).

For the science-industry cooperation to develop it is necessary to understand that the linear model of innovation has never proven its worth in practice because the large investments and the top scientific achievements do not automatically create profit. That's why, during the 1970s, when the innovation based competitiveness emerged, many countries substituted the linear model of innovation with the interactive model. The linear model presumes the automatic translation of scientific results to the business sector use and encourages the independence of science from the industry.

By contrast, the integrative model is based on the interaction of science and the industry. This interaction is a mechanism of the commercialization of research and of the building of the technology capacity of firms. Therefore, some distinguished scholars pointed out that, in modern countries, the science-industry cooperation emerge as an important political issue (Dosi, 1988). Still, that were not the case in Croatia.

D. The inappropriate environment

The importance of the technology accumulation, industrial research and the science-industry cooperation for the long-term economic growth is poorly perceived and understood in Croatia. Correspondingly, the creation of proper environment that would encourage these new factors of economic growth was very much neglected.

To illustrate: Croatia lacks:

- domestic venture capital industry – a special financial institution for supporting new technologies or technology based business like seed capital or risk capital
- system of encouraging the protection of intellectual property in research by patenting, licensing or by other method of the commercialization of innovation and research results
- large infrastructural institutions for technology transfer like technology or science parks
- technology foresight programs as an exercise in self-analysis of technology limits we are facing
- significant efforts in developing competence is generic technologies like biotechnology, nano-technology, new materials or even computer technologies which play today the same role that the electricity played in the past.

The shortcomings of the exiting NIS show how cultural values, historical heritage, political will and social recognition form the mentality and the paradigm of semi-modernism, both of them obstacles to the modern way of thinking about the development (Table 3).[4]

Table 3
Differences in modern and traditional approach to some elements of NSI

NSI elements	Traditional approach	Croatian specifities	Modern approach
Technology capabilities of companies (TC)	• Implicitly assumed as immanent to companies • New technology is exogenous process • Technology can be bought on the free market • Market is perfect	• TC is irrelevant sine rent seekers and tycoons dominate in the management structures • Privatization according to the empty shells model	• Technology is endogenous process • TC is continuously improved by learning and accumulation • State intervenes to amortize market imperfections
Structure of R&D sector	• Domination of the academic science funded by the state	• Domination of the academic science funded by the state • Descientization, anti-intellectualism	• Domination of industrial private sector in investing and performing R&D
Weak science-industry cooperation	• Linear model of innovation	• Science and universities are "ivory tower"	• Interactive model of innovation • Science-industry cooperation is decisive factor of economic development • Networking • Public-private-partnership
Proper environment	• Neo-liberal approach • Market perfection • No need for deliberate social action or state intervention	• Not recognized as a factor of development	• Depends on intentional social activities, self-organization and self-management • State support is indispensable

Still, parts of the government administration did try to set up a proper environment by creating different support programs. The most important efforts are those of the **Ministry of crafts and small and medium sized companies** which has launched a range of different programs for upgrading firms' technology capabilities and export[5]. Also, the Croatian Program for Innovative Technological Development (HITRA) launched in 2001 by the Ministry of science and Technology (MoST) aimed at encouraging the science-industry cooperation via technology projects and the support of the knowledge-based companies. These endeavors should be taken as the foundations of the Croatian NIS, but without the national consensus on the technology development they have limited and short-term effects.

HOW TO BECOME KNOWLEDGE-BASED ECONOMY/SOCIETY?

The formula for becoming KBE/S is quite simple and can be expressed as follows:

KBE/S = (science + education) × innovation + technology.[6]

However, to implement the formula a level of social and political modernism that would allow the comprehension of the following ideas is required that:

- driving force of KBE is knowledge (and education) embodied in the technological change which consists of the technological capability to create and absorb innovations
- managing the technology change (innovations) is located primarily in companies (industry) and is the result of the accumulation of technology and learning
- technological change is biased towards knowledge-based innovations and that the knowledge flow from science to industry and back is the key concept of modern development
- technological change and learning are essentially social processes which can be accelerated by proper social and political actions targeted primarily at the science-industry cooperation
- intentional social and political action to facilitate knowledge flow is also known as NIS, so building up an efficient NIS with the emphasis on the technological capability of companies by means of the science-industry – government cooperation is a key to achieve KBE.

The social and political acceptance of the aforementioned ideas calls for:

- the radical change in the traditional economic doctrine, a shift from the classical growth theories to the new growth theory (Table 4)
- the change in the mentality dominated by the belief in a perfect market towards the belief in the creation the national innovation system as an intentional social and political activity of planning and managing national R&D resources, if necessary even by the state intervention.

The shift from the classical growth theories to the new growth theory also asked for the shift from the exogenous to the endogenous growth model. In contrast to the traditional economy which acknowledges only tangible investments in capital and labor (machinery, plants, buildings and worker's wages) as the main production and growth factors, the growth of the new economy is based on the accumulation and investments into the intangible capital, primarily knowledge and human capital. Basing economic development in R&D, technology and learning is, in comparison to the traditional economy, quite a radical approach and some countries were not able to comprehend it. The shift from the traditional cost-based competitiveness of firms to the competitiveness based on innovation requires the substitution of the classical science and industrial policy with the innovation policy as the strategic integration of both science and technology into the new policy of economic development.

The neo-classical exogenous growth theory formulated by Solow in the early 1960s (Solow, 1957) was the needed breakthrough in the economic theory. The theory states that the largest part of the economic growth Šone half (OECD, 1992:168) or even 3/4 (Solow, 1957) cannot be explained by the traditional economic factors of labor and capital (conventional capital). It can be explained by another, the third production factor, the so-called technological change[7]. However, it has been treated as an exogenous factor, "manna from heaven" (Petit, 1995) making, in an incomprehensible way, the production factors more productive. It was seen as unrelated to the pace of economic growth and therefore not capable of explaining it.

Table 4
The shift in economic theory

KNOWLEDGE-BASED CONOMY	TRADITIONAL ECONOMY
1. BACKGROUND: new growth theory – endogenous growth model	1. BACKGROUND: neo-classical growth theory – exogenous growth model
2. PRODUCTION FACTORS: knowledge as endogenous to economy and society transformed into the innovation	2. PRODUCTION FACTORS: capital, labor, technology as exogenous to economy and society
3. INVESTMENTS: intangible capital, R&D, learning, products & process improving	3. INVESTMENTS: tangible capital, machinery, plants, buildings and labor in terms of wages
4. COMPETITIVNESS based on innovation	4. COMPETITIVNESS cost-based

The neoclassical theoretical framework, which was not able to explain the nature of economic growth and technology change, assumed that:

1. all social and economic processes, including the emergence of technology, are regulated by the perfect market and by the competition,
2. new technologies appear as the market demands them (demand-pull model),
3. they are freely available under the same conditions for all, they do not cost anything nor do they require any special knowledge
4. according to the linear model of innovation technologies appear at the last phase of research and are embodied in machinery.

Contrary to this approach, according to the new growth theory formulated by P. Romer as the "endogenous growth model" (Romer, 1989, 1990) the driving force of economic growth is knowledge or idea. Knowledge is completely new kind of production factor which, when imbedded in new technology, innovation, machinery, process or similar, has the effects of externalities and spill-over and therefore creates continuous returns on investment and continuous economic growth.

Due to externalities and spill-over, knowledge has the permanent positive effects on economic and social development. Therefore, technology as materialized knowledge is not a factor exogenous to economic and social processes but is endogenous to society and economy. The new growth theory has overcome the neo-classical approach of diminishing returns to investments. It has also overcome the theorem of economic stagnation.

To accept the new growth model means to accept the knowledge and education as the new production factors and accept all the rules imposed by the "knowledge economy" including the new business culture, new mental concepts as well as the new ways of behavior.

WHAT CAN SOCIAL SCIENCES DO?

The endogenization of R&D is just the first and more simple part of the "how to become knowledge-economy" equation. The second part is about "social change" and the shift in mentality necessary for the acceptance of the first steps towards the new economy – the materialization and the commercialization of science and education through innovation and new technologies.

In spite of the externalities and the spill-over effects of knowledge (implying that investments in all kinds of knowledge are effective), it must be commercialized to become economically valuable. Starting from the basic definition of technological innovation as "the first application of science end technology in a new way, with commercial successes (OECD, 1992)" the capitalization of knowledge is realized by being translated to innovation, which leads us to the technological capability of companies, managing technological change (innovations) and technology accumulation. In other words, it leads us to the concept of the national innovation system (see Freeman, C., 1988a; Lundvall, B. A., 1988; Niosi, J. at al., 1993), the concept the origins of which go back to the early 1980s when the business philosophy of companies was best illustrated by the slogan "innovate or liquidate" (Grayson, 1996:18).

In contrast to science policy, national innovation system stresses the commercial utilization of innovation as well as the commercial application of research results with the purpose of achieving economic growth and competitiveness.

Emphasizing the need to interconnect all the institutions and subjects relevant for the production and diffusion of innovation it goes far beyond science planning and coordination. It has gradually been replacing standard R&D policies.

Some of the more technologically advanced industrializing countries like Japan and Korea in the past and Finland or Ireland today, are the proof that a proper innovation system enables even the less developed countries to accumulate technology, which results in a more complex production sector and, eventually, in entering the knowledge-based economy[8].

The advancement of these countries supports the well-known conclusion that economic progress and technology development are primarily social processes (OECD, 1992) meaning that achieving KBE depends on the social ability of self-organization and on the self-management system which encourages the commercialization of knowledge through innovations and new technologies. NSI is socially rooted and depends on historical heritage, culture, ethics, political attitudes, etc. That's why the national innovation systems differ so significantly across the countries and regions.

Social sciences could, therefore, help construct the national innovation system and enhance economic growth. Today, the theory of Triple Helix (TH) emerges as the most useful theoretic platform, analytical framework and normative approach for social research and social action in building NIS and enhancing economic growth.

"The Triple Helix is intended to be a sociological expression of what has become an increasingly knowledge-based social order" (Shinn, 2002). As Leydersdorff and Etzkowitz (2003) pointed out "(...) it can be considered as an epistemological tool that helps us to explain current transitions towards knowledge-based economy. Three helices are sufficiently complex to help us understand the social reproduction of the dynamics of innovation (...)".

In our opinion, this status of TH as a high-level theory on social structures and their dynamics within knowledge-based socio-economic system is based on the same assumptions that make NIS one of the most popular theories of economic development.

NIS is by definition "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1988). In a narrow since it involves only the institutions that are directly concerned with scientific and technical activities[9].

For the small and the less developed countries with scarce R&D and technology resources the concept of NIS is extremely important since it is based on the assumption that the competitiveness of a nation does not only depend on the scale of R&D but also "upon the way in which the available resources are managed and organized, both at the enterprise and at the national level". Proper NIS may enable a country with rather limited resources to make very rapid progress while inappropriate NIS can cause the waste of the abundant resources (OECD, 1992).

If we translate this massage from NIS to social sciences, it would mean that economic growth and technology development are complex social phenomena primarily based on the ability of a society to organize itself to stimulate technology change and innovations as the main driving forces of growth. TH model of evolutionary convergence of the three key players/helices towards economic growth is very close to the idea of self-organization of society towards economic growth and social welfare. The Triple Helix emerges as a new theoretical and analytical framework for studying sociology of science in the knowledge-based society resembling NIS which is used to describe the necessary transformation of economy towards innovation base competition and knowledge intensive production. The role of TH in social sciences is virtually equal to the role of NIS in economic sciences.

TH and NIS share some basic constitutive elements: the basic theoretical premise of socio-economic system as a constructive element, the same evolutionary approach of constructing the socio -economic system[10] as well as the same goals and functioning principles (Table 5). However, there are also some differences between these two concepts, for example the limitations of NIS to national borders vs. the European or wider perspectives of TH (Leydesdorff, 2002). The most important difference is the analytical approach, which, in turn, is the most criticized aspect of TH theory (Etzkowitz & Leydesdorff, 2000). While NIS analyses growth from the perspective of an industrial company which is seen as central to economic development and perceives innovation as the main driving force, TH analyses growth from the position of the equal importance of each of the three helices and their spontaneous convergence towards growth.

Table 5
A tentative list if similarities and differences between TH and NIS

Elements	Theory of TH	Theory of NSI
Goals	Knowledge based society	Knowledge based economy
Theoretical premises	Economic growth is result of socio-economic construction	Economic growth is result of socio-economic construction
Driving forces	Knowledge flow	Innovation flow
Central institutions	Equal role of science, industry, government	Industrial company
Main constitutional elements	Science, industry, government (S-I-G)	Research/science institutions in the industrial and public sectors; government as facilitator of cooperation; other sectors that influence producing innovation
Principle of development	Evolution of helices	Evolution of innovation
Principle of functioning	S-I-G cooperation	Pubic-private partnership (networking)

This is, probably, the main reason why NIS is, in economics, commonly accepted as a model used to explain the innovation-based national competitiveness and to respond to the imperialism of other countries, while TH is heavily attacked by a number of scholars.

Actually, the concept of Triple Helix (TH) has, from the very start, been controversial: while some scholars perceive it as a "narrative fantasy (O'Malley, McOuat, Doolittle, 2002), and a possible threat to academic freedom (Viale & Campodall'Orto, 2002), others treat TH as "a serious research school" (Shinn, 2002) and accept it as a natural framework for studying the science-industry interaction. However, both sides agree that TH enjoys great popularity, particularly among the developing countries and is still of growing interest to sociologists, economists and science policy makers.

Putting aside the objection that universities should abandon the "third mission" of direct contribution to industry and should return to research and teaching (Etzkowitz & Leydesdorff, 2000), there is a serious criticism that TH is rhetorically powerful but in practice a very vague model (O'Malley, McOuat, Doolittle, 2002; Viale & Campodall'Orto, 2000; Jensen & Tragardh, 2002). It might be a problem to implement it, especially in the underdeveloped regions because it will not make the underdeveloped regions less underdeveloped, since these regions lack the basic prerequisites for the implementation of TH, e.g. competence, education, research etc. (Jensen & Tragardh, 2002).

This really is bad news for the developing countries which perceive TH as the theoretical background and the practical model using which the economically underdeveloped areas can recover relying on their national knowledge resources. Are we, the developing countries, delusional about TH? Do we advocate for a concept which can be applied only in the advanced countries?

Indeed, the famous theory of technological accumulation convincingly explains that the technological capability for managing innovations (technological change) (Bell and Pavitt, 1993) is gradually built up from productive skills to technological (innovation changing) abilities. There is a long way to go accumulating technology, before one can come from production capabilities to the knowledge intensive sectors. It may be reasonable to accept that the industry-science interaction is relevant only at these complex levels of knowledge-intensive productions while on the lower levels it is irrelevant. Indeed, building technological capabilities at the lower levels includes a lot of training in management and marketing, quality certification, technology and business audits. The dominant process of economic development is working and reworking – a creative imitation of the existing innovations in which the research is not necessarily involved because companies do not absorb much R&D. The industrial company and the innovation as the driving force are central to NIS. In TH none of the three helices has the central role because economic growth is seen as the result of the knowledge flow based on the interaction and the spontaneous convergence of the three helices towards growth. One can only assume that the spontaneous convergence will be directed towards innovation.

Both, TH and NIS are based on the knowledge flow between science and industry, private companies and universities/research institutes.[11]

The since industry- links differ across countries and the most intensive (measured by the patent citations) are in the most developed OECD countries; the USA, Canada, the United Kingdom and Australia. Such links are less developed in France, Germany and Japan which is explained by the initiatives for the technology transfer from the public sector to private industry as regards patent protection, operative research and such (OECD, 2001).

However, the serious doubts about the "prime mover" still remain – what came first: a certain level of industrial complexity that generates the demand for cooperation with industry or was it the other way around, that the cooperation between industry and science generates faster economic development. In other words: do the developing countries and their governments need to stimulate S-I links or should they take care only that technological capabilities of companies reach the level of absorption of R&D? Is today possible to develop technological capabilities without R&D?

Some analyses speak in favor of S-I links being pre-requisites for technology development and economic growth.

The **first argument** is the history of the grant- land universities in the USA and the emergence of the chemical and electrical engineering as the fist knowledge-based industries (also in the USA and, in a lesser degree, in Germany) revealed that S-I links have a long tradition and they were established much before knowledge-based economy. The **second** is that certain comprehensive analysis' of the relationship of science and education to industrial performance revealed that although industrial performance is rarely directly linked either to research or education there is a strong relationship between the economic development and the interaction between industry and scientific research (Shinn, 1998).

The **third** and the most important argument for the developing countries has to do with NIS and its fundamental transition from science to innovation that generates the shift of focus from R&D **in public institutes and universities** to R&D, innovative activities and technology capabilities **in companies**. NIS appeared as the reaction to the linear model of technology development (technology as the last phase of research) pushing forward the technology policy and industrial performance and giving science and research the supporting roles. Indeed, countries like Finland or Ireland, which substituted classical R&D policies with innovation policies succeeded in transforming into knowledge-based economies. Did that destroy science in those countries? It seems that it has not happened. The dominance of innovation over scientific research does not mean the weakening of public R&D. Just the opposite: The developing countries are, same as the developed countries, forced to catch-up with the more advanced countries and even with the technology leaders in spite of their scarce R&D resources.[12] The catching up process involves three basic capabilities (see Andersen and Lundvall, 1988):

- the capability to use (not necessarily to create) radical innovations and generic technologies (e.g. nano-technology, biotechnology, etc.)
- the capability for incremental innovations – adopting and modifying foreign technologies, re-engineering
- the capability for producing the small high technology products for entering market niches.

The development of these catching-up capabilities demands almost the same level of technological capability and accumulation as does the creation of the new technologies since the copying of innovation is today almost as expensive and complex process as is creating radical innovations. It is estimated that the imitation cost amounts to 50% or even 75% of the creation of innovation (Bell and Pavitt, 1993; Nelson, 1990:201). The modern innovation is much more intensive with research; therefore both, the private and the public research systems should be properly developed.

The technology transfer was, not so long ago, considered to be a relatively cost-free and automatic process performed via free knowledge dissemination or via buying the machinery. It has been recognized since, that the technology transfer depends on the national intellectual and research potentials (Fageberg, 1988; Unger, 1988). "The successful exploitation of imported technology is strongly connected to the ability of adaptation and improvement of this technology by own R&D" (Freeman, 1991). The research intensity, educated labor, technology accumulation as well as science-industry cooperation are therefore the key-concepts for both the developed and the less developed countries.

Finally, innovation has today been shifted not only from individual to institutionally organized activity but to network activity. The traditional science-industry cooperation from the 1970s based on the individual and the small-scale institutional cooperation has grown into the concept of the Public-Private-Partnership – PPP[13] especially when the strategic or generic technologies are concerned (OECD, 1998).

In fact, the stress on innovation as the capitalization of science together with network activity make the concept of science- industry cooperation strongest than ever. The need for innovation as research intensified activity is being generated both in the developed and the less developed countries.

There is the need for cooperation between individuals and companies, industry and universities. The knowledge production today is closely connected to its market exploitation and therefore the science-industry cooperation is a key-concept of the modern development.

CONCLUSION

Croatia is an example of the well known fact that "technology development and economic growth are fundamentally social processes. Croatia, as many other transition countries, has demonstrated a social inability to absorb global changes that have driven the country to stagnation which has finally turned into collapse" (Družić, 1994).

This social inability has roots in the Croatian society which is a mixture of the traditional and modern elements. The nation in general and the political and business elites in particular are unable to reach the breaking-point in understanding and accepting the innovation as a new driving force and the science-industry-government cooperation as a tool for activating this driving force. The national innovation policy, technological capability, human capital, science-industry cooperation, etc. have been swapped out by the traditional values of national homogenization and by the business ethic imposed on by tycoons and irresponsible managers.

Therefore, the development of NIS as a social and political consensus on technology and innovation as national development priorities has never had a chance to emerge. The domination of the traditional science policy over the innovation policy is a quite natural outcome Croatian semi-modern society. The social climate of traditionalism and the lack of open-minded elites hindered the reorganization of the new knowledge-based factors of growth and ended in failure in the adjustment of the institutions and the government policies to global changes and requirements of the knowledge-based economy.

The establishment of NIS as a system of the management of innovation requires a certain level of social capital and modernity, particularly in terms of democratization in setting national development priorities. The science-industry-government cooperation as communication between the three constitutive elements of the knowledge-base society creates, if nothing else, a democratic forum for establishing the national priorities. Therefore, the TH concept is a valid and useful concept for the developing countries.

FOOTNOTES

[1] EU candidate countries are: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia, Turkey.

[2] For the purposes of this paper the term pre-accession countries refers to the countries from the same geographic region as the candidate countries, which, unlike the candidate countries, have not yet applied for the EU membership, naimely: Albania, Bosnia and Herzegovina, Croatia, Serbia and Montenegro and F.Y.R. of Macedonia.

[3] Measured in a narrow sense which would include public and private spending on higher education R&D and software, while a broader sense would include all levels of education.

[4] To illustrate: the HITRA programme for supporting the science-industry cooperation launched in 2001 by MoST was heavily criticized by both sides; by the scientists who saw it as an attack on the academic freedom and by the industry which percieved it as an incompetent and too complicated attempt to assist industry on the part of the administration.

[5] There are different programs like "Snowball" and "Entrepreneur" involving 66 regional and local self government units and 18 commercial banks, aimed at the provision of credits for export-import, development and application of the new technologies (mainly the computerization and automatisation of business operations). In addition, the Ministry provides grants for innovators and grants for the introduction of the ISO quality standards and environmental protection.

[6] Inspired by the formula (KNB = (research + education) × science + technology) devised by Romeo Ilie, Research and European Integration Programmes, Head of Office, during the CIPRE seminar: *Role of different actors in the policy and decision-making process,* 18-25 September 2003, Bucharest.

[7] According to the standard interpretation, "technical change" is the result of introducing new production procedures or of organising business in a new way (technological and organisational *innovations)* which generates "technical progress" usually manifested as the increase in productivity and the decrease in the unit costs at given input levels.

[8] The concept of the National system of innovation was, in 1990, adopted by the Science and technology Council of Finland as the description of the orientation towards knowledge intensive technology. Christopher Freeman was one of the authorities of this evolutionary economics by which Finnish Technology was directed (Särkikoski, 1994.) It has become known as the Finnish model of the technology transfer.

[9] Says Olatunji Adeoti (2002).

[10] TH is an evolutionary model based on the evolution of helices in the sense of the spontaneous convergence of the industry, the academia and the government through the processes of communication of all the actors involved (Leydersdorff, 2002).

[11] The success of NIS depends on knowledge flow, too. Some of the analysis identify in OECD countries four types of knowledge flow: technology alliances, science-industry cooperation, technology embodied in machinery and intermediate products, the mobility of experts and educated labour (OECD, 1997).

[12] It is estimated that, today, the 90% of total resources for R&D and technological development is provided by the 10 most developed countries which, naturally, perform the largest part of scientific and technological activities. For example, so-called G7 countries (world's seven larges economies) publish around 70 per cent of world's science (May, 1977).

[13] In the area of technology policy the term public/private partnership can be defined as any innovation based relationship whereby public and private actors jointly contribute financial, research, human and infrastructure resources, either directly or in kind" (Cervantes, 1998).

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Dr Vesna ANDRIJEVIĆ-MATOVAC

Assistant Professor
Faculty of Economics, Department for Economic Theory,
University of Zagreb, Trg J. F. Kennedy 6, 10000 Zagreb, Croatia
Phone: +385 1 2383-106, Fax: +385 1 2335-633
E-mail: vandrijevic@efzg.hr

CROATIAN NATIONAL INNOVATION SYSTEM: HOW TO CREATE AND TRANSFER KNOWLEDGE AND TECHNOLOGY

INTRODUCTION

Increasing export activity is the basic precondition for Croatian economic development. The Croatian market is small and insufficient for more powerful growth, and, because of conditions of globalization, it faces competition both in the domestic market and in exporting outside the Croatian borders. Croatian enterprises have to be aware of these facts and bear in mind that the export of knowledge and technology presents the only way towards competitiveness in the global market. The enterprise can be observed as a system that integrates the specialized knowledge of individuals, transforms it into goods and services, and thereby creates knowledge and technology (Grant, 1996).

Enterprise efficiency in creating knowledge and technology is at the highest level in countries that have successful national innovation systems. Constituent factors in a national innovation system are: "producers" of knowledge and innovations, infrastructure backup and entrepreneurs – the actual users of innovation. The national innovation system unites all the different factors that contribute to innovation development and the realization of innovation processes and includes an institutional infrastructure network of developing innovation centres, technological parks, backup financial institutions (venture capital, business angels), etc. The main components of a national innovation system are innovative enterprises, the education system, the financial system and the government (Nelson, 1993).

The aim of this paper is to analyze the characteristics of the Croatian system for innovation stimulation and to suggest measures for its improvement on the basis of research results on innovative activity in Croatian enterprises and based on the experience of successful countries.

The paper consists of the following parts. First, the characteristics of the Croatian system for innovation stimulation will be described. Second, the results of research on innovation activity in Croatian enterprises will be shown. This is followed by a description of successful Croatian enterprises and those of other countries which are successful in giving incentives to innovation. Finally, measures for the improvement of the Croatian innovation system will be presented.

GIVING INCENTIVES TO INNOVATION IN CROATIA

The Ministry of Science and Technology presented in 1999 the National Science and Research Programme which defines: (1) the role of science and technology in the development of the Republic of Croatia; (2) the direction of national investments to science and technology; (3) the drawing up of a strategy plan of viable development and the application of new technologies; (4) incentives for scientific and technological development and (5) international cooperation in science and technology.

The bearers of technological and scientific development according to the Programme are: the economy sector, the sector of university education, public scientific research institutions, and private non-profit institutions. The programme envisages the construction of a national network of technological centres through the following institutions: (1) business- innovation centres, (2) centres for technology transfer, (3) financial institutions, (4) institutions for prognosis and supervision, (5) innovational and engineering services, and (6) other centres of technological excellence. The most important activities conducted in the Croatian economy with a view to giving incentives to innovative activities are described below.

HITRA Programme

The Croatian Programme of Innovative Technological Development (CPITD-HITRA) encompasses the public scientific-research sector and the economy, and in this way integrates scientific and technological policies. The HITRA Programme consists of two sub-programmes which are complementary in their goals and purpose: Technology projects – TEST and Knowledge-based companies – RAZUM (PRUDENCE). The first falls under the responsibility of the Ministry, while the latter is performed by the Business–innovation Centre of Croatia – BICRO.

The technological research-development project (TEST) finances the development of the "idea" in the "original solution", and stimulates the activation of scientific-research resources based on the idea of the entrepreneur, as well as the development of academic entrepreneurship. The drawing up of feasibility studies and evaluation reports on the enterprise are the subject of the RAZUM (PRUDENCE) sub-programme.

Entrepreneur Centres

More than 20 entrepreneur centres are under development in Croatia. In addition, four technology centres in Zagreb, Rijeka, Osijek and Split are supported by the Ministry for the development of technology-based businesses. There is also the Technology Park supported by the City of Zagreb, the oldest centre, which serves as an incubator for numerous small enterprises in the initial phase of development, and which are given space, expertise and financial help for growth and expansion.

Stimulation of innovative entrepreneurship and protection of intellectual property rights in Croatia

Government and non-government institutions may provide incentives to innovative entrepreneurship. The most frequently mentioned associations are: the Croatian Federation of Innovators, different associations of innovators, and the Association for Inventive Work at the Croatian Chamber of Economy. The Croatian Federation of Innovators in the Community for technical culture under the patronage of the Department of Education and Sport reports each year on about 300 inventions for patent protection, which contributes considerably to the development of the Croatian economy. The Association for Inventive Work is a non-profit organization and gathers members from all layers of society and the economy – associations of innovators, individual innovators, enterprises that conduct inventive work, technology parks and centres, development-research institutes, and faculties and institutions which conduct research and development of new products and technologies.

Numerous laws exist which constitute a legal frame for the Croatian system of intellectual property. However, this is not enough for the protection of intellectual property. Croatian innovators often object to the long and costly patent process. There are many innovations in Croatian enterprises, but there are not so many whose intellectual rights have been protected (Andrijević-Matovac, 2003).

The Ministry of the Economy, Labour and Entrepreneurship

The Ministry of the Economy, Labour and Entrepreneurship ensures the initial budget, non-returnable subsidies in the form of incentives for the introduction of innovation in the market which are intended for technological monitoring of the idea, as well as credit resources for entrepreneurs who use innovations in their production and business.

The Croatian Agency for Small Business (HAMAG) has been established. It is envisaged as an institution which will coordinate the implementation of medium-term and short-term programmes of development of small enterprises. It is a special professional government body for small businesses, and aims at realizing a unique approach in the improvement of efficiency in carrying out incentive measures. In the frame of its activity there will be incentive measures for innovative activities in small and medium enterprises.

RESEARCH ON INNOVATIVE ACTIVITY IN CROATIAN INDUSTRIAL ENTERPRISES

Methodology and research sample

Research was conducted on the level of innovative potential in successful enterprises in Croatian industry (Andrijević-Matovac, 2003). Industrial enterprises were selected since they are the main actors and incubators of innovative activity.

The research methodology was developed on the basis of the OSLO Manual (OECD, 1992), which was used for the development of a questionnaire used for gathering information on innovation and the intellectual capital of successful enterprises in Croatian industry. On the assumption that large enterprises have a research and development department and thus a higher level of innovative activity (Archibugi, Michie, 1997), the sample included 300 large industrial enterprises selected by the criterion of total income. The questionnaire was sent to the enterprises for the first time in October, 2001. A total of 58 enterprises responded to it in the first round. The questionnaire was sent for the second time to the rest of the enterprises in March, 2002. In the second round another 33 enterprises responded. In total, the questionnaire was responded to by 91 enterprises, making up 33% of the whole sample, which is considered acceptable for this type of research (Alreck, 2001). The main results of the research are presented below.

Main results of the research

The main results of the research on innovation activity in Croatian enterprises are presented and are compared with the experiences of enterprises in the European Union and in countries in transition: (1) ways of acquiring new technologies; (2) innovation activities; (3) aims of innovation activities; (4) resources of ideas and information for innovation activity; (5) factors that give incentives to and disrupt innovation activities; (6) concession of material rights to technology; (7) development strategies connected with innovation activities; and (8) investment in knowledge, research and development.

Ways of acquiring new technologies

A large number of Croatian enterprises purchased capital equipment, while other means of acquiring new technologies were as follows: buying information systems with new technologies, production processes with new technologies, services with technology contents, materials or semi-products with new technologies, and engaging experts. The acquisition of new technology increased in the period 1996-2000 in comparison with the period 1990-1995 (Table 1). A large number of enterprises acquire new technologies from European countries, while the number of enterprises which acquire new technologies from Croatia and the USA is very small. The rest of the countries are much less significant as a source of new technologies for Croatian enterprises.

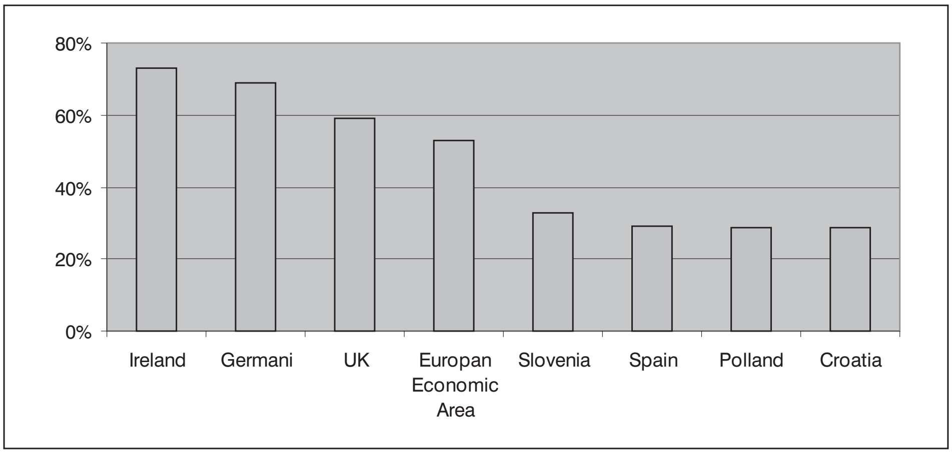
Table 1
Number of enterprises per acquisition of new technologies for the periods 1990-1995 and 1996-2000

The way of acquisition of new technologies	1990-1995	1996-2000
Research-development contract (cooperation)	4	7
Patent purchase	4	6
Purchase of industrial models and samples	7	2
Purchase of trade marks	6	1
Purchase of business secrets	6	7
Purchase of rights for use of foreign inventions	5	2
Purchase of information systems with new technologies	17	31
Purchase of capital equipment	32	50
Services with technological contents	17	18
Production processes with new technologies	16	41
Materials and semi-productions with new technologies	12	28
Engaging experts	16	31
Other activities	4	9

Innovation activities

Croatian enterprises have a low level of innovation activity in comparison with the countries of the European Union, both in relation to the "old" member states and the "new" member states. All the research work was done according to the instructions of the Oslo Manual (Mickiewitz et al., 2001), but it was conducted in different periods of time. However, since the same methodology was applied, the results are considered suitable for comparison. The research on 6 EU countries was conducted in the period from 1995 to 1997, the research on Slovenia in 1998, and on Poland from 1997 to 1998. For example, the share of Croatian innovation enterprises for the period from 1996 to 2000 was 28.6%, while the share of innovation enterprises in Slovenia was 33% in 1998.

Figure 1
The share of enterprises that had innovation activity from selected countries (Andrijević-Matovac, 2003 and Mickiewicz et al., 2001).



The innovation activity of Croatian enterprises can also be evaluated on the basis of the structure of innovation costs. Croatian enterprises spend a great amount of resources on the acquisition of patents and licences, and less on research-development activity than enterprises in the European Union (Radošević, 2002). On that basis we can conclude that in comparison with EU countries only in very few cases do Croatian enterprises produce new technology on their own.

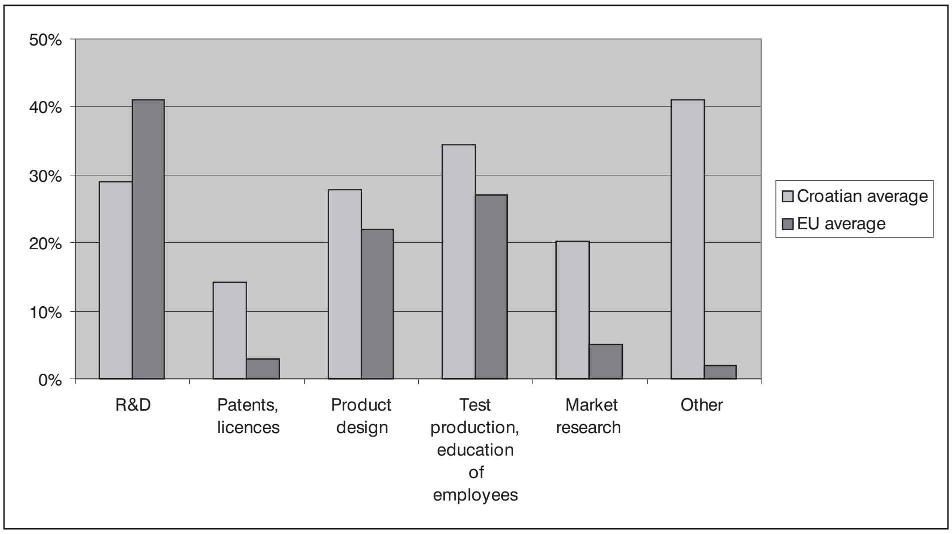


Figure 2
Innovative activities with innovation costs in percentages (Andrijević-Matovac, 2003 and Radošević, 2002)

Aims of innovation activities

Croatian industrial enterprises cite the following aims of their innovation activities as the most important: introduction of new products, widening of their product line within their basic programme, widening of the market, reducing costs, but increasing quality. This does not distinguish Croatian enterprises from enterprises in the EU and Russia (Radošević, 2002), which quote similar aims as the most important ones.

Sources of ideas and information for innovation activity

The most important sources of ideas and information for the innovation activity of Croatian enterprises are a company's management, research and development, and sales and marketing. Buyers and clients are in fourth place. On the other hand, enterprises in the European Union put buyers or clients in first place, followed by internal sources – management, and research and development (Radošević, 2002). We can conclude that Croatian enterprises are still not aware of how important a buyer's satisfaction is.

Factors that give incentive to or disrupt innovation activities

For Croatian enterprises the most important factors which give incentive to innovation activity are the management's vision of the enterprise on one hand, and the human and research potentials of the enterprise on the other hand.

These factors are internal factors. Among the external factors, information about the market is ranked the highest, while certain relief for innovation activity has been ranked relatively low.

The next obstacles in innovation activity quoted as the most important by Croatian enterprises are: insufficient financing, an excessively long period of return on investment, and small innovation potential. This is similar for enterprises in the "old" member states of the European Union, and for the new members, Slovenia and Hungary (Radošević, 2002).

Concession of material rights to technology

The results of Croatian research show that fewer than 10% of enterprises from the sample would concede technology to other enterprises, and the most common way of doing this was the sale of capital equipment into European countries. A similar situation can be found in the countries of the European Union (Radošević, 2002).

Development strategies connected with innovation activities

The respondents evaluated the importance of the goals connected with innovation activities as part of the strategy of their enterprise. One of the aims connected with innovation activities received relatively high grades, but these were the aims connected with the existing comparative advantages of the enterprise: the introduction of new products in existing markets, improving existing technologies, more efficient use of existing materials and continuous education of personnel.

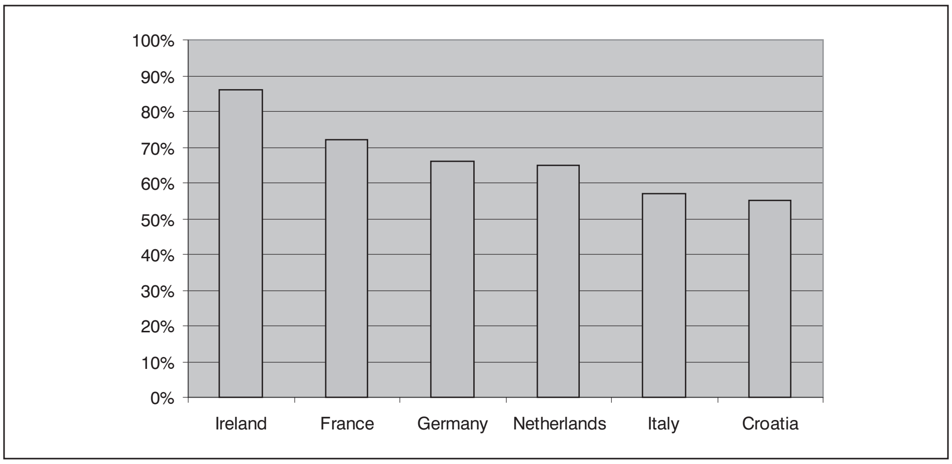
However, the aims that would enable the development of knowledge and technology received lower grades, and they related to the development of new technologies, the creation of an innovative organizational structure, the introduction of a reward system for innovation research scientists, the use of new materials and the improvement of technologies developed in other enterprises.

Investment in knowledge, research and development

Most Croatian enterprises invest in the education of personnel. However, it is necessary to point out that the largest share of resources was spent on courses in foreign languages and the education of production workers and administrative staff.

More than half of Croatian enterprises conduct research-development activities (Figure 3), which lies within the range of most European countries (Mickiewiz et al., 2001). The situation looks good at first sight, but it is necessary to take into consideration that Croatian enterprises spend on average 2.8% of total income on research and development. Since larger investments in research and development would stimulate the growth of the enterprise, as well as economic growth as a whole, investments from 5 to 10% of total income are recommended (Brown et al., 1998). Although a great number of Croatian enterprises conduct research-development activity, it is common that they invest very small amounts in it.

Figure 3
Share of enterprises that invest in research and development (according to Andrijević-Matovac, 2003 and Mickiewicz et al., 2001)



Summary of the research

On the basis of the research conducted on the enterprises of Croatian industry, the following conclusions can be made about innovation activity in Croatian enterprises. New technology was acquired by half of the enterprises in the sample in the period from 1990 to 2000, but in the same period approximately 1/10 of the enterprises conceded their technology to other parties. In most cases this involved the purchase or sale of capital equipment. On the basis of this information it can be concluded that innovation activity in Croatian enterprises is low. This conclusion is confirmed by the fact that 28.6% of Croatian enterprises in the period from 1996 to 2000 reported innovation, which is considerably lower than the average of the European Union, and lower than is common in other transition countries. Croatian industrial enterprises make the largest part of their income on other products that are essentially unchanged or subject to gradual change.

Investment in innovation activity is mostly earmarked for the acquisition of patents and licenses, and their exploitation (test production, education of employees and technical preparation). On the other hand, enterprises from the European Union invest most of their resources in research and development. The smallest share of the total income of Croatian enterprises is made from newly introduced or considerably changed products. Investing in research and development is also low. It seems that the primary goal of Croatian enterprises is to use innovation to maintain their good position in the market, but they do not consider themselves to be innovative organizations which should create new knowledge and technology.

However, the situation is not as bad as it seems at first sight. The number of enterprises which reported innovations increased in the period 1996-2000, and the same applies to the average number of innovations by enterprise. At the beginning of the observed period, only 10 enterprises reported innovations, with 7.8 innovations per enterprise on average, and their number increased at the end of the period to 21 enterprises with reported innovations, with an average of 11 innovations per enterprise. However, in the same period, patent activity was much weaker than innovative activity due to the war events in Croatia and to a long patent process.

Croatian enterprises quote approximately the same goals for innovation activities as enterprises in the European Union and in Russia: the introduction of new products, enlarging the product line within the basic programme, expanding the market, reducing costs, but also increasing quality. It is the same with the factors that stimulate innovation activity and with the obstacles for innovation activity. It is promising that the strategic goals connected with innovation activity received high scores. However, these goals are connected to improving existing programmes: introduction of new products in existing markets, improvement of existing technology, more efficient use of existing materials and continuous education of personnel. On the other hand, the following goals were also reported: the development of new technologies, the creation of an innovative organizational structure, the introduction of a reward system for innovation research scientists and the use of new materials. These are the very factors that could enable the real development of new knowledge and technologies.

In the research of innovation activity in Croatian enterprises (Andrijević-Matovac, 2003), special emphasis was put on the experiences of Croatian enterprises which are successful in the field of innovation. The following areas will be analyzed and compared with the average of Croatian industry: goals of innovation activities, sources of ideas and information for innovation development, obstacles and stimulating factors for innovation activities, and enterprise development strategies.

Successful enterprises conduct innovation activities aimed at expanding their assortment, winning new markets and improving conditions of work and business, for which emphasis was laid upon the introduction of new products within the basic programme and winning new market segments. The average Croatian enterprise, on the other hand, emphasizes decreasing the costs of labour, materials, energy and even cutting costs of designing products. In other words, successful enterprises see innovation as a breakthrough into new markets with the help of new products, whereas the average Croatian enterprise hopes that innovations can help reduce their costs.

The source of ideas and information for innovations can come from outside or inside the company. The average industrial enterprise in Croatia relies to a great extent on outside sources of ideas and information, such as buyers, clients, competition, suppliers and fairs/exhibitions. On the other hand, successful enterprises in most cases use their own research and development department, but they also gave high grades to institutional external sources of ideas and information.

The national innovation system aims to remove obstacles and increase stimulation for innovative activity. Consequently, we conducted a special analysis of what stimulation factors and obstacles were highlighted by the average Croatian industry. Successful companies think that insufficient sources of financing and a too long period of return on investment are the biggest obstacles to innovation activity. The research-development capacity and the research potential of enterprises are predominant stimulating factors for innovation activity. The average Croatian industry also mentions factors that prevent the introduction of change in the enterprise and an insufficient capacity to use technical services, while the stimulating factor for innovation activity is expected from a "higher level", that is, from the management or from the government.

For innovation activity in a company, it is important that innovations are part of the enterprise strategy. In such a way, the strategy of successful enterprises is connected with innovation and knowledge, and high grades were given to the introduction of new products in existing markets, the launching of existing products in new markets, new technological development, improvements in the motivation system for better management and continuous education of the staff. However, the average Croatian industry gave those strategic aims considerably lower grades.

The characteristics of successful Croatian companies confirm the results of Australian research that investigated which forces led some companies to engage in more innovation activities (Webster, 2003). The results of that survey show that factors common to all industries, such as extent of learning, knowledge spillover, appropriability and managerial style, are the most important.

EXPERIENCES OF THE COUNTRIES SUCCESSFUL IN THE STIMULATION OF INNOVATIONS

For the purpose of defining more clearly the measures that could increase the efficiency of the Croatian system for stimulating innovation, the experiences of the leading countries in the field of knowledge and technology export are analyzed below. Ireland and Finland have been selected for this analysis.

Irish national innovation system

The rapid growth of the Irish economy over the past few years is connected with the sector of high technology (Irish Council for Science, Technology and Innovation, 2001). In the period from 1990 to 1996 production increased by 75.5%. The growth was mainly contributed to by pharmaceutical (157.8%) and information companies (92.4%).

Such fast progress is the result of the view of the Irish government that an advanced economy that wishes to use its innovation potential to the full has to develop and maintain connections between numerous components of a national system of innovation: (1) universities and similar institutions that conduct basic research and which "form" highly-educated experts; (2) enterprises, especially those which invest in knowledge-based business; (3) public and private institutions which support education in general as well as training for certain professions; (4) government agencies that finance and conduct activities for the promotion and advance of technological change.

In the National Development Plan for the period 2000-2006, the Irish government has allocated 2.4 billion EUR for research, development and innovation activities (Ireland R&D Information Service, 2002), which will be distributed through all government departments and agencies. The following activities will be financed: education and training (elementary, secondary and lifelong education), higher education (interaction with industry, technology awareness, research programmes and design), financing (enterprises and councils), promotion of innovation (rewards, companies, media), innovation structure (information technology, commercialization of technology, technological incubators and innovation knots).

Finnish national innovation system

The main characteristic of the Finnish policy in science and technology has been long-term continuous development since 1980 (Seppala, 2001). Finland has conducted a successful transition from a manufacturing to a knowledge-based economy. On the other hand, in order to maintain a successful position, it is necessary to continuously invest in the production of knowledge, which includes the following factors: (1) good conditions for the development of the IT industry through a policy of education, science and technology; (2) the development of other areas apart from information science, for example, biotechnology and knowledge services, (3) increasing the level of the application of research results with greater cooperation between the public and private sector, and (4) developing universities as the foundation for the intellectual and material good.

RECOMMENDATIONS FOR THE DEVELOPMENT OF A SUCCESSFUL NATIONAL SYSTEM

A national innovation system can also be defined as a body of institutions whose interactions define the creation of innovation, in the sense of "national companies" (Nelson, 1993). The task of a national innovation system is to trigger and allocate resources and to manage the risk inherent in technological advance. Recommendations for a successful innovation system are the following (West, 2001):

- All elements of the system have to be present and structured so as to complement one another. Otherwise, they will be of little use.
- Non-profit institutions have to sponsor factors of knowledge creation. Individual participants in a com-

pletely competitive market cannot have a sufficient return to justify the risk; in other words, a free market left to its own mechanisms will allocate fewer resources for innovations than is needed.

- The economy has to set considerable investment resources in motion and submit them to unequally risky ventures in relation to other potential investments. Savings and investments should be directed to risky, but potentially lucrative, sectors until the enterprises that are the bearers of innovation and new technologies "get back on their feet".
- When you "enter" a new industry, it is necessary to find a way of diversifying risk. In the long run, this is often done by using investment capital (USA), government and banks (Europe) or large corporations (Japan).
- The structure of risk and the reward system will influence the selection of an optimal system of risk management. Risks encountered by innovative enterprises "are technical, market and managerial". A national innovation system has to give support to the management of technical risk, while the owners of enterprises are experts in the management of market and managerial risks.
- Innovations generally improve the whole economic productivity, either by improving or closing down certain industries.
- In non-productive intensive industries, the most valuable things are "trapped" by the owner of the company.

The Croatian innovation system has only recently started to develop and it is hard to expect it to be sufficiently prepared for the new challenges of the global information society:

- The Croatian activation of resources is weak and the allocation of capital and risk management show that there is a prejudice against technological innovations. Although we are all proud of our innovators who achieve success in international competitions, an investor willing to finance their ideas can seldom be found. In other words, there is a need for a better connection between the manufacturing sector and the generators of innovations, such as talented individuals and universities.
- In Croatia there is no institutional support for investment in risk ventures which are potential generators of development. At present, programmes like HITRA and TEST are just small ones, and considerable resources need to be invested in them.

- There are no resources for diversifying the risk of "entering" a new industry. In the Croatian economy, which is based on the concept of the free market, there are no such instruments.
- The closing down of existing industries is even more important for small nations like Croatia. For example, it is expected that biotechnology will develop new substitutes for raw materials and semi-products in the production of energy, agriculture and in the food industry, as well as in the defence industry. This means that countries that will not participate in biotechnological research will be marginalized in the global economy.
- In the Croatian economy there is the threat that innovative companies might become the property of foreigners, which would bring about the "disappearance" of a great deal of newly created capital from the national economy.

The question arises about what can and what has to be done by the Croatian government to ensure better conditions for research, development and innovation activity. However, there is also the question of what enterprises themselves need to do in order to develop their own innovative potentials. On the basis of the present situation in the Croatian economy and the experiences of successful Croatian enterprises, the following measures can be suggested for the Croatian innovation system to become more successful.

The measures are divided into the following groups: (1) measures for ensuring adequate input, (2) measures for ensuring a suitable environment and (3) measures for the improvement of communication.

Measures for ensuring adequate input

1. High quality educated human resources are a precondition for the development of a knowledge society. It is necessary to increase the quality of and access to education in basic sciences, and especially in the area of information sciences.
2. There is a tradition of financing education and research from government sources. However, these resources are still too small. Let us remind ourselves that companies like Pliva and Ericsson Tesla invest more in research and development in the field of technology than the Ministry of Science and Technology. It is questionable whether the total privatization of those sectors would contribute to the development of the Croatian economy.

3. It is necessary to ensure sources for financing technological innovative activity in more cases than now. There is also a need to make efforts in the area of tax exemptions for those companies, so that the return on investment in research and development can be improved. For example, it is possible to introduce tax exemptions for the costs of research and development within a company, because these departments are the greatest stimulating factor for innovation development.

Measures for ensuring a suitable environment

1. It is necessary to simplify the legal procedure for the protection of intellectual property and make it less expensive. It is also necessary to ensure the implementation of that protection. It is estimated that due to the theft of software in Croatia there was a loss of about 4000 jobs, while the companies and the government suffered great harm. Only occasionally are actions conducted to discover "illegal" operations, which have been found in great numbers. It seems that in the mind of a Croatian citizen this is not a criminal act, but something that can be tolerated.
2. Bureaucratic obstacles are also an immense stumbling block for the development of entrepreneurship, which is a basic prerequisite for the development of a knowledge-based company. There is a great need to simplify the procedure of founding an enterprise and to obtain incentives through the HITRA and TEST programmes.
3. Innovators usually have good ideas, but they do not have adequate knowledge to technologically realise their ideas and to commercialise them. In Croatia there is a network of consultants in the company "Technology Park Zagreb". However, the consultant market in Croatia is only in its early stages, and the quality of consultant services is low. Incentives should be given to the founding of a Croatian Society of Consultants which, through its active work, would promote the most important characteristics of consultants described in the third chapter. The following should be ensured: (1) a legal frame to regulate who can perform consultant work, and (2) resources in which the state would participate to a great extent in financing consultant services. Such concrete financial help would stimulate the use of consultant services by investors, which would increase the commercial return on investment from innovations.

4. It is important to stimulate the development of companies directed to growth by enlarging their assortment, winning new markets and improving the quality of new products. Those enterprises are the bearers of innovation, while enterprises focused on reducing costs are concerned mostly with their own survival and do not have the strength for innovative activity.

Measures for the improvement of communication

1. It is important to stimulate cooperation between universities and companies, which can be conducted through the following forms of actions: (1) help in research in the form of financial assistance, equipment and infrastructure, (2) informal cooperation between individuals from industry and science, (3) research commissioned by industrial companies, (4) programmes of exchange of experts, and the education of students in industry, (5) joint research projects partially financed by the government, (6) research consortiums and (7) cooperative research centres.
2. It is recommended to try to increase the awareness of citizens in Croatia of the importance of innovation through promotional programmes, as well as to raise awareness of the measures that support innovation activities. Apart from news in the media about innovative companies, it would be beneficial to organize and publicly promote competitions in which the best Croatian innovative enterprises would be rewarded.

CONCLUSION

The aim of this paper was to analyse the characteristics of the Croatian system of innovation stimulation, and suggest measures for its improvement on the basis of research results on innovative activity in Croatian enterprises and in comparison with the experience of successful countries.

The results of the innovative activity of Croatian enterprises show that the innovative activity of Croatian enterprises is below the level of the countries of the European Union. However, there has been a trend of growth in innovative activity in the last 5 years, so the replies of the respondents to questions on innovation are similar to those in the EU. The majority in the sample work in research and development departments.

Some Croatian enterprises are in the forefront of their counterparts, not only at home, but also over a wider regional scope. Therefore, their experiences were analysed and it was found that such enterprises have different goals which stimulate them to engage in innovative activity. It was also found that they use different sources of ideas and information for innovative activity in relation to the average Croatian company. These enterprises see innovation as a resource for entering new markets by means of new products, and they mostly rely on buyers and institutionalized sources of ideas and information for innovation. Successful enterprises also give an important role to innovations in forming the development strategy of the enterprise.

On the basis of the research results, we assessed the efficiency of the Croatian system for the stimulation of innovation and concluded that it was not sufficiently prepared for the new challenges of a global information society, particularly because of the: (1) weak activation of resources for innovation, (2) weak institutional support for investments in risk ventures which are potential generators of development, (3) weak diversification of the risk in "entering" a new industry, (4) closing down of existing industries due to the development of new branches of science, such as biotechnology, (5) danger that innovative enterprises become the property of foreigners, which would lead to the "disappearance" of a great deal of newly created capital in the national economy.

On the basis of these conclusions, the experience of countries which are successful in the field of innovations, and the recommendations for the building of a successful innovation system, the following measures to ensure greater success for the Croatian national system are suggested: (1) measures for ensuring adequate input, (2) measures for ensuring a suitable environment and (3) measures for the improvement of communication.

Measures for ensuring adequate input include increasing the quality of and access to education in basic sciences, increasing resources from the state for education and research, increasing allocations of resources in order to finance technologically innovative activity, and also to reduce the tax obligations of innovative enterprises. Measures for ensuring a suitable environment include simplifying and reducing costs in the legal procedure of protecting intellectual property, removing bureaucratic obstacles, stimulating innovators in the use of consultant services that would be partially financed by the government, stimulating the development of enterprises that are directed to growth by enlarging their assortment, by winning new markets and by improving the quality of new products. Measures for improving communication include stimulating cooperation between universities and enterprises and by increasing the awareness of Croatian citizens of the importance of innovations with the help of different promotional programmes.

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Maja BUČAR

Faculty of Social Sciences, University of Ljubljana, Slovenia
Phone: +386 1 5805-195, Fax: +386 1 5805-109
E-mail: maja.bucar@guest.arnes.si

SLOVENIA'S POTENTIAL FOR KNOWLEDGE-BASED ECONOMY WITH FOCUS ON R&D AND INNOVATION POLICY

INTRODUCTION

The key objective of transition to a market economy for the accession countries[1] had been catching up to developed economies, especially those already members of the EU. If the previous system was blamed for insufficient drive to growth, market push was expected to provide the right stimulus to national economies to bridge the gap to the developed world. Based on such expectations was the economic policy: primary attention was given to macroeconomic measures which would open and liberalise the economy, eliminate the barriers to competition and set up rules and practices commonly found in the West.

Yet at the same time, developed economies were undergoing transition towards an economic system based on knowledge and information as the key factors of growth. A tight relationship between science, innovation, creation and dissemination of new technologies was forged. The importance of appropriate human capital development was receiving increased policy-makers attention. Theory and policy practice called for a closer involvement of the state in the area of science and education to enable smooth transition to knowledge-based economy and society. The position of science had significantly shifted in this transition process to knowledge- based society, since science had moved from specialised factor in cultural scene to a dominant position in the area of economic development (Mali, 2002:308).

In more recent years, the awareness of the concept of knowledge-based economy and society increased in transition countries as well. Slovenia is no exception in this regard. A number of official policy papers address the need to actively promote development in this direction. In day-to day policies, the implementation of the basic prerequisites for knowledge-based economy does not seem to be a priority. Knowledge-based economy/society is closely linked to the transition to a more innovative economy/society. This is only achievable with a much more focused

R&D and innovation policy, which need to become a central element of development policy.

The paper attempts to analyse Slovenian research and innovation policy from the perspective of transition to knowledge-based society. While Slovenia had tried to develop a coherent and modern national innovation system by following the advice of foreign and local experts, it had not yet succeeded in putting the innovation in the heart of economic and development policy. Such narrow treatment of innovation accounts for the inadequate contribution of relatively well-developed public R&D to the economic growth, for slow reforms of the education sector and insufficient technological restructuring of the business sector. All together, such trends seriously threaten the long-term economic growth and restrict Slovenia's possibilities for catching-up with the developed countries.

The transition to the knowledge- based economy/society is basically not a technological issue, but above all, a development issue with strong economic, social and cultural dimensions (Stare, Bučar, 2001). A transition to knowledge-based economy/society requires, among other elements, a well developed and efficient national innovation system and a horizontally integrated innovation policy. As we will show in the paper, current understanding of innovation and conception of the innovation policy are not in line with the requests of knowledge-based economy/society.

THE KEY ELEMENTS OF KNOWLEDGE BASED ECONOMY AND SOCIETY

According to the World Bank KAM project (WB, 2002, p. 8-9), "there are four essential, and interrelated, elements of any strategy for building a knowledge economy:

1. *Creating an appropriate economic incentive and institutional regime* that encourages the widespread and efficient use of local and global knowledge in all sectors of the economy, that fosters entrepreneurship, and that permits and supports the economic and social transformations engendered by the knowledge revolution;
2. *Creating a society of skilled, flexible and creative people*, with opportunities for quality education and life-long learning available to all, and a flexible and appropriate mix of public and private funding;
3. *Building a dynamic information infrastructure*, and a competitive and innovative information sector of the economy, that fosters a variety of efficient and competitive

information and communications services and tools available to all sectors of society. This includes not only "high-end" information and communications technologies (ICTs) such as the Internet and mobile telephony but also other elements of an information-rich society such as radio, television and other media, computers and other devices for storing, processing and using information, and a range of communication services;

4. *Creating an efficient innovation system* comprising firms, science and research centres, universities, think tanks and other organizations that can tap into and contribute to the growing stock of global knowledge, adapt it to local needs, and use it to create new products, services, and ways of doing business."

In this paper, we shall focus especially on the last point, *creation of efficient national innovation system*. We apply a "broad" approach to national innovation system where the "narrow" directly innovation-related institutions (the institutions, which promote the acquisition and dissemination of knowledge and are the main sources of (technological) innovation) are embedded in a much wider socio-economic system in which political and cultural influences as well as economic policies help to determine the scale, direction and relative success of all innovative activities (Freeman, 2002:194). Thinking of national innovation system in these terms necessarily makes the policy approach a much more complex undertaking (Stare and Bučar, 2002), but at the same time only such complex approach is suitable when discussing the knowledge economy/society.

Current economic theory and findings from most innovative economies in the world confirm the importance of innovation system and innovation policy. Empirical evidence from developed market economies shows that the ability of countries to innovate determines significantly the rate of economic growth as well as their international competitiveness. The findings of economic theory (Freeman and Soete, 1997; Stern et al., 2000; Baumol, 2002 and many others) and especially economic policy in developed countries of treating innovation as a key factor of economic growth (OECD, 2001a) resulted in the increased governments' attention and (direct and in-direct) intervention in developing a proper innovation environment. OECD (2001a) study on factors of growth in the nineties concludes, *"Innovation[2] is a major driver of economic growth"*. It influences growth at both the microeconomic and macroeconomic levels. At macroeconomic level, innovation contributes to the three drivers of output growth: capital, labour and multifactor productivity (MFP)[3]. A number of analysis and documents discussing national innovation system/policy, national innovative capacity, and the measures to promote innovation, R&D policies in favour of innovation etc., has proliferated in recent years. Also at the level of EU, many activities are being developed[4]. A new EU innovation policy approach was presented in March 2003, putting innovation in a forefront of designing all other policies. This is reflected in the following definition of innovation: *"Innovation is viewed as a multi-dimensional concept, which goes beyond technological innovation to encompass, for example, new means of distribution, marketing or design. Innovation is thus not only limited to high-tech sectors of the economy, but rather is an omnipresent driver for growth."* (EC Communication on Innovation Policy, March 2003).

Innovation has been developed as a policy issue at different paces throughout the transition countries. As a result, the longevity, coherence and coverage of the policy frameworks varies. Even where policy exists there remains a large gap between declarations in support of innovation and actual implementation (INNO, 2001). Levels of funding to support innovation are extremely low and the scope of intervention is limited. Since narrow approach to innovation system is prevailing, the policy is mainly focused on research institutes or on the few R&D performing firms in the economy. Innovation is understood as a new product/process based on new technology in a strictly technical sense. Accordingly, improvements in organisational methods or managerial style or new ways of marketing are usually not seen as innovation activity. Little attention has been paid to raising awareness of innovation, improving innovation management capacities in companies, and ensuring that companies have access to competent advisory services. Funding programmes for collaborative, market-oriented R&D are small. The main focus of attention is on infrastructure linked to universities in the form of science and technology parks. There are few examples of universities developing commercialisation activities. (Reid, 2003)

Many of the instruments and measures introduced in transition countries are in fact copies of the measures and instruments, which functioned in more developed EU countries (innovation agencies, technology centres and parks, innovation relay centres, regional development offices, technology or SME funds, etc.). Simple transfer to a still very different business environment doesn't vouch for their success. Little has been done so far to adjust them to the local conditions. (Bučar, 2003)

Indicators included in the Innovation Scoreboard reflect a gap between the transition countries, covered by the Scoreboard and the EU. It shows a very different situation among the transition countries themselves as well as significant differences of the group with the EU average.

No 1	Indicator	EU	MT	BG	CY	CZ	EE	HU	LT	LV	PL	RO	*SI*	SK	TR
1,1	New S&E grads	100	60	46		39	67	44	91	54	58		*128*		53
1,2	Pop with 3rd education	100	33	100	126	55	139	66	212	86	55	47	*67*	50	38
1,3	Life-long learning	100	114		36		62	35	44	192	61	13	*44*		38
1,4	Empl med/hi-tech manufacturing	100	94	73	14	121	63	116	42	23	100	65	*115*	89	16
1,5	Empl hi-tech services	100	85	75	51	89	94	90	56	61		40	*75*	84	
2,1	Public R&D / GDP	100		70	30	81	79	67	79	43	67	15	*101*	36	79
2,2	Business R&D / GDP	100		9	4	63	12	28	5	16	20	23	*65*	35	21
2.3.1A	EPO patents / pop	100	2	2	4	8	5	11	1	2	2	1	*13*	4	
2.3.2	USPTO hi-tech patents / pop	100	21	1		5		2	4		0	0	*4*	2	0
3,1	SMEs innov in-house	100	35				75		116		9		*38*		56
3,2	SMEs innov co-op	100	44				116		107						161
3,3	Innovation exp	100					65				111		*105*		
4,1	Hi-tech venture capital / GDP	100				9		14	372	258	19		*62*		54
4,2	New capital	100	213								13				40
4,3	New-to-market prod	100	582				92								145
4.4A	Internet access / pop	100	81	24	70	43	96	47	22	23	31	14	*96*	53	12
4,5	ICT expenditures / GDP	100	51	48		116	120	111	74	99	74	28	*59*	94	45
4.6A	Inward FDI / GDP	100	280	87	78	141	176	143	68	96	70	58	*51*	80	16

Source: Calculated based on EC (2002a), 2002 European Innovation Scoreboard: Technical Paper No. 2, Candidate Countries, November 26, European Trend Chart on Innovation, DG Enterprise. www.cordis.lu/trendchart

Table 1
Candidate Countries Scoreboard 2002 (EU=100)

How does current state of affairs in innovation matters influence the ability of transition countries to move towards knowledge-based economy/society? Let us examine this on the case of Slovenia, which has scored above or close to EU average in 5 indicators out of 18 and is ranked fourth among the candidate countries as to its innovation capability (Nauwelaers and Reid, 2002). It is interesting to note that the largest gaps identified are in the indicators related to business sector (the ratio of BERD to GDP, high tech venture capital to GDP, SMEs innovation activity, employment in high tech services, etc.) and in measures, which indirectly reflect the business focus of science community (the number of patents). This would indicate potentially neglected areas in current Slovenian innovation system.

NATIONAL INNOVATION SYSTEM IN SLOVENIA

Institutional setting

The institutional framework of innovation policy had since independence gone through several changes, reflecting in part the search for the most efficient division of tasks among different ministries and in part the influence of both, science and business communities. Observing the practice in other developed countries and following the recommendations of EU, Slovenia introduced several measures, instruments and legal documents to support innovation, entrepreneurship and technological development. Initially, innovation policy was a segment of the R&D policy and under the management of the Ministry of Science and Technology. Within the Ministry, the people responsible for technology development and innovation fought for a more visible position, feeling that their programmes were not given the same attention as those in the support of public (scientific) research. Several analysis, both national and international, called for strengthening of the technology and innovation dimension of the Ministry's focus and eventually two separate departments were formed, both at the level of State Secretaries: one for science and the other for technology.

This was not the end of changes in the organisational set-up. As the result of the reorganisation of the government after the end-1999 elections, the Ministry of Science and Technology was dismantled, and assimilated by two Ministries. The Ministry of Economy now hosts the "technology" section of the ex-MZT, while the Ministry of Education, Science and Sport adopted its "science" part. Most of the issues dealing with technology and innovation are now under the Ministry of Economy (ME). The Entrepreneurship and Competitiveness Department of the ME, in charge of the innovation policy and technology development-reorganised its programmes for the period 2002-2006 (some inherited and some newly developed), but more changes are being planned with regard to organisational structure. In Nov. 2002, a new Law on Research and Development was adopted, under which two separate agencies are to be established within a year from passing of the Law: Agency for Scientific Research and Agency for Development and Technological Research. The idea behind such institutional setting is that the agencies (each in its sphere) would be responsible for permanent, professional and independent selection process of projects and programmes, which are to be financed from public resources. Each agency is to have its board of directors, a manager and a scientific (expert) council, as set forth by the law.

The numerous changes in the institutional setting of the innovation system reflect a search for the optimal allocation of tasks and instruments among different government's ministries and offices. The negative side effect is that the people involved in these processes are preoccupied with the changes of the system instead of focusing more on the delivery side. Also, little was done in the area of evaluation of past set-up, which could point out some good practices, but also most common criticisms in terms of low level of policy coordination and integration. What is noticeable though are the expectations and continuous optimism in policy documents that the planned new measures will bring about the change in government's attitude towards innovation. With each legal change to come, a policy shift towards more active support to innovation was expected, much the same as at current moment with forthcoming formation of the two Agencies. The actual change in attitude towards the role of innovation and R&D has been developing at a much slower pace with only gradual increase in budget allocations for innovation and R&D support. One could say that while at the declaration level, Slovenian government has always been in favour of innovation policy, the actual awareness of the impact and of the importance of coherent national innovation and R&D system was second (or third) only to the process of joining the EU (negotiations, legal harmonisation, macroeconomic policy adjustments, etc.).

Research and Development System as an integral part of Innovation System

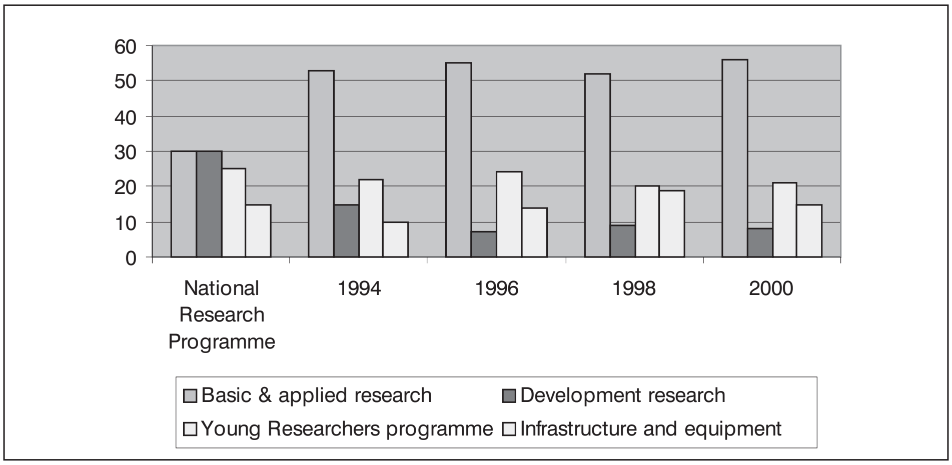
Slovenia was rather successful in preserving its R&D system after the transition (Bučar and Stanovnik, 2001). Some decrease of funds was experienced only in the first years (beginning of 1990s) due to collapse of large industrial conglomerates. The state picked up the financing of R&D, which allowed survival of most of the major research units. The side consequence of increased share of public funds for R&D was reorientation of academic and public research organisations in direction of a more fundamental research (see Graph 1) and looser ties with business sector. The negative implication of these trends is often criticised poor link between relatively well developed public research sector and business community needs: the latter is not satisfied with the level of response or the type of knowledge available in public R&D.

In recent years the investment of business sector in R&D is growing and accounts for more than a half of total funds, yet little of that money finds its way in the public research sector. The trends are not dramatically different in other countries, but still in the moment, when a more dynamic growth is called for, it is hard to accept that majority of the research potential of a small country is not involved in activity, which would support the needs of its economy.

Table 2
R&D expenditures by source of financing, 1993-2000 (in EUR million*)

	1993	1994	1995**	1996	1997	1998	1999	2000
Business	66.0	86.5	112.8	106.6	122.9	135.5	162.2	159.8
Government	101.9	121.8	125.7	104.0	86.7	104.9	106.6	121.1
Private, non-profit	0.2	0.3	0.2	0.8	0.5	0.1	0.2	0.1
mult1Foreign	5.5	5.5	7.2	5.8	18.9	17.3	16.0	18.6
Total	173.7	214.11	245.9	217.2	229.0	257.8	285.0	299.6
As % of GDP	1.61	1.77	1.71	1.44	1.42	1.48	1.51	1.51

** Calculated from SIT using average annual exchange rate.*
** In 1995, the figures for R&D expenditures were overvalued due to a statistical error made in higher education.
Source: Statistical Office of the Republic of Slovenia, Rapid Reports on R&D for consecutive years



Source: Ministry of Science and Technology, 1995 for NRP, where the planned ratio between different types of activity was set; Min. of Education, Sport and Science, 2002: actual budget figures for corresponding years

Graph 1
The structure of public funds for R&D in percentages

As, mentioned the business sector is investing increasingly into R&D, but most of the resources remain within the sector. Several studies of the research in business were carried out by different authors, pointing to the concentration of R&D efforts in manufacturing and further, within selected number of manufacturing branches. The pharmaceutical industry remains the most important R&D

performer, followed by electrical machinery, medical and precision instruments, TV and communication equipment, transport equipment, rubber industry, etc. The share of services in R&D is disproportionably low, comparing to the increasing share of service sector in GDP. Larger business seems to be much more aware of the need to invest in innovation and R&D, but has low expectations as to the cooperation with public research sphere.

A critical element, which deserves more attention in innovation policy planning, is relatively low absorption capacity of the business sector if measured by current status of R&D units in industry. The research units in business are usually small and employ on average 10 engineers. Education structure of researchers in business sector is substantially lower than in public research units (of 2535 researchers with Ph.d. degree, only 172 work in business sector). This would imply that with the exception of few, the research conducted in these units is focusing primarily on development or adaptation of imported technical solutions.

Several events have triggered off a more lively debate on R&D and innovation policy during the last year. First, the Law on R&D with its expected operational legal acts opened the question of how the two Agencies should be designed and what their interaction with respective communities (science, business) should be. Parallel to this, the Guidelines of the National Research and Development Programme (NRDP) were being discussed (mostly in research and academic circles, but also at Chamber of Economy), where a heated debate on priorities was started.

Two different sets of priorities were discussed: the type of research (basic vs. applied and developmental) and the scientific field (natural science vs. social, etc.). The business sector was rather critical of public R&D as insufficiently motivated for cooperation, slow in response time and unwilling/unable to provide the type of knowledge/ technology the business needs. They argued for a changed regulative framework with stronger focus on economic relevance of research. Many representatives of academia and public R&D institutes object to dramatic change of conditions of financing and evaluation criteria. Several arguments were made on account of basic research being of utmost importance for the survival of a nation. In the eyes of some scientists, the only approach is provision of more money for research, with no or little attached conditions. Their focus is on science policy and little concern is given to innovation policy. Innovation is a matter for business sector with no direct link to science policy/funding. As the reasons for low cooperation with industry some quote non-interest on behalf of industry, insufficient financial means of the industry, evaluation criteria of the Ministry of Education, Science and Sports (MESS) for the programmes they currently fund, etc.

This and several other policy debates revealed inability of the two sectors to carry out constructive dialog and a need for the government to act as an in-between. This was reflected also in adoption of the Guidelines for the NRDP. The negotiations on the exact wording of the Guidelines were prolonged and involved several groups: the government, science community, business sector with different associations and Chamber of Industry and Trade, both Universities and Academy of Science and Arts. At the end, several policy directives were agreed upon, but the document remained at descriptive level with more specific measures to be developed by NRDP. The Guidelines suggest that public funding of R&D should follow priorities, decided in cooperation with both business and science community. In the selection process, EU VIth Framework priorities can be used, complemented with national needs and capabilities. The Guidelines suggest a need for socio-economic and technology foresight, which could be used as the basic criteria for priority setting. Also, the structure of public funding should move in the direction of applicative and developmental research and stop the domination of basic research. But the suggested ratio of 30% basic, 30% applicative and 40% developmental projects was not accepted by the Science and Technology Council, and the decision is left with the government. The document however mentions several times a need for research to be more focused, better coordinated with economic and developmental needs of the country, more cost-efficient, etc. It is expected that these directives will be build into future evaluation system for public R&D financing. Already in the documentation requested by MESS for the next period of financing of research groups (June 2003 call), a special segment on the relevance of research was included (relevant for economic and social development, for technological development, for the national identity and sovereignty).

Slovenia is at the moment in a position to choose between a vicious and vitreous circle in its R&D policy. The first option, closer to reality today, is the continuation of the publicly funded research, focusing on science citation index and scientific excellence and having little, if any, concern for the needs of the surrounding and the growing demand of the business sector. Business continues to rely on technology solutions from abroad and/or innovates at a much slower pace, resulting in reduced competitiveness. The consequence of lower competitiveness is lower economic growth. This, in turn, limits the ability of the government to fund public R&D. With fewer funds available, the quality and quantity of public R&D is diminished. On the other hand, a closer link with business sector and more focus both in academic and R&D institutions on the business needs could channel some of the business sector R&D investment in the public sector and help in more dynamic technological restructuring. This would contribute to higher growth and revenue, both for business and R&D sector, as several cases in developed countries confirm. This interlinkage is still poorly understood in science circles, at least judging by the current policy discussions.

Innovation activity

According to numerous data and analyses (Ministry of Economy, 2000), the existing level of technological and managerial capabilities in Slovenia is not yet at a level where market forces alone would be sufficient for its dynamic and integral restructuring. Slovenian enterprises are too slow in changing and innovating their production programmes, techniques, products and/or services. Wholly Slovenian owned companies introduce some sort of innovation to only 37% of their programmes over a five-year period, those with majority foreign ownership 55%, while the most competitive companies in the developed market economies change 75% of their programmes during the same time period (Sočan, 1998).

Can it be assessed that such slow reaction time of Slovenian companies is a reflection of market conditions, meaning that current level of competition does not yet stimulate innovation? There is some truth in this. The loss of ex-Yugoslav market right after the declaration of independence and parallel changes of Eastern markets led to serious cuts in production, in staff lay-offs, to the rationalisation of the expenses (passive restructuring). Very seldom and in a very limited scope enterprises restored to the introduction of organisational, technological or other innovative changes (active restructuring), which could lead to increased competitiveness in the long run. This of course cannot be taken across the board since there are several cases of successful technological restructuring with the introduction of information-communication technologies, but not enough to dominate the scene as yet.

The recent results of Innovation Survey (see Table 3) were not encouraging in view of innovation policy. Data (while not fully comparable with previous surveys dues to somewhat changed sample) reflects no positive trends, except for small increase in the share of innovative enterprises in the service sector. If less than one third of Slovenian enterprises qualify as innovative, the transition to knowledge-based society is not going to take the shape of catching up, but becoming a "second-tier" partner at the best.

Table 3
Innovation activity in manufacturing in 1994-1996, 1997-1998 and 1999-2000

	1994-1996	1997-1998		1999-2000	
M-manufacturing S- services	M	M	S	P	S
Share of innovative enterprises		33.0	11.5	28.3	13.8
Share of innov. expenditure in GDP(%)	1.2	1.5	–	1.4	–
Share of large enterprises in innovation expenditure (%)	80.1	75.3	90.8	74.0	
Innovation intensity (%)*	3.3	3.9	–	3.4	2.2

* Innovation intensity is the share of innovation expenditure in the sales revenues of an enterprise.

Source: SURS Innovation Survey, 1998, 2000, 2003

Slovenia's government has so far followed (consciously) the strategy advocated by orthodox economists, where technological restructuring is to be led by market forces. The increased competition due to open and liberalised trade policy would by itself force the enterprises to act innovatively and rapidly introduce necessary technological and organisational changes. The role of the government is therefore to focus on elimination of obstacles to full competition (liberalisation, de-regulation). Such macroeconomic policy (which is not a development strategy, as stressed by number of domestic experts) does not guarantee the basic conditions for a radical leap-frogging and catching-up of the more developed countries. Even in the most developed countries we can see the governments systematically support the transition to knowledge society via investments into R&D, education and infrastructure. Active innovation policy is not considered as contradictory to market-based economy. In fact, the governments play an important role in creating the environment, favourable to growth, innovation, entrepreneurship and industrial restructuring. This includes the level and type of government funding of R&D, an appropriate education and human resources policy, creation of favourable entrepreneurial environment, infrastructure investment, competitive market for financial services, fiscal and monetary policies in favour of R&D and venture capital, etc.

There are several positive indices in this regard in Slovenian innovation policy. Besides the already mentioned changes in the organisational set-up, Slovenia has put the creation on an innovation supportive environment as the top priority in the Single Programming Document, prepared for the channelling of EU structural funds. Several activities are going to be supported, focusing on creation of technology networks, research and development cooperation, innovation training, etc. The SPD needs to be negotiated with the EU Commission on one hand and on the other, since it requires local financial participation, the budgetary provisions for 2004 need to be made for local shares in each proposed activity. To succeed in placing innovation so highly on priority list was a major achievement of the ME and is a reflection of gradual change in attitude towards innovation in the overall government policy. Yet one of the key problems with Slovenian innovation policy so far has been the gap between declared and implemented (see in more detail in Bučar and Stare, 2002) and one can only hope that this faith is not going to repeat itself again with SPD.

ASSESSMENT OF SLOVENIA'S INNOVATION POTENTIAL FOR THE TRANSITION TO KNOWLEDGE ECONOMY/SOCIETY

The on-going discussions and policy debates reflect the growing awareness of the importance of coherent national innovation policy for further economic growth and competitiveness. Yet on the other hand, several indicators show that the gap between policy and actual practice remains wide. Some of the key characteristics of a innovation system in a knowledge-based economy are still poorly understood by the stakeholders, especially within the science community. Arguments in favour of status quo are still made by people of significant authority in public R&D sector. The centrality of innovation policy is not yet accepted concept by those who design economic policy at the national level.

Business sector R&D expenditures reflect a high degree of concentration in only very few industrial branches and can be assigned to a small number of individual large companies active in a limited number of industries. These few companies are all export oriented and therefore facing global competition. So it would be premature to conclude that the rising business expenditures on R&D already reflect the positive outcome of macroeconomic policies of open market economy, since majority of these companies were in the forefront of investments in R&D and innovation in the past as well. INNO study provided broader insight, finding a dual picture in all candidate countries where "a few firms are heavily investing in innovation activities, while the overwhelming majority of other companies, especially SMEs, are not undertaking innovation." This duality is especially worrisome since one of the supposed policy focus of transition countries during the last decade was the promotion of SMEs and at least in terms of number of creation of new enterprises the goal was achieved in all observed countries. What it signals (but requires a more detailed analysis) is that the new enterprises are not innovative enough and are seldom the result of entrepreneurial effort to turn invention to innovation.

While a wide range of instruments and support measures was put in place during the transition period (see in more detail in Bučar and Stare, 2002b), the impact of these on innovation has been limited. This opens a question of their design and implementation. Major difficulties pertain to non-securing sufficient funds even for approved government initiatives and programmes aimed at supporting innovation, to non-transparency in the allocation of funds and to poor coordination among different governmental bodies regarding the funds/mechanisms. Sometimes it seems there is more interest in the number of instruments (the more, the better) than in their actual efficacy. This leads to insufficient financial and human resources devoted to the implementation of the measure/instrument.

A serious handicap of current innovation system is the lack of systematic monitoring and evaluation system. Insufficiently developed monitoring of the impact of the introduced measures sometimes resulted in their abandoning or in introduction of new (alternative) mechanisms without a prior evaluation of reasons for failure. A systematic monitoring of all the measures in a manner, which would show the impact and reflect the difficulties in the implementation process, was never introduced. This lack of continuous evaluation of policies and instruments makes it impossible to learn from one's mistakes and therefore work on improving certain mechanisms. Instead, a transfer of something, which worked in Finland or Ireland to Slovenian environment is practiced, expecting it to have the same impact as in its country (ideas of clusters or incubators could be examples of such). The only adjustment, is the financial one: measures are expected to work in Slovenia with a much smaller financial support.

The awareness raising is one of the areas of innovation policy, which should be given a more systematic attention. While several different activities in the field of R&D and innovation took place, there is no centrifugal force, bringing the efforts of different institutions or individuals under the common framework. This can be singled out as one of the key deficiencies of the Slovenian innovation policy. In principle, the need to raise public awareness of the importance of innovation policy was considered by the government as an important area, but the fact remains that few coordinated activities were organized in this regard. Especially lacking was the awareness raising among the general public, since at most events "the convienced are convincing themselves" (Bučar, 2003, SLORITTS). Putting innovation and entrepreneurship at the centre of economic development policy calls for significant increase in activities related to awareness raising on the importance of innovation and entrepreneurship as two of the main factors of growth and competitiveness. This is needed both within the government and business community as well as within the general public.

CONCLUDING THOUGHTS

Knowledge-based economy/society opens many challenges to the transition countries. Essentially, macroeconomic policy in many of them, and in candidate countries especially, evolved around making national economy compatible with the EU standards. Macroeconomic stabilisation and liberalisation were the absolute priority. Such macroeconomic policy (which is not a forward-looking development strategy) does not guarantee the basic conditions for catching-up of the more developed countries or is sufficient for the transition to knowledge economy/society. The "exploitation" of national innovation system as one of the key elements of knowledge based economy for economic growth is not envisaged. As found out by Mickiewicz and Radošević (2001:10) for transition countries as a group: "In the past ten years innovation policy was considered secondary to the transition related concerns. However, the exhaustion of growth and productivity improvements based on non-investment related reallocations will bring the issues of innovation and industrial upgrading into the policy focus."

Countries in transition should therefore realise that "Neither wholly free-market led nor wholly government –led development of market institutions and technology infrastructure will deliver transformation towards knowledge-based economy." (Dyker and Radošević, 2000:64) Current focus on price and trade liberalisation and privatisation are maybe essential to transformation from socialist to market-based economies, but not sufficient conditions for transformation to innovation-based economy. If, as evidence from OECD countries show, long-term growth depends increasingly on innovation, developing and implementing sound national innovation policy is an essential ingredient of macroeconomic policy. Reforming national innovation system and setting forth a clear innovation policy was expected to be one of the elements of transition process as well, but so far the macroeconomic policy makers in transition countries have not changed significantly their attitude towards innovation policy (Bučar, Stare, 2002) and technological restructuring. Current approach neglects certain key characteristics of business sector as well as of general business climate in transition countries.

One of the key tasks in front of transition countries is therefore to establish productive links with the research sector and national economy and put the science into the service of economy.[5] As Perez and Soete (1988:459) warn: "The real catching-up process can only be achieved through acquiring the capacity for participating in the generation and improvement of technologies as opposed to the simple "use" of them." This means being able to enter either as early imitator or as innovators of new products or processes. To do so, a strong science and technology capacity must be developed. While strong arguments can be put forward in favour of scientific autonomy, science community in transition countries should be also considering the need and indeed responsibility of a more substantial contribution to national economic development. After all, the funds to support scientific research (even the one based on sole curiosity) come from the taxpayers (business + individuals): and the more successful and competitive business sector will be, more financial resources (and autonomy) the science may have in the future.

The analysis of the countries that in the history were successful in catching-up with technologically and economically more developed countries by leap-frogging certain development stages shows that this was never achieved without a conscious action of the government[6]. Along with a modern economy, a modern government with a vision and efficient institutional environment is needed to enable a dynamic and qualitative economic and social development. Already stressed key role of innovation in knowledge society requires the establishment of coherent modern and future-oriented innovation system (Bučar and Mulej, 1999). This should be one of the key priorities for the government. The contemporary role of the state is not in providing direct aid to individual economic actors, but in establishing the framework leading to sustainable and stable development. The government should not underestimate the importance of creation of general awareness and support for change. As can be seen from examples in more developed environments[7], bringing public in policy debates is essential. This is a segment little developed in transition countries.

Even in the most developed countries the governments systematically support the transition to knowledge society via investments into R&D, education and infrastructure. These countries have their national innovation policy with well-elaborated mechanisms of support of innovation activities. Simply copying these would not do, though, because there are too many specifics in innovation environment in transition countries. But ignoring the fact that a coherent national innovation system is needed is even more dangerous. Transition countries need to upgrade their national innovative capacity (Stern et al., 2001). National innovative capacity depends on the presence of a strong common innovation infrastructure, or crosscutting factors that contribute broadly to innovativeness throughout the economy. It includes a country's overall science and technology policy environment, the mechanisms in place for supporting basic research and higher education, and cumulative "stock" of technological knowledge.

Let us take here a quote from Abramovitz (1991:32): "Our ability to advance the frontiers of technology and to exploit its possibilities depends in some way on our political institutions, on level of general and technical education, and on the development of forms of industrial organisation and business practice that are adapted to the needs of emerging technologies and consumer demand." What has to be kept in mind, though, is a historic moment of building information or a knowledge society, which is taking place globally. The implications of lagging behind can be detrimental for transition countries. We are catching a moving target, a one where many private and public efforts, backed by comprehensive programmes and immense funds are concentrated on achieving a successful transition to new society. This calls for full integration of innovation in development policies and strategies and a radically different level of innovative thinking in the governments, business and each citizen in the transition countries.

FOOTNOTES

[1] Accession countries: term used to depict ex-socialist countries of Central and Eastern Europe who are to join EU in 2004.

[2] Defined as: development, deployment and economic utilisation of new products, processes and services. (OECD, 2001b:51)

[3] MFP, as has long been recognised, is driven by technological and non-technological innovation- improved management practices, organisational changes, and improved ways of producing goods and services.

[4] Among activities designed at EU level is the Innovation Scoreboard and Innovation Trend Chart Reports, both regularly involving candidate countries. A list of EU publications and studies on innovation is also wide.

[5] This is often strongly opposed by basic scientists, who argue for scientific freedom to choose the object of their research. In fact, it is a sensitive political issue, often "spiced" with questions of national pride and identity.

[6] Freeman (1989) points out the complexity of such undertakings: The success of any country to catch-up within next decades depends crucially on their ability for institutional innovation, infrastructure, investment in education, S&T and last, but not least, on the international economic system.

[7] This is quoted from a document "Innovation system (EU) five priority objectives EU:..." society is often being reticent about innovation. We need to make both the opportunities and the risks of new technologies as transparent as possible in a broad dialogue with science, business and the general public, taking account of the potential economic and social costs of non-innovation... countries with a strongly consensual approach, supporting quality debate on innovation issues, also produce strong figures for innovation-related indicators." (Innovation in a knowledge driven economy: Communication from the Commission to the Council and the European Parliament, Brussels, COM, 2000).

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Mira KRNETA, M.S.

Croatian Consultant Net
Phone/Fax: +385 21 475-462, Mobile: +385 98 9522-967
E-mail: mkrneta@consultant.com, mira.krneta@st.t-com.hr

Anči LEBURIĆ, Ph.D.

Assistant professor
University of Split, Department of Sociology
Phone/Fax: +385 21 470-784; 456-081, Mobile: +385 (0)98 834-215
E-mail: anci.leburic@st.t-com.hr, E-mail: aleburic@yahoo.com
http://www.welcome.to/anci

THE APPLICATION OF TRIPLE-HELIX MODEL IN AGRICULTURAL SECTOR OF CROATIA

Nothing new that is really comes without collaboration!
James Watson, Nobel Prize Winner, as a co-discoverer of double-helix DNA molecule

INTRODUCTION

Since 1990s we have witnessed a strengthening awareness that innovation, particularly technological, is a structural element in the current competitive system, contributing to the growth of production and to the material wealth of the countries (OECD, 1991:12). The position of a country in the competitive system should be based upon knowledge, i.e. on the development of some new products and methods, which will bring not only success for the firm that is implementing them but also for the economy of the country as a whole.

Knowledge has been considered as a common good that can be shared without fear of losing its value. It is impossible to prevent its wide spreading and exploitation. Therefore, the firms are increasingly intensifying their research and development activity (R&D)[1], emphasizing the importance of collaboration with other research institutions (OECD, 2001:45). However, so far this collaboration has mainly come down to some indirect contacts between certain firms and research institutions, in the form of either publication of periodical articles or attendance of conferences (Cohen et al., 2002:15). At the same time, many national industries are becoming aware of the lack of such tools that would make the collaboration between the firms and research institutions more successful and productive (Bakkevib, Jakobsen, 2003:2). On the basis of literature, it has been understood that generating and spreading of the knowledge is an interactive and a communicatively intensive process, which requires development of back-up tools to be used by the firms not only for the promotion of knowledge but also for more successful cooperation with other firms and with R&D environment.[2] The role of the universities should become more distinct and influential as an indirect source of knowledge for development of industrial innovation and entrepreneurship (Klofsten, 2000:23; Etzkowitz, Klofsten, 2002:32; Cohen, 2002:19).

Recently, numerous examples of the most developed countries as well as some developing countries, or the countries in transition, have shown that their government strategy, backed-up by support of the university and R&D institutions, has been encouraging development of regional industry, particularly small and medium enterprises (SMEs).

The convergence of three realities (actors), university, industry and government, has become a transition model of the society based upon knowledge, and it has been articulated as *Triple-Helix Model*. This model was originally derived from the survey of the industrial reconstruction of Boston, Massachusetts, in the 1930s, by commercializing the research results achieved from the collaboration between university, industry and government (Etzkowitz, Klofsten, 2002:5). Today, it is considered to be a useful tool for the research of regional socio-economic systems in Europe (Viale, Ghiglione, 1998:3), in Nordic countries (Ylinenpää, 2001:4), and a back-up tool for the development of innovation centers providing support to small and medium enterprises in Italy (Cariola, 1999:10), in contemporary Russia (Kazakova, 2001:3) and the like.

Triple-Helix model implies the development of a trilateral network of organizational links between university, government and industry (Etzkowitz, 2002:12), in which university (and similar research and educational institutions) should be regarded as the main source where knowledge is being generated and from which it is being spread. In order to be able to commercialize the results of research activities, to link up with industrial processes and to support the growth of new firms, it is necessary to develop an entrepreneurial spirit of the university. Government should provide some strategic guidelines for development of a sectorial and a regional economy of the country, by implementing a number of direct and indirect economic measures and by ensuring financing sources of R&D activities. Government should also be responsible for launching of R&D projects of special importance for the country, particularly when their high financial standards cannot be met without financial help of the government. The role of the firms, the last link of this trefoil, should be to concentrate their resources on the commercial part of R&D activity, to develop new products or technologies, and, to provide universities and R&D institutions with feedback information on some new potential research areas.

Taking the hypotheses of *Model* as a starting point, two innovative projects of the agricultural sector in Croatia have been analyzed, both implying implementation of *in-vitro* technology for the production of seed potatoes and pyrethrum. The former project is in its implementation stage. In other words, the first ton of virus-free seed material had already been produced in greenhouses, and then planted on the fields of the sub-contractors. The latter is still in its planning stage. Therefore, it will be necessary to define the trilateral links of *triple helix matrix*, as a prerequisite for a successful launching of this considerably complex project.

These two projects are important for the economic growth of Croatia since they are both related to a strategically important agricultural crop. The former crop being seed potato, which has been imported so far, and it is beyond any dispute that the country still depends on its import. The latter crop is pyrethrum, which is essential for development of an ecological agricultural production, and which was being produced to a great extent in the period preceding World War 2.

Our hypotheses emphasize the importance of both crops since the main prerequisite for their successful production is an interface between the knowledge resources, particularly those of applied knowledge (universities, institutes, laboratories) on one hand, and big agricultural producers, who can ensure a production basis for commercialization of knowledge, and a number of small and medium entrepreneurs, on the other. It also presupposes some stimulative policies and economic measures for the implementation of R&D projects, for the provision of financial resources, and for a rise of employment rate etc.

The results (primarily analytical) achieved by such a methodological approach can be exploited (i.e. become applicable) in the following ways: (1) in planning development strategy of the agricultural sector, particularly for certain crops or regions (regions under special government concern, islands etc.); (2) in laying out a challenging development system according to the proposed strategic goals and development projects in certain sectors of the economy, and (3) in specifying the exact role of universities, certain colleges and university departments (e.g. Department of Sociology in Split, which is being founded now), as well as R&D institutions in the processes of generation and application of knowledge. In this way the research results can be capitalized and other research projects can be initiated.

TRIPLE HELIX MODEL – MAIN PROPOSITIONS

In order to found our economic growth on knowledge and innovations it is necessary to redefine knowledge, a leading development resource in the society, and to develop a suitable infrastructure. In this way the knowledge will be concentrated, interconnected and used for the purpose of economic growth and development. In this sense, we can expect some changes in all interface-segments of the model: in R&D institutions[3], in firms, in corporate sector and in government bodies.

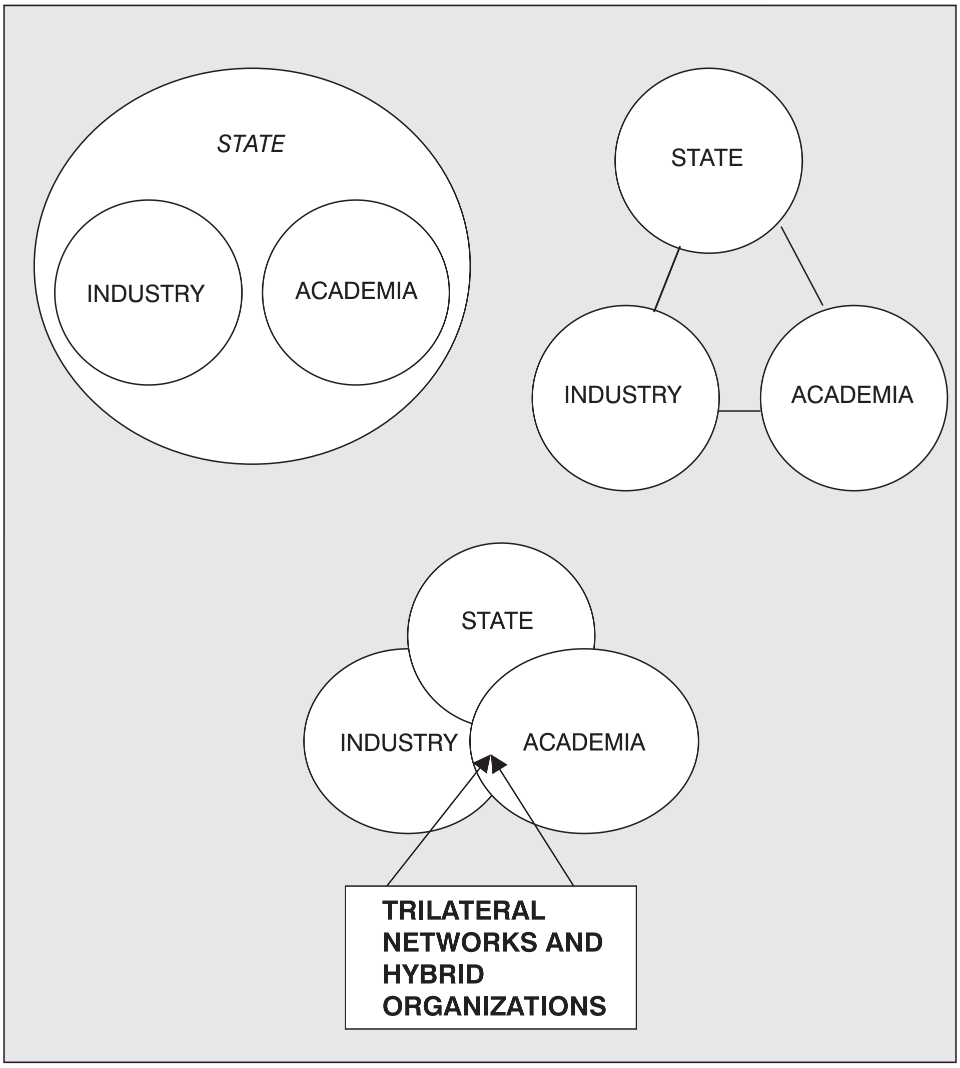
Triple Helix Model, as such, illustrates trilateral links, interfaces and influences of the segments as well as necessary changes of the structure in various stages of knowledge exploitation.

Triple spiral model shows the university-economy-government relationships as relatively equal and interdependent ones, overlapping with each other and changing each other's roles (Etzkowitz, 2002:2).

However, in reality, the relationships between university, economy and government are quite different regarding the institutional frame of the country and an achieved level of strategy transition in the society. There is such a development strategy, which is based upon the prevailing industrial production versus an economic development strategy, which is based upon knowledge and its exploitation.

The roles of economic and political segments are predominantly important in *statist* (or socialistic) *model* of interface between science, economy and government, like in *laissez-faire model,* while the role of knowledge is of minor importance there. On the other hand, the roles of all the segments in *triple helix model* are equalized, assuming the transition of the society based upon knowledge. *Picture 1.* shows different models of interface between knowledge, economy and government.

In the countries (such as U.S.A., W. Europe), in which some prerequisites for integration of knowledge, economy and government have already been provided, triple *helix model* is being recognized as an empirical model. It can be realized as *bottom up*, i.e. by an interaction between some individuals and organizations in various institutional spheres involved in some individual projects, or as *top down*, when it is supported by government incentive policies and measures (Etzkowitz, 2002:4).



Picture 1

From statist model to triple helix model (According to: Etzkowitz, Leydesdorff, 2000:111)

A developing society based upon innovation distinguishes three levels of this model. The first level refers to the interior development structure of each segment of the model. For example, some colleges and universities have been redefining their development strategic goals. Once they used to be mainly scientific-educational institutions, now they are increasingly focusing on R&D activity. The only indicator of their success is their position on the market, while their behavior is characterized by entrepreneurial spirit. Most firms have become aware of the need for mutual integration and for development of strategic alliances in order to be able to concentrate their knowledge resources and to utilize both the synergic effects of integration and the competitive advantages as well.

The second level deals with the impacts of segments on each other. For example, government has been systematically giving support to R&D activity, to innovations and to commercialization of knowledge by ensuring more favorable financing sources for such projects or by granting a tax relief. Some efforts have also been made to develop a standard system of intellectual property protection and various aspects of technology transfer, etc.

The third level refers to trilateral links between the segments of the model, to their overlapping and to development of different organizational forms of their integrated activity. The forms can be structurally adapted in order to be able to generate new ideas or to exploit the knowledge.

However, interrelationships between the segments of the model are not *a priori* coordinated or stable over the long term. During the process of generation and exploitation of knowledge there are constant changes and transformations being carried on in each segment of the triple spiral, in their interactions and in the ways they influence each other. Dynamic aspect of the model implies some communication overlaps between the segments. Therefore, we can expect that discussions and negotiations going on at the level of a trilateral network and a hybrid structure will result in a transformation or a coordination of the institutional framework and will create an innovation-minded environment (Etzkowitz, Leydesdorff, 2000:115).

Redefining of interrelationships between universities, economy and government in order to encourage innovation processes in the society and to commercialize knowledge can be applied at all levels: multinational, national and regional, as well. Yet, in an effort to develop innovation processes, the concentration of resources of the triple spiral model at a regional level will require enhancement of some local conditions by interconnecting R&D with other activities. This can be done only by mutual efforts of all three segments: university, economy and government.

According to Etzkowitz (2002:7) this is the first stage of transformation of the value scale among the promoters of regional economic growth. This stage provides a more favorable *business atmosphere* and some stimulating entrepreneurial tools as prerequisites for an economic growth based upon knowledge. In the following two stages the most innovative ideas and strategies generated from multiple interactions between university, economy and government are being accepted by consensus and there are some attempts to implement them in practice. The key issues of interactions between the segments of *Triple Helix Model* are: how to formalize the results achieved in an innovation process, how to build up a suitable organizational structure for commercialization of knowledge, how to draw the most favorable financial sources, and how to find the most suitable form in which capital, technology and know-how will be combined.

However, if the interrelationships between university, economy and government are not well defined or poorly defined and therefore it is not possible to generate, implement or commercialize results of innovation processes, it is necessary to ensure a systematic gathering and recording of all the results of both successful and failure projects. In this way the achieved results and the concealed knowledge may be explicitly uncovered and applied on some future projects. It is evident that both the acquisition of techniques needed for memorizing knowledge and the achieved project results are important factors for the process of capitalization of knowledge and for an economic growth based upon this resource especially in a country in which mostly *ab ovo* projects are practiced, in which keeping and sending of documents is regarded as *needless* activity for transfer of knowledge, and in which cooperation or collaboration *happen only by chance.*

APPLICATION OF TRIPLE-HELIX MODEL IN DEVELOPMENT OF PYRETHRUM AND POTATO PRODUCTION

Applicability of the main propositions of *Triple Helix Model*, i.e. of cooperation between institutional knowledge, economy and government in the process of capitalization of knowledge for the purpose of developing national economy, has been analyzed on two projects in agricultural sector of Croatia. The former deals with plantation cultivation of pyrethrum and the latter deals with cultivation of seed – potato.

Both projects are based upon an innovation technique in cultivation of crops – *in vitro technology* and its market applicability, that is, on micro-multiplication of economically important crops, including vegetative multiplication of highly valuable and market-demanded plant genotype, as well as the production of early generations of healthy plants, which can be further cultivated in greenhouses or planted on the fields as an agricultural crop. The application of *in vitro method* of multiplication ensures the following: (1) rapid multiplication of the initial plant, (2) production of healthy plant balm, (3) generation of a unique genotype or phenotype, and (4) economically profitable production of the plants based upon the above mentioned elements (Jelaska, 1982:42)

1. Case study: Pyrethrum, Dalmatian chrysanthemum (*Chrysanthemum cinerariifolium, Dalmatian pyrethrum*), grows in its natural habitat on the Adriatic coast and on the islands. It is an autochthonous (self-grown) plant with irregular long-shaped olive-green leaves, with a number of tender white flowers with yellow bulrush on a stem. The plant is well known, because its flower contains natural insecticide *pyrethrum*, which, if used correctly, is not toxic for humans and warm-blooded animals. It is also rapidly biodegradable, unlike synthetic insecticides, so it is not harmful for the environment. Due to the complexity of the compound and its instability, it is unlikely that insects become resistant on usage of pyrethrin.

Toxin *pyrethrum* was first recorded in early Chinese history. It is believed that the plant was brought to Europe from China, together with silk, a long time ago. In the 19^{th} century there were big plantations of pyrethrum in Iran and in Dalmatia. In the first decade of the 20^{th} century the plantations of pyrethrum covered some two thousand hectares (5000 acres) of the land in Dalmatia. An average production of pyrethrum was approximately thousand tons of dry bulrushes (Kolak, Šatorić, Rukavina, Filipaj, 1999:432). Throughout the later period the areas planted with pyrethrum, as well as its annual production, have been constantly decreasing. According to a recent survey (1997) the area planted with pyrethrum is minimal and the concentration of pyrethrin is 0.46%.

In view of the world production of pyrethrum, in the period preceding the World War 2., Japan had the largest areas planted with pyrethrum, and the biggest annual production of pyrethrin. During the WW2, and in the period following the war, the production and processing of dry bulrushes, i.e. the extraction of pyrethrin rapidly grew in some East African countries. Since mid 1990s Kenya, which is the second producer of dry bulrushes in the world today, has been developing its own production basis for the selection of the plant clones exactly on the seeds of Dalmatian pyrethrum. During the last 15 years, Australia has developed the most modern industry of pyrethrin in the world, which is located on the island of Tasmania. The annual production of pyrethrin has been constantly growing thanks to innovations in multiplication method and to new techniques for the extraction of the compound from the dry bulrushes of the pyrethrum flower. As a result, a stable offer of this insecticide on the world market has been guaranteed.

Considering the facts that Croatia has favorable climatic and soil conditions for self-growth of this plant in the coastal area and on the islands, it is obvious that essential prerequisites for re-cultivation of pyrethrum, an important plant culture, already exist. However, in order to be able to design and plan the plantations of pyrethrum, to produce dry bulrushes, to extract pyrethrin and to develop industry of insecticide based upon natural product, it is necessary to connect all the segments of triple helix model. In other words, there must be an interaction between institutionalized knowledge, agricultural sector of the country and government back-up tools and measures.

In innovation segment of the project for re-cultivation of pyrethrum on the plantations it is necessary: (1) to select plants with relatively highest concentration of pyrethrin, in reference to 0.46% concentration found in self-grown plants, which are prevailing in this area today, (2) to produce, by applying *in vitro technology,* healthy plants (virus-free seed material), which guarantees the expected annual crops, and by applying the method of micro multiplication of plants in the greenhouses until they reach the planting stage and get planted on the plantations, (3) to define an adequate system of agrotechnical measures for the protection of growing plants, as well as a protection system on the plantations, (4) to develop a system of picking of the mature flowers, of their drying and storage prior to the processing, (5) to define technology for the processing of pyrethrum flowers, and for the extraction of pyrethrin from the flowers, and (6) to define the ways and procedures of standard production of the final product – a number of various insecticides, which are available on the market today, while their further development will satisfy the expected demand on the market in the future.

Various institutions that generate knowledge including colleges, university departments in the country, laboratories and R&D centers have concentrated necessary resources capable to find the best solutions of the specified R&D areas. While doing so, they must consider the specific qualities of the country and configuration of the region suitable for cultivation of this plant, as well as the existing development level of the processing industry in the country.

The following prerequisites have to be met in the agricultural sector of the country for a successful realization of the project: (1) to identify adequate production re-

Pictures 2, 3 and 4
The flowers of pyrethrum, cultivation of plants in green houses and plantations of pyrethrum

sources for laboratory production of seed material and for cultivation of plants in greenhouses, and to develop cultivation of pyrethrum on the plantations, (2) to define a model of business connections for the production of the plant, i.e. a cooperation between family estates (farms) and big agricultural producers in order to dimension the area with cultivated plants, i.e. to expand the plantation area in proportion to the laboratory and greenhouse capacities, and according to the planned annual production growth, (3) to recognize business interest for starting up industrial production of pyrethrin (insecticide on natural basis) by investing in construction of the plants for extraction and serial production as well as the storage of semi-manufactured and final product, and by developing distribution network.

At the government level, planning and implementation of the project assumes that strategic guidelines for development of agricultural production already exist, that strategic importance and position of each plant has been established (including those plants which do not participate in agricultural sector today, but have been proposed for commercial cultivation in near future). Furthermore, it is necessary: (1) to define the ways and sources of financing of R&D activities in this project, (2) to identify stimulating measures (including tax relief), employment policy, sources of financing etc. for R&D organizations and for agricultural and industrial producers, and (3) to define development strategy as a regional development policy with regard to the most favorable locations for laboratory and greenhouse production, for plantation cultivation and for construction of processing plants.

The feasibility of the project can be assessed from the viewpoint of certainty that agricultural production is organized on crops which are not prevailing in agricultural sector of the country (corn, wheat), or are not included in its agricultural production (pyrethrum is a self-grown plant). An interface of the knowledge, economy and government is a necessary prerequisite for getting involved in such a complex, manifold and an expectedly long-term project, particularly in an environment where an intensive, steady and highly interactive cooperation is not a common practice.

Finally, the feasibility of the project of starting-up industrial production of pyrethrin in Croatia can be considered with regard to the information on implementation of the EU development project for pyrethrin cultivation in Mediterranean area for the purpose of an evaluation of insecticide market and for the sake of health protection in these countries. The aim of this project is to generate an advanced subtype of *Chrysanthemum cinerariaefolium,* adapted for a possible cultivation in eight Mediterranean countries, which can compete with traditional species of this plant being cultivated in some African countries, or with advanced plant species being cultivated in Australia.[4]

2. Case study: The other project, which deals with the production of seed potato, has already been partly realized, unlike the previous one dealing with the production of pyrethrum, which is still in its planning stage. In the innovation stage of the seed-potato project, the plant genotypes of seed potato, the ones mostly demanded at the market or mostly imported, have already been developed. Almost a ton of virus-free seed material, which will be used as seed basis for starting up the production of seed potato on our own fields, has already been cultivated in laboratories and by micro multiplication in greenhouses.

Tubers of seed potato were planted on a sub-contractor's field in Žumberak last spring. Constant control on the field has shown that the virus-free crop has been retained and this can guarantee a high yield of seed material in the following planting period, the implication being existence of average climatic conditions and implementation of some agrotechnical measures. At the same time, some new virus-free seed material for new sorts of seed potatoes has been produced in laboratories and greenhouses by using method of micro-multiplication. One of the leading producers of seed potato in the country has recognized it as a strategically important crop for the development of his firm.

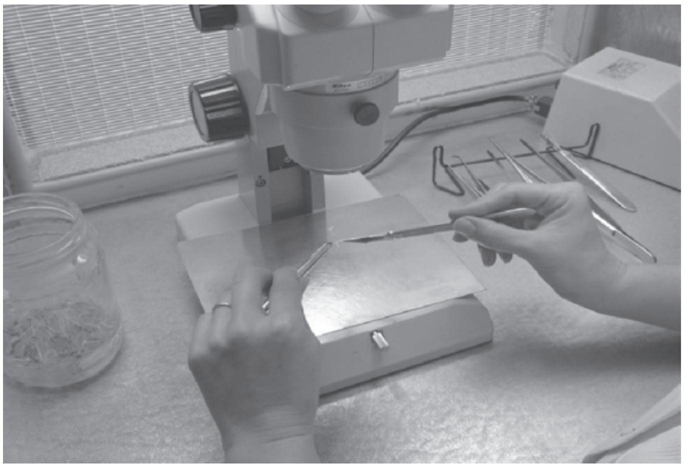
Past experience on the realization of the seed-potato project has shown that cooperation between innovation and production segments of the possible triple model has been successful only because the interests of the researchers of greenhouse plant production and food manufacturers have been mutually recognized. In the laboratory segment of this project, the accrued knowledge and experience have generated virus-free seed material; its micro-multiplication has been provided, including the production of virus-free tubers, which have been prepared for commercial cultivation and for the first planting on the fields.

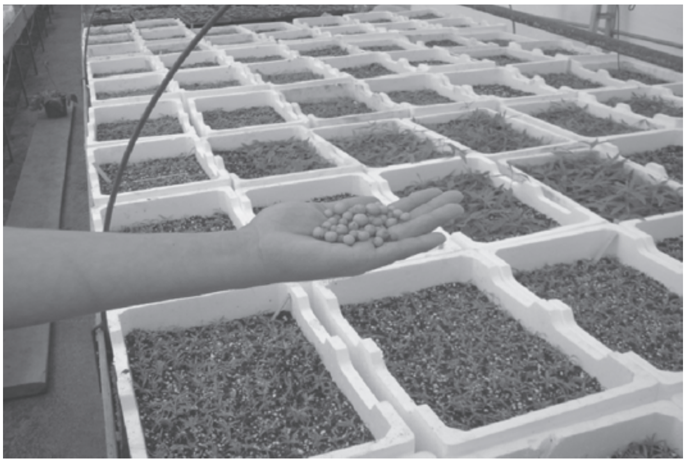
In the production stage of this project the required arable land area for the first and the second multiplied production can be provided (up to 50 ha of the planted area). For further production it is necessary: (1) to connect (formally and on the basis of vested interest) cultivators of seed potato as sub-contractors, who will take over one generation of virus-free seed material, plant it on their own fields, take necessary agrotechnical measures, including protection measures in order to ensure high degree of virus-free conditions as a main prerequisite for expected above-average yields, and (2) to provide technological support in gathering, storing and keeping of seed potato, including construction of an adequate storage space (capacity and climatic conditions), (3) to invest in extension and/or construction of manufacturing plants in which potato can be further processed for the production of some food products (half-finished, finished, frozen), stock-cattle feed, in industry of alcohol etc., (4) to organize production of mercantile potato on arable fields of the subcontractors, or on the field of big agro-industrial conglomerates, and (5) to provide technological propositions for packing of the final potato product and for placing it on the export market.

The present economic policy in the segment of potato seed production in our country encourages import of seed potato and provides stimulating measures for the cultivators of seed potato, who are subsidized per kilo of produced seed. The main market supplier of potato seed is Netherlands, the leading producer of seed potato in Europe. A complete dependence of our seed potato producers on import has many disadvantages. They are often faced not only with price fluctuations but also with market fluctuations of the offered quantities of suitable sorts. In addition, if it should happen that the imported seed material has failed to be biologically controlled, this carries a risk that the area planted with such seeds develops a virus infection, which will result in a decreased annual yield per acre, below the national average, and even much lower than the world average.[5]

In any case, a complete dependence on the seed potato import may result in the concentration of valuable resources (especially financial resources) in some other sectors e.g. in the commercial one, where the short-term interests are not investments in development of their own seed material, particularly of strategically important crops. Therefore, in order to implement the seed-potato production development project, in accordance with the main propositions of triple helix model, we should at least expect the following: (1) family farms should be encouraged to cooperate with available arable areas where developed virus-free seed material can be cultivated in all the stages from multiplication to the production of the first quantity of seed potato to be offered on the market (in the spring of 2005.); (2) a tax-relief system should be estab-

Pictures 5, 6 and 7
Micro-multiplication, cultivation in green-houses and the first multiplication of virus free seed potato material





lished and favorable investments in expansion of arable area should be provided; (3) processing capacity increase should be encouraged, especially of undeveloped segments (food production, cattle-stock feed, alcohol industry – all based upon potato as a raw material), as well as investments in modern technology, e.g. processing machinery, modern warehouses etc.

As a result of the first multiplication of virus-free seed material, approximately 1 ton of seed material has been produced, and then planted on an area of 2 ha (5 acres). In the following multiplication stage, assuming that the yield per acre at the lower limit is about 15 t/ha, it would be necessary to ensure the area of 14 ha on which about 30 tons of superlative seed material can be planted. In the third multiplication stage, about 200 tons of elite seed material planted on 100 ha (250 acres) could be reasonably expected. After the last multiplication stage, some 1,5 thousand tons of seed potato (which has been imported from Netherlands as *class A*) can be offered on domestic market in the spring of 2006.

According to the available statistic data[6], today Croatia imports about 16 thousand tons of seed potato, and the areas planted with early, late and seed potato covers some 63 thousand hectares (157 500 acres). Due to the lack of a rigid control on import of the seeds in general, additional quantities of seed potatoes are imported through some illegal channels. Assuming that annual yield per acre will be minimal, it is reasonable to expect that the implementation of this seed-potato production development project will ensure about 9% of the registered seed potato import in 2006. Since we are talking here about virus-free seed material, and since we have heard for the seed-potato producers in Croatia, whose annual yield per acre is from 45 even up to 60 t/ha, the economic profitability of this investment seems to be unquestionable.

CONCLUSION

Both development projects significantly encourage a regional economic growth. Pyrethrum was once cultivated in the coastal area and on the islands, and today it grows there as a self-grown plant. Considering the quality of the soil and favorable climatic conditions, the plantations of pyrethrum should be located in the coastal area of the country. In R&D stage, following the experience of Mediterranean countries, Pyrethrum plant clones can be generated by applying *in vitro* technology and by micro-multiplication. The clones are adapted to planting conditions that exist on certain parts of coastal areas and on the islands, and contain an increased percentage of pyrethrin, which ensures more economical production and processing. Besides, processing and storage capacities can be located in the same region in which all the prerequisites for a planned development of pyrethrin industry have been already met.

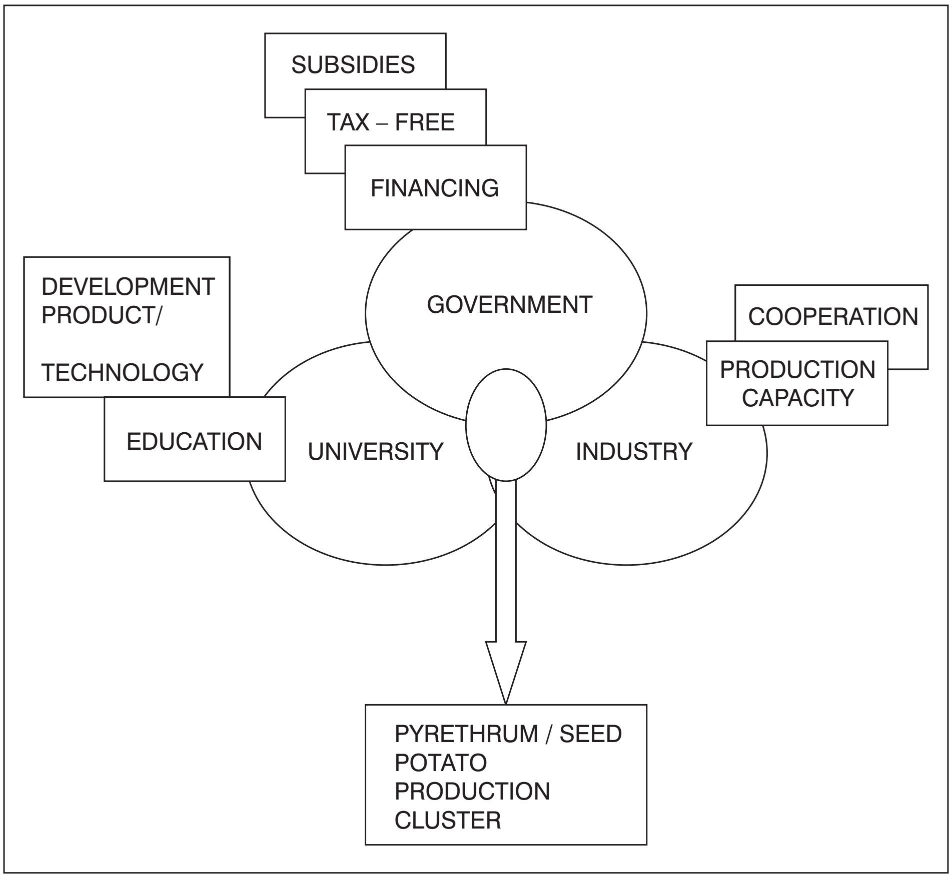
Type of soil, climatic conditions and risk of virus infection are the circumstances that outline and encourage regional concentration of seed potato production in the country. So far there have been successful plantations of seed and mercantile potato on the arable areas of Lika, Zagorje and Međimurje. Some of these regions are considered to be economically undeveloped. Lika, for example, is one of the most undeveloped regions in the country. Therefore, in this case, the seed-potato production development project can encourage economic growth of an undeveloped region, as well.

In the end, realization of both development projects, regardless of the different levels of their present project development, can be successfully implemented if there is an intensive interaction and cooperation between three segments: university, economy and government in all stages of the project realization. Main areas of the project development in each segment and possible manifestations of trilateral organizations and hybrid structures are illustrated on.

Universities and other similar institutions, which generate knowledge, should concentrate all the available resources for the development of the product (and by applying *in vitro* technology they will develop some new species or those species that qualify in view of an expected economically-efficient production). They should also develop new technological solutions to be used in production and crop industry development. They should also provide an efficient educational system and encourage the transition of a concealed knowledge into an explicit one, so that its application value can be generated.

Corporative sector is responsible for the provision of resources, required for commercial exploitation of the knowledge. It should develop production, processing and distribution structures in all the stages of the production cycle, until the final products are placed on the market.

Government should provide development infrastructure and ensure implementation of the project at all possible levels (strategy, policy, measures and activity), taking in consideration an innovative character of the project, strategic interests and some regional characteristics of the economic growth.



Picture 8

Triple Helix configuration in realization of the development project for agricultural production of pyrethrum and seed potato

If the interaction of the three segments in realization of the above described projects is constant and intensive, and provided that all the development activities in each segment are well planned and theoretically organized, so called *cluster* interaction can be formed, i.e. a cooperation and collaboration between existing or newly-formed structures in realization of the development projects as a whole.

In fact, an orientation of the economic growth of the country towards capitalization and commercial application of the knowledge presupposes cooperation, collaboration and integration of the three segments: institutionalized forms of knowledge, economic sector and government. However, innovation segment will be successfully developed only if all other segments have been developed, if their mutual interaction has been achieved and if trilateral structure has been generated.

In the context of main propositions of *Triple Helix Model*, the above analyzed development projects as specific *case studies* of agricultural sector in Croatia, can be assessed as feasible. However, their success as regards the expected impacts they may have on economic growth of Croatia, will, to a great extent, depend on ability and readiness of the triad to establish a common strategic interest of the analyzed projects. Besides, an intensive coordination, communication and interaction in realization of all aspects of the projects should be provided, and the most adequate forms of trilateral structure and network in project realization and in implementation of the results to the final product and to the full realization of the expected economic impact should be developed.

Theoretical organization, planning and realization of some specific development projects based upon the main propositions of *Triple Helix Model* can be useful in several ways, especially in a country where all the prerequisites for integration of the segments of the model on strategic and political levels have not been created yet. In this way, the proposed strategies can be concretized and the knowledge and experience, also applicable in other development projects, can become accumulated.

In the context of economic growth of Croatia, various structural interactions aiming to commercialize research results, will be exploitable in terms of (1) theoretical organization of the agricultural development strategy by identifying plants/crops of strategic importance for the country and by adequately defining their position in regard to their production capacity, quality of seed material and their dependence on import, (2) planning and realization of regional development by putting an emphasis on enhancement of the agricultural production, (3) building up a development stimulation system pursuant to strategic goals, and (4) concretization of the role of institutional forms of knowledge in R&D activity and in other knowledge-generating processes, or, in other words, commercialization and capitalization of the accrued knowledge.

Actual assessment of omnipresent social crises in our society reminds us of past experience and of numerous social science theories. Main reasons for our referring to the past experience may be a lack of knowledge, inadequate or unavailable knowledge, or, as the case might be, it has been wrongly applied or not applied at all by social forces. Cifrić states that "... the problem with public good is not in the fact that private interests clash with public interests, but in the fact that a number of private interests in modern society have been identified/labeled as public interests, and actual public good has become an abstract category, and not actual social contents." (Cifrić, 2000:15). This is exactly what the authors of this paper have tried to avoid, in an effort to draw public and private notions in a closer interaction with social and developmental ones. Namely, all sorts of unions between science (theory) and practice seem to be everlasting questions, as old as the society itself. This is where sociology appears too, trying to be a more engaged science in cooperation with economic science. Nevertheless, so far, various dualisms have been prevailing here, but there are some prospects that triple model interactions will take charge, what has been apostrophized in this paper.

However, we should bear in mind that modern society has been defined as a risky society *Risikogesellshaft*, according to Beck, (1986), the risks being the result of human activity. Actually, they are the results of decisions, which get materialized in industrial production. A democratic procedure of decision-making has not been practiced in the domains of entrepreneurship, science and technology so far, although these are the social spheres where actual decisions about (sub) political innovativeness should be made. It is in fact concealed in the term "progress", which, on the other hand, has an undoubtedly magic power, and creates an opportunity for numerous dialogues and discussions and for various social activities. This is the right place for our discussion on *Triple Helix Model*, which presupposes an interactive and integrative activity of various social factors that will all together change the quality of life in the future Croatia. We support the theses on development of a specific type of society, so called a sustainable society, which presupposes an adequate balance between long-term and short-term social objectives. Such a society should be established on the basis of scientific and technological creativity and entrepreneurship. However, this transition into a new millennium society (into 21st century) will be a significant, valuable, technical, political and cultural challenge for Croatia that might be realized only by means of new ideas, new ways of thinking, new methodologies, new methods and new model approaches.

FOOTNOTES

1 The term "research and development" (R&D), Croatian (I&R), has been extensively used by many countries on the recommendation of OECD.

2 These concepts are comprised in the following theories: cluster theory (Porter, 1998), innovation systems theory (Lundvall, 1992; Nelson, 1993) and in learning theory (Lundvall, 1992).

3 They are often called University, although they can also be some other organizations that formally do not belong to the university in narrower sense.

[4] To find more about this project visit the following web site http://www.nf-2000.org; 14. 09. 2002.

[5] According to the data obtained from Institute for Agricultural Zoology at Agricultural Faculty, University of Zagreb, the anylyses of the soil in cadastral districts of Belice and Gardinovac in Međimurje, where potato has been planted on 1,200 ha, have shown that out of 151 samples, 109 (or 38 ha of the planted area) are infected with potato cystlike memathode, a disease which can decrease the yield up to 80% as compared to the average yield crop in this area (according to: http://www.agr.hr/document; 27. 09. 2003).

[6] See data of Bureau of Statistics; http://www.dzs.hr/Hrv/2003/1-1-6h2003.htm; 27. 09. 2003.

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IV.

THE ROLE OF INNOVATION, TECHNOLOGY AND ORGANISATIONAL CHANGE IN ECONOMIC GROWTH

Dr Sonja RADAS

Research Fellow
Institute of Economics
Trg J. F. Kennedy 7
10000 Zagreb, Croatia
Phone: +385 1 2335-700
E-mail: sradas@eizg.hr

INDUSTRY-SCIENCE COLLABORATION IN CROATIA: FIRM'S PERSPECTIVE*

INTRODUCTION

The role of research cooperation between industry and academic institutions has received increased attention in recent years. Industry-science relationship is considered to be one of the important parts of innovation system, because of the expected positive impact on commercial performance. Among other things, by collaborating with scientists firms are expected to introduce more innovative products, and to create more efficient and innovative processes. This should positively reflect on the firm's ability to successfully compete in the market.

This paper is partly based on a larger study whose goal was to determine incentives for improving industry-science collaboration in Croatia.[1] In order to see if university-industry collaboration can indeed be a vital and sustainable part of innovation system, we need to understand what motivates each of the partners to enter the collaboration. Firms are likely to enter collaboration for different reasons that research institutions, and their decision to collaborate may be explained by using different criteria than would be valid for research institutions.

This paper focuses on firm's point of view. It explores the intensity of the collaboration between business sector and research institutions in Croatia, and industry's satisfaction with this collaboration. In order to understand industry's decision to enter research collaboration, firms' motives for collaboration were explored. Apart from motivations, this study explored how some characteristics of firms and their environment influence the decision to collaborate. In particular, firms were asked about their technology and innovation orientation, their customers, their financial resources and support, and their opinion of academics. These factors can impact both how closely companies cooperate with research institutions, and how they are satisfied with the outcome of that collaboration.

This paper seeks to develop understanding of determinants of collaboration intensity and industry's satisfaction with the collaboration. This is accomplished by investigating firms' motivations and firms' perceptions about themselves and their environment.

LITERATURE REVIEW

In the last ten years there have been a number of empirical studies regarding various aspects of industry-science collaboration. Carayol (2003) systematizes this literature in five streams: the study of the various forms of interactions, the study of collaboration agreements, the analysis of academics' aims for collaborating, the negative consequences on the academics' behavior, and finally firms' aims for collaborating.

Here we focus on literature review pertaining to the last topic, since this paper examines industry-science collaboration from firm's point of view focusing on firm's motivations and perceptions of themselves and collaboration environment.

Several empirical studies have explored firms' motivations for industry science collaboration and firms' view of that collaboration. Caloghirou et al. (2001) investigated the characteristics of university-industry collaboration in a large set of research joint ventures established in the context of European Framework Programs over a period of fourteen years. They found that firms collaborate with universities with the aim to achieve research synergies, to keep up with major technological developments, and to share R&D cost. The same study found that the major benefit that firms enjoy from that collaboration is enhancing their knowledge base, followed by improvements in production processes. Interestingly authors did not find significant impact of collaboration on product development.

Lee (2000) built a survey of 140 companies collaborating with universities. The study showed that firms collaborating with universities on R&D projects benefited in several ways. In particular, firms gained "increased access to new research and discoveries", the collaboration helped in making "significant progress toward the development of new products and processes", and finally firms were maintaining a closer relationship with the university.

Hall et al. (2001) studied contractual data from the US government ATP research program accompanied by questionnaires. The study explored whether intellectual property rights present an impediment to university-industry collaboration. The findings point out that intellectual property rights indeed can present an obstacle, depending on intellectual property characteristics of the research project, expected results of the research project, and firm's previous experience collaborating with universities.

In a related study Hall et al. (2000) researched ATP projects data again. They found that the research projects involving universities were less likely to be prematurely ended than the other projects. From here authors concluded that such collaborative projects create certain "research awareness".

Adams et al. (2001) investigated firms that were involved in Industry University Cooperative Research Centers, and found that firms collaborate on projects where academics' research complements firm's own research.

Zucker and Darby (2000) studied university-industry collaboration in the setting of biotech firms, and showed that cooperating with "star scientists" had a positive impact on the number of patents granted, number of projects completing all three stages of pharmaceutical process and finally on the market.

Most studies to date are performed on developed economies. There are few empirical studies that investigated industry-science relationship in transition countries. Koschatzky (2002) investigated knowledge transfer between research and industry in Slovenia, and finds that although collaboration between large research institutes and companies is satisfactory, cooperation between universities and companies is weak. The only published study on the theme of industry-science cooperation in Croatia is by Švarc et al. (1996). Authors investigated science-industry links in Croatia and reported similar findings as Koschatzky (2002). In particular, their paper focuses on survey of academics and shows that Croatian academics have weak overall collaboration with industry.

DATA

The data for this study, which focuses on industry-science relationship in Croatia, was collected in spring of 2002. Survey work was preceded by exploratory research, during which in-depth interviews were conducted with R&D directors from ten firms and with scientists from ten academic institutions. The topics of interviews were industry-science collaboration, motivations, perceptions of the other partner, and perceived impediments for collaboration. The purpose of exploratory research was to address the specific features of industry-science collaboration in Croatia. In the preparation for exploratory interviews current literature (Lee, 2000 and Caloghirou et al., 2001) was used as a guide. On the bases of exploratory research a survey instruments was constructed. Questions that were asked in the large survey were based on the exploratory in-depth interviews. We can say that the questionnaire was "written" by firms themselves, and as such reflect the specifics of Croatian environment.

Two hundred and thirty (230) firms were chosen for the survey. Those firms were registered as performing some technology-related activities, and also as having invested in R&D in the time period between 1997 and 1999[2]. This later condition ensured that only active firms were included. Out of 230 firms that were targeted, 190 responded. This represents the response rate of 82.6%. The survey instrument was a questionnaire, and respondents were R&D directors of selected companies who were surveyed over telephone.

In the remainder of this section I will explain variables used in the study, starting with variables that measure some basic facts about collaboration, continuing with variables pertaining to perceptions, and closing with variables describing motivations.

Collaboration intensity, quality and commercial effect

One of the first indicators of industry-science collaboration is how intensely firms engage in collaborative projects. Respondents were asked to indicate how intensely their company collaborates with researchers in Croatia; answers were offered on a Lickert scale from 1 (does not collaborate at all), to 5 (collaborates very intensely).

Except for the information about how closely firms collaborate with academics, we would like to know how satisfied firms are with that collaboration. To explore that issue, respondents were asked about quality and commercial effect of collaboration. The reason for separating collaboration quality and commercial benefit came from exploratory interviews. Some R&D directors said that although they find Croatian academics to be professional and willing to do their best, there are limitations when it comes to how much they can contribute to firm's bottom line. Since the absence of commercial benefit can impact company's propensity to engage in cooperative relationships, this variable was included in the analysis.

R&D directors were asked how they perceived the quality level of collaboration with research institutions in Croatia. Answers were offered on the Lickert scale starting from 1 (completely unsatisfactory), ending with 5 (exceptionally good). Market benefit of the cooperation was explored by a question asking respondents to rate commercial effect of the collaboration. Again a Lickert 5-point scale was offered, starting from 1 (completely unsatisfactory), ending with 5 (exceptionally good).

Some Croatian firms collaborate with foreign research institutions and consultants. In fact, Croatian academics believe that this is quite prevalent practice among companies that do engage in cooperation. In order to determine the magnitude of this cooperation, two questions were asked. One asked if respondent's company collaborates with foreign research institutions, and the other question investigates whether they collaborate with foreign consultants. Both questions offered only yes and no answers.

Motivations

In exploratory interviews with firms and subsequent questionnaire preparation, current literature was used as a guide (Lee, 2000 and Caloghirou et al., 2001). However, in-depth interviews conducted during the exploratory phase showed that some of the motivations that firms have in developed economies (EU and USA), were not considered important by Croatian firms, or respondents did not think they applied to Croatian situation. In addition, some motives, that were not present in other studies, were discovered during exploratory interviews. For example, cooperation in Croatia can happen quite often purely because of formal regulations. Another specificity of Croatian study is that in some cases collaboration exists because firms need the name of the research institution as a proof of quality and/or reliability of their products (for example if a product is tested at a well-respected research institute, customers are more likely to believe in its quality)[3].

As a result of exploratory interviews, five motivation statements were formulated. These statements are presented in table 1. Respondents were presented with motivation statements from table 1, and asked to indicate their agreement on a Lickert scale starting from 1 (completely disagree), ending with 5 (completely agree).

Table 1
Firms' motivations for collaboration with research institutions

- Access to new technologies which bring competitive advantage
- It is more efficient to use existing potential then to develop own
- The name of research institution can be used as a proof of quality (the product is tested by...)
- The need to solve a concrete problem
- Collaboration happens only because it is enforced by regulations, laws or other legal reasons

Firm perceptions of themselves, academics, and business environment

In order to fully understand the firm's point of view in industry-university collaboration, we need to have more information about the firms. In literature, firm characteristics that are linked with collaboration include mostly size, sector and country of the plant (Carayol, 2003; Hall et al., 2001). Some studies also include R&D budget, and number of R&D staff (Adams et al., 2001). Zucker and Darby (2001) in their study of collaboration in biotechnology industry also specify variables like the number of patents, number of products in development, and number of products on the market. Although in this study we also collect information like firm size, R&D budget, number of patents and number of new products on the market, in order to gain deeper understanding we go beyond descriptive statistics to include firm's perceptions on themselves, academics, and their environment as it concerns collaboration.

In this study there are 18 questions investigating firm's perceptions about various issues regarding their industry-science relationships (please see table 2 for the list of questions). The questions were presented as statements; respondents were asked to indicate their agreement with the statements on a five-item Lickert scale starting from 1 (completely disagree), ending with 5 (completely agree). As was the case with motivations statements, the literature was a starting point for exploratory interviews with R&D directors. The mentioned 18 questions were formulated on the bases of these interviews.

In order to reduce the quantity of information, factor analysis was performed. The result of the factor analysis is five factors presented in table 2.[4] Considering the items that load on particular factors, the factors were named *Innovation and technological capacity, Ability of research institutions, Banks investors and taxes, External orientation* and *Customers*.

Factor *Innovation and technological capacity* explains the largest percent of variance. This factor deals with the importance of innovation and technologies, the existence of long-term vision in the firm, and the existence of well-trained people who have the ability to hook up with academics and make the collaboration happen.

Ability of research institutions speaks to the applicability of research performed in academia and adequate level of equipments in research institutions. Another statement that loads on this factor is preference for foreign consultants over domestic research institutions. This last statement also speaks to the ability of researchers because it is indicative of how companies view capability of domestic researchers to resolve companies' actual problems.

Financial environment is addressed in the third factor *Banks investors and taxes*. The factor includes firm's own financial resources, the propensity of banks and investors to finance firm's innovation efforts, and the tax incentives for innovation. Interestingly, this factor also picks up whether the firm is oriented toward solving mostly short-term problems. When financial support does not exist, firms do not have sufficient resources to engage in long-term projects, and consequently they are occupied by resolving the most pressing problems.

Factor *External orientation* refers to things that firms receive from their environment. This includes advanced technology and highly skilled employees. This factor also includes the importance of networking for innovation.

Factor *Customers* addresses how supportive customers are of innovation efforts, and how demanding of innovation they are.

Table 2
Firm perceptions of themselves, academics and business environment: perceptions factors[5]

Factor	
Innovation and technological capacity	• Your company has a long term vision • Innovations are considered very important in your company • New technologies are considered very important in your company • There are people in your company who have knowledge to serve as liaison between the company and research institution • Your company has access to advanced technologies
Ability of research institutions	• Research institutions are not adequately equipped • Academics work on things that are not applicable • Your company prefers to hire foreign consultants than local research institutions
Banks, investors and taxes	• Banks and investors are mostly ready to support your innovation efforts • Tax system in Croatia gives incentives to innovation efforts in your company • Your company has sufficient financial resources for research and development • Your company is oriented mostly to solving short-term problems
External orientation	• Easier access to advanced technologies would help your company to become more innovative • Your company has no difficulties in attracting highly educated employees • Networking for innovation is considered very important for your company
Customers	• Your customers are very interested in innovative products and services • Your customers are supportive of your innovation activities

DATA ANALYSIS AND RESULTS

Intensity of collaboration

The most basic information one can collect about industry-science collaboration is whether firms collaborate and how intensely they collaborate with research institutions. An obvious question that arises here is why some firms collaborate more closely than the others. One would expect that there are differences between firms that cooperate closely, and those that cooperate less closely; the important question is where these differences lie. For example, we would expect that firms where innovations and technologies are more important have closer ties with academics, as improvements in new products and access to new technologies were found to result from such collaborative relationships (Caloghirou et al., 2001; Lee, 2000). We would expect firms that have good opinion of academics to have more intense contact with them. Firms that are oriented toward networking possibly also have closer contact with research institutions. Financial resources are another factor that can determine the level of collaboration. Also, it is possible that firms that have more intense collaboration do so because they have very demanding customers who by asking for new and innovative products instigate innovation efforts that involve collaboration with research institutions.

To investigate which of the above issues has bearing on the collaboration intensity, regression analysis was conducted with intensity as dependent variable and factors *Innovation and technological capacity, Ability of research institutions, Banks investors and taxes, External orientation*, and *Customers* as independent variables. Best subsets polynomial regression method was employed (adjusted R^2=0.12, F=7.42). The only significant factor yielded by this analysis is *Innovation and technological capacity* (t=4.69, p=0,000005). To confirm that result, ordinal probit was used with the same dependent variable and predictors. Again, the only significant factor is *Innovation and technological capacity* (Wald stat.=19.12, p=0.000012). Interestingly, neither ability of researchers, financial resources nor customers have any significant impact on collaboration intensity. The only significant effect came from *Innovation and technological capacity*, meaning that firms which see themselves as innovation and technology oriented are more likely to engage in cooperation with research institutions.

To understand what compels some companies to collaborate more closely with academics than other companies, we need to look into their motivations. We have seen that companies seek collaboration with research institutions for various reasons (the list of motivations is presented in table 1), and it is possible that some of these reasons can result in a more intense collaboration. To explore this question, relationships between intensity of collaboration and motivations were investigated. Intensity of collaboration was used as the dependent variable and motivation variables were used as predictors in polynomial regression, best subsets method (adjusted R^2 is 0.16, F=8.39). Three motivation variables were significant, namely *access to new technologies and processes*, *effectiveness of using existing research resources instead of developing own*, and *need to resolve concrete problems*. Ordinal probit analysis was used to verify these results. Again, *access to new technologies and processes* (estimate=–0.23, Wald st.=8.19, p=0.004), and *need to resolve concrete problems* (estimate=–0.2, Wald st.=0.08, p=0.02) are significant, while effectiveness of using existing research resources is not significant to 10% level. This result is in tune with existing literature, as both *access to new technologies and processes* and *need to resolve concrete problems* were indeed found in other studies (Lee, 2000 and Caloghirou, 2001). Please see table 3 for details.

Table 3
Collaboration intensity as a function of motivation factors

Motivation variables	Estimate	Statistics
Access to new technologies and processes	0.18 linear term	Linear term t=2.78, p=0.006
Effectiveness of using existing research resources instead of developing own	0.97 linear term	Linear term t=3.14, p=0.002
	–0.14 quadratic term	Quadratic term t=–2.89, p=0.004
Need to resolve concrete problems	0.02 quadratic term	Quadratic term t=2.81, p=0.006

Without doubt, we can say that *access to new technologies and processes* is one of the main predictors of collaboration intensity. The more important it is to the firm to have this access, the more it will collaborate with academics. Regarding *need to resolve concrete problems*, the more important that issue is to the firms, the more intensive will be the collaboration with academics.[6] Both these results support findings of Lee (2000) and Caloghirou (2001). We need to be careful in interpretation of the *effectiveness of using existing research resources instead of developing own*, as it comes out as significant in regression but not in ordinal probit. This might be due to the non-linear relationship.

More precisely, as the importance of using existing resources increases, the intensity increases to some point, but after that collaboration intensity declines. This indicates that by itself, the need to substitute own resources by those owned by academics is not sufficient to explain very high collaboration intensity levels. Formal reasons for collaboration like regulations and using institution name do not appear to be significant in predicting collaboration intensity.

Satisfaction with collaboration

Except for collaboration intensity, another indicator that can give us insight into the collaboration is satisfaction with collaboration quality and satisfaction with commercial benefit of that collaboration. We would expect to observe that firms, which have closer relationship with academics, are more satisfied with its quality, because otherwise there would be no reason for them to keep up that partnership. Correlation analysis shows that collaboration intensity is significantly correlated with collaboration quality ($r=0.4$, $p=0.000$).

As expected, quality and commercial effect are also correlated ($r=0.55$, $p=0.000$), indicating that firms that are happier with the quality of cooperation also give higher ratings to its commercial outcome. Interestingly, commercial effect of collaboration (rating 2.94) is rated significantly lower than collaboration quality (rating 3.52, t-test statistics $t=7.73$). Although it may be difficult for R&D directors to correctly assess commercial effect of academic collaboration due to the fact that industry projects are based on teamwork where academics participate in certain phases (instead of being involved continually from the beginning to the end, as mentioned in Lee 2000), the significantly lower score of commercial effect merits attention. This interesting finding requires special consideration in a country like Croatia, which is trying to improve industry-science relationships. One reason for that discrepancy might be the poor choice of projects (non-ambitious or routine projects with no commercial impact). Another reason may be inability of academics to offer solutions to problems that would have real commercial impact (either due to lack of equipment, the lack of relevant knowledge and information about the most recent research in that area, etc.).

We have seen that firms differ in their rating of collaboration quality. We can argue that firm's rating would depend on how advanced the firm is in technology and innovations, on firm's financial resources, on firm's opinion of academics etc. To explore that issue, the relationship between collaboration quality rating and factors *Innovation and technological capacity, Ability of research institutions, Banks investors and taxes, External orientation*, and *Customers* was examined. Methods of analysis were again polynomial regression, and ordinal probit, where quality was used as dependent variable. Best subsets regression method yields two significant factors, *Innovation and technological capacity*, and *External orientation* (adjusted R^2=0.12, F=5.17). Please see table 4 for details.

Table 4
Collaboration quality as a function of firm and environment factors

Motivation variables	Coefficient	Statistics
Innovation and technological capacity	Linear term estimate=0.34	Linear term t=4.36, p=0.00002
External orientation	Linear term estimate=0.15	Linear term t=2.07, p=0.04

This relationship is re-checked using ordinal probit analysis, which yields one significant factor *Innovation and technological capacity* (coefficient=–0.35, Wald=14.7, p=0.0001). Factor *External orientation* is somewhat significant (coefficient=–0.15, Wald=3.37, p=0.066). Probit analysis confirms the findings from regression analysis. These findings show that the only significant impact on collaboration quality is due to the factor *Innovation and technological capacity*, and to some extent to the factor *External orientation.* This indicates that those firms where innovation and technology are important, that have long-term vision and high quality employees, tend to rate quality of collaboration higher. Also firms that are more oriented toward networking tend to rate their collaborations as higher quality. Interestingly, perceived ability of academics does not have significant influence on collaboration quality rating.

As seen in exploratory interviews, although firms can be satisfied with collaboration quality, they need not rate commercial effect very highly. We have shown that indeed companies regard commercial benefit of collaboration as significantly lower than collaboration quality. To gain deeper insight into what could drive this result, we seek to find a relationship between commercial effect rating and factors *Innovation and technological capacity, Ability of research institutions, Banks investors and taxes, External orientation*, and *Customers.* Polynomial regression best subset method was performed (adjusted R^2=0.08, F=4.33), and it yields that the only significant factor is *Innovation and technological capacity*. Factor *Banks, investors and taxes* is somewhat significant. Please see table 5 for details.

Table 5

Commercial effect as a function of firm and environment factors

Motivation variables	Coefficient	Statistics
Innovation and technological capacity	Linear term estimate=0.27	Linear term t=3.31, p=0.001
Banks investors and taxes	Linear term estimate=0.14	Linear term t=1.77, p=0.08

Ordinal probit analysis was conducted to confirm significance of the two mentioned factors. *Innovation and technological capacity* is significant (coefficient=–0.28, Wald=10.33, p=0.001), and *Banks, investors and taxes* as well (coefficient=–0.17, Wald=4.02, p=0.04, log-likelihood=–223.9). This means that firms that see themselves as innovation and technology oriented are more satisfied with commercial benefit of cooperation. Interestingly, the only other factor that has implications on commercial benefit is availability of financial resources for innovation. How can we explain these findings? Firms that are more innovation and technology oriented are able to engage in more demanding and innovative projects, where contribution of outside researchers is crucial. Projects of that type have potentially greater market impact. Being more research savvy, such firms can also better define the contribution that they expect from academics. Taking this in account, it is not surprising that this contribution would be rated as commercially more valuable than in other firms. In similar vain, companies that have sufficient financial resources and support from banks, investors and tax system are more likely to engage in challenging and innovative projects where faculty input is crucial and potential market impact is greater.

To explore whether satisfaction with collaboration quality depends on motivations for entering into collaborative relationship, quality of collaboration was regressed on motivations using polynomial regression, best subsets method (adjusted R^2=0.15, F=6.54). There are three motivations that are significantly related to quality rating. More precisely, these are *using the name of research institution, the need to solve a concrete problem,* and *enforcement from outside.* As the first two motivational factors increase, the quality rating increases as well. Interestingly, as *enforcement from outside* increases, the quality rating decreases, indicating that as the enforcement from outside gains in importance, the collaboration will be perceived as lower quality. Please see table 6.

Table 6
Collaboration quality as a function of motivation factors

Motivation variables	Estimate	Statistics
Using the name of research institution (The name of research institution can be used as a proof of quality (the product is tested by...)	Linear term estimate=0.18	Linear term t=2.78, p=0.006
The need to solve a concrete problem	Quadratic term estimate=0.03	Quadratic term t=2.77, p=0.006
Enforcement from outside (Collaboration happens only because it is enforced by regulations, laws or other legal reasons)	Linear term estimate=–0.1	Linear term t=–2.02, p=0.04

It is conceivable that firms rate commercial benefit of collaboration with academics differently depending on their motivations for cooperation. Exploring this connection between commercial effect and motivation could potentially shed some light on the discrepancy between quality rating and commercial benefit rating. To establish a connection between commercial effect of collaboration and motivations, commercial effect of collaboration was used as dependent variable while motivations were used as predictors. Polynomial regression, best subsets method, was employed (adjusted R^2=0.20, F=11.17). Please see table 7 for details.

Table7
Commercial effect as a function of motivation factors

Motivation variables	Estimate	Statistics
Using the name of research institution (The name of research institution can be used as a proof of quality (the product is tested by...)	Linear term estimate=0.86 Quadratic term estimate=–0.11	Linear term t=2.68, p=0.008 Quadratic term t=–2.21, p=0.03
The need to solve a concrete problem	Linear term estimate=0.23	Linear term t=3.5, p=0.0006
Enforcement from outside (Collaboration happens only because it is enforced by regulations, laws or other legal reasons)	Quadratic term estimate=0.03	Quadratic term t=2.94, p=0.004

Interestingly, the same motivations appear to be significant both for commercial effect rating and for quality rating, but in slightly different way. The relationship between *using the name of research institution* and commercial effect rating is non-linear, more precisely as using institution's name increases in importance commercial effect will be perceived as better, but only up to a point after which this trend reverses. Motivational variable *enforcement from outside* is positively related to commercial effect, indicating that although being forced in collaboration negatively reflects on perception of quality, fulfilling these requirements from outside may enable the firm to cash in on results (by gaining access to some markets for example), which reflects positively on perception of commercial benefit.

Collaboration with foreign research institutions

In exploratory interviews with academics, a lot was said about propensity of Croatian industry to seek academic expertise in foreign research institutions. To test whether that is true, we counted firms that do collaborate with foreign academics and those firms that collaborate with domestic research institutions. Croatian academics seem to think that out of firms that do have collaborative relationships, many more collaborate with foreign instead of domestic institutions. However, the data does not support that (Pearson chi square is 1.39, $p=0.24$).

One reason why firms would cooperate with foreign institutions is if they are not happy with what they can get from research institutions at home. If that is true, then those firms that cannot find a suitable domestic institution indeed can be expected to form research partnerships abroad. In other words, collaboration with foreign research institutions can depend on intensity and satisfaction with domestic partners. To examine whether domestic collaboration has any effect on relationships with foreign researchers, we use information on collaboration intensity with domestic institutions, satisfaction with quality and satisfaction with commercial effect of such collaboration. When collaboration intensity with domestic institutions, quality and commercial effect of such collaboration were used as predictors, only intensity has significant bearing on collaboration with foreign institutions. Since collaboration with foreign institutions was a yes-no question, logit analysis was used (estimate=0.51, $p=0.01$, loglikelihood=–102).

The findings indicate that satisfaction with domestic collaboration is not a significant predictor. In other words, if a company is unhappy with domestic researchers, we cannot predict that it will try to find a better partner abroad. Although the satisfaction does not impact foreign collaboration, the data shows that intensity of domestic collaboration does have bearing on foreign collaboration. In other words those firms that collaborate more intensely with academics at home are also more likely to collaborate with foreign researchers.

To understand better the above results, we need to investigate whether propensity to cooperate with foreign researchers depends on some firm characteristics. Firms that do collaborate with foreign institutions may have different characteristics from those that do not engage in that practice. A natural thought is that, since foreign researchers are more expensive, larger firms will be more likely to partner with them because they have more resources. Interestingly, logit analysis shows that the firm size is not significantly related to collaboration with foreign institutions. Although size is the easiest thing to explore, richer source of information are firm's perceptions about innovation, financial support, customers, etc. contained in the five perception factors. To explore if companies that do have such cooperation differ in those factors, the foreign collaboration was explored against factors *Innovation and technological capacity, Ability of research institutions, Banks investors and taxes, External orientation*, and *Customers* using logit analysis. The only significant factor is *Innovation and technological capability* (estimate=0.56, p=0.002, loglikelihood=–113.6). Factor *Banks, investors and taxes* is significant to 10% level (coefficient=0.28, Wald st.=2.89, p=0.09). This indicates that companies that perceive themselves as innovation and technology oriented tend to collaborate with foreign researchers (these companies tend to cooperate with academics at home as well). To some extent financial resources are also important because the cost of such cooperation is higher. Interestingly, companies' opinion of academics' ability has no bearing on whether they hire foreign researchers.

To explore the foreign collaboration further, firms were asked about cooperation with foreign consultants. Interestingly the same factors *Innovation and technological capacity* (coefficient=0.43, Wald st.=7.81, p=0.005) and *Banks, investors and taxes* (coefficient=0.33, Wald st.=4.53, p=0.03) appear as significant in logit analysis. Overall fit is given by log-likelihood=–122.7. Again we observe that innovation and technology-oriented firms tend to work with foreign consultants. Since consultants are hired on projects of lesser research complexity, financial matters become more important here than in cooperation with foreign researchers.

CONCLUSION AND RECOMMENDATIONS

This study focuses on industry-science collaboration in Croatia from firms' point of view. This paper attempts to shed more light on intensity of collaborative relationships and resulting satisfaction by considering firms' motivations and characteristics.

The most significant predictor of collaboration intensity, satisfaction with collaboration quality and satisfaction with commercial effect of collaboration is innovation and technological capacity of the firm. Possessing that capacity includes attributing high importance to innovations and technology, having access to advanced technologies, having long-term vision and highly skilled employees. Such firms are more likely to intensely collaborate with researchers in Croatia, and they tend to be satisfied with the collaboration quality and commercial effect. Such firms are also inclined to have collaborations with foreign researchers and consultants. The strongest motivation for firms with innovation and technological capacity is access to new technologies and processes.[8] In general (for all firms) data shows that except for access to new technologies and processes, the need to resolve concrete problems is another important motive. The more important either of these two motives is to the firm, the more intensely it will collaborate with academics. Contrary to expectations, factors like ability of researchers, financial resources, and demanding customers do not have any significant impact on collaboration intensity. It is surprising that perceived ability of academics does not have significant influence neither on collaboration quality rating, nor on commercial benefit rating.

Another factor that contributes to collaboration quality rating is firm's networking orientation. Firms with stronger external orientation are more satisfied with collaboration quality, but this does not carry through to satisfaction with commercial benefit. Firms that have better financial backing will express more satisfaction with commercial results.

Although firms that are motivated by access to new technologies and the need to resolve concrete problems are likely to have more intense collaboration with researchers, only the need to resolve concrete problems is linked both to the perception of quality and to the commercial benefit. Firms recognize that solving concrete problems does bring commercial results. Except for solving problems, both measures of satisfaction are positively related to using institution's name as a proof of quality. If firm is forced into collaboration by some regulations or legal requirements, it is likely that this will reflect negatively on the perception of collaboration quality. Although being forced in collaboration negatively reflects on perception of quality, fulfilling formal requirements imposed from outside may enable the firm to cash in on results (by gaining access to some markets for example), which reflects positively on perception of commercial benefit.

An interesting result is discrepancy between average rating for collaboration quality and average rating for commercial effect of collaboration, where commercial effect is significantly lower. This interesting finding requires special consideration in a country like Croatia, which is trying to improve industry-science relationships.

These insights can be useful to policy makers in situations when they have to make decisions on which actions to take to promote industry-science relationship. This study indicates that incentives aimed at strengthening firm's innovation and technological capacity may have positive impact on intensity of collaborative relationships. In other words, helping firms to become more innovation and technology oriented might induce them to form more intense relationships with researchers.

This study also shows that policy makers should use caution when promoting collaboration through regulations, or through other formal and legal means. Promoting collaboration by means of formal requirements directed at firms does not have significant impact on how intensely firms collaborate with researchers. These interventions tend to lower the perceived quality of collaboration, which in turn might further weaken firms' intention to collaborate. Resources spent in formulating and enforcing regulations might fail to yield desired outcome. Instead, resources might be better spent for incentives aimed at improving industry's innovation and technological capability.

FOOTNOTES

* This paper is based on a project funded by Croatian Ministry of Science and Technology, and executed by the Ekonomski institut Zagreb. Author would like to thank Jelena Budak and Edo Rajh, both from Ekonomski institut Zagreb.

[1] The study was financed by Ministry of Science and Technology, and performed by Ekonomski institut, Zagreb

[2] Those 230 firms represented total population of firms in Croatia which satisfied both conditions.

[3] Interestingly both formal regulations and using institution's name were mentioned by academics as well.

[4] By eigenvalue criterion 6 factor solution was chosen. Since the last factor had eigenvalue almost equal to 1, five factor solution was compared to 6 factor solution. Since the last factor in the 6 factor solution was difficult to interpret, 5 factor solution was chosen.

[5] Number of variables: 18

Method: Principal components, Varimax normal rotation

log(10) determinant of correlation matrix: –1.9043

Number of factors extracted: 5

Eigenvalues: 3.93621 1.80007 1.55676 1.39979 1.33195

[6] We need to be cautious in using this finding, as the coefficient is rather low although it is significant.

[7] Correlation r=0.28, p=0.0000

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Sanja TIŠMA

Resource Economics and Environmental Policy Department
Institute for International Relations, Zagreb, Croatia
E-mail: bsanja@irmo.hr

Krešimir JURLIN

International Economic and Political Relations Department
Institute for International Relations, Zagreb, Croatia
E-mail: kreso@irmo.hr

Anamarija PISAROVIĆ

Resource Economics and Environmental Policy Department
Institute for International Relations, Zagreb, Croatia
E-mail: apisarov@irmo.hr

THE ROLE OF RESEARCH AND DEVELOPMENT IN ENHANCING CROATIAN COMPETITIVENESS

INTRODUCTION

The share of knowledge-based and high-tech products in the world trade and output is increasing. In the conditions of scientific-technological revolution, the technology is set apart as a separate production factor with a key role in determining the production possibilities and structure of foreign trade. In addition, knowledge emerged as a new factor of production in terms of business competence of successful companies, regions and nations. In short, knowledge based economic activities rely on possessing specific information and abilities in order to effectuate the specific advantages in respect to products or production processes which will ensure a considerably greater added value.

According to Posner (1961), permanent development of products and innovation of production and services enable single countries certain advantage to master technologies that enable creation of higher quality products or lower prices, as well as new products, not represented on the world market so far. The technology must not be considered *per se* available in factorial sense, because its availability in a certain country is not a given condition, but a result of innovation, learning and imitation process.

The goal of building capacity for technology adoption is not easy to achieve due to variety of knowledge needed i.e. technical, technological, organizational and managerial skills. According to UNCTAD-a (1999), successful countries didn't apply the policy of import substitution or passive market liberalization. Generally, these countries had built strategic approach of adopting the technology based on the curve of active learning specific for each technology, as well as developing the possibilities which are crucial in locating the high-technology production in a certain country.

Investment in research and development, especially in business sector is a precondition for adopting new production processes and creation of new competitive products that will enable high added value. Therefore, it's necessary to stimulate companies' developmental function based on knowledge, technology and innovation. State has the important role in terms of developing the education system corresponding to entrepreneurship requirements, organizing state funded research projects as well as stimulating research and development in business sector as well as linking research conducted by universities, state and private ones.

In the past decade, Croatia was behind in using knowledge as a production factor, losing export markets for technologically demanding products as well as breaking linkages with the world-leading companies. Companies were more focused on privatization, surviving and defensive restructuring. The restructuring, by developing the existing technologically intensive activities and moreover by entering more advanced production segments suitable to Croatian rather high labour costs and educated workforce is necessary. However, the business sector didn't so far adequately use this potential by investments in own research and development. Only in the past few years a greater intensity in research-technological activities in business sector is recorded.

recent developments in r&d EXPenditure in croatia

The expenditure for research and development in Croatia are relatively modest, but the situation is much the same in more developed EU candidate-countries. The estimated R&D intensity in Croatia (share of expenditure for research and development in GDP) in 2001 (1.25%) is considerably lower than the EU average (2.21% in 1999), but greater than in Ireland and Italy. In comparison with other EU candidate countries, only Slovenia and Czech Republic have higher R&D intensity than Croatia. In spite of a noticeable increase in the past few years, the share of expenditure in business sector for R&D (42% in 2001) is still considerably below the average in developed countries, where some two thirds of R&D expenditures accounts for business sector. In the period under review there was no significant increase in the number of employed researchers and from 6149 in 1997[1] the number increased to 6656 by the year 2001, due to increased employment in the sector of higher education.

There is a relatively large number of researchers and Croatia with 37 researchers per 10.000 persons of workforce. In that respect Croatia is ahead of Italy, Austria, Czech Republic and Hungary, but considerably below the average of EU countries (52 researchers). However, exceptionally low is the share of researchers in business sector with 16% of the total researchers' employment in Croatia, whereas the same indicators for EU countries are 49% and for OECD are 63%.

Table 1
Main indicators for R&D in 2001 (or last year with available data)

	Expenditure for R&D (mil. €)	Expenditure for R&D per capita	Expenditure for R&D % GDP	% R&D in business sector	Number of researchers per 10.000 persons of workforce	Patent registration of residents per mil. residents (1999)
Croatia (2001)	276	63	1,25	42	37	61
EU-15	141,200	374	1.90	66	52	–
Germany	50,316	612	2,46	70	60	904
Austria	3,687	455	1,79	56	34	380
Ireland	1,076	283	1,21	74	51	327
Italy	11,524	200	1,04	54	33	167
Slovenia	297	149	1,52	56	21	147
Czech Republic	744	72	1,33	60	26	60
Hungary	405	40	0,80	44	31	77
Lithuania	73	21	0,60	22	–	24

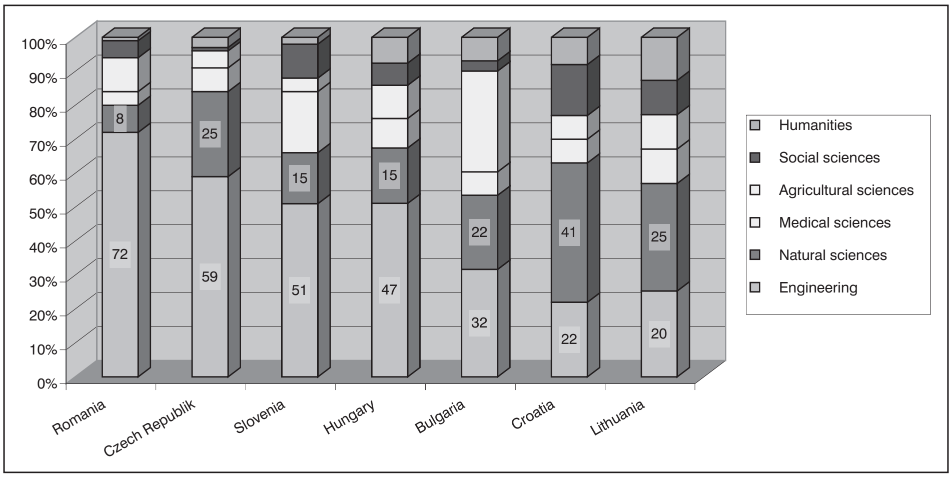
Source: Eurostat, Statistics in focus, Theme 9 – 1/2003, 3-2003 "Research and development 2000", State Bureau of Statisitcs

Note: R&D expenditure is calculated as gross expenditure for research and development. Official data on Croatian R&D expenditures are adapted to include the assessed R&D activities within small enterprises that are not included in the R&D statistics.

Concerning the patent registration, Croatia is similar to transitional countries, which are behind the EU countries, except Slovenia. This activity in Croatia is 6 times lower than in Austria and 15 times lower than in Germany.

In Croatia there is a considerably large share of natural science in research-development activities which account for 41% of total expenditure, whereas the share of engineering is relatively low, only about 22% which makes Croatia considerably behind from comparing countries (Fig. 1).

However, the presented indicators can not indicate the qualitative aspects of research and development activities while these data are usually obtained by surveys. One of the most known "benchmark" survey of competitiveness is conducted every year in the framework of the Global Competitiveness Report, published by the World Economic Forum (WEF). In the year 2002 Croatia was for the first time included in the report which enables us to benchmark the survey data on research and development activities.



Source: Eurostat, Statistics in focus, Theme 9 – 1/2003, 3-2003 "Research and development 2000", State Bureau of Statistics

Figure 1
Research-and development activities according to scientific fields in 2000

The average mark on R&D related survey responses of 3,71 (in range from 1 to 7) and average rank value of 52 roughly matches the average assessment of Croatian national competitiveness, which indicates that R&D activities are neither strength nor a specific weakness in the overall Croatian competitiveness.

	Score		Rank	
	Croatia	EU	Croatia	EU
Average score of R&D activities	3,71	4,84	52	24
Licence as a way of acquiring new technologies	4,87	4,96	33	29
Quality of scientific research institutions	4,25	5,05	37	19
Research and creation of new products, processes or imitations	3,28	4,96	41	16
Interest of companies for accepting new technologies	4,82	5,17	45	32
Labour or technological intensity of production	3,42	5,34	50	16
Public procurement of high technology: focused towards innovation stimulation or low price	3,40	4,11	51	25
Cooperation with local universities	2,90	4,55	56	18
Importance of innovation for companies revenues	5,11	5,37	57	36
Subventions or tax-deductables for R&D	2,66	4,21	58	18
Company investment in R&D	2,87	4,58	59	20
Direct foreign investment as a source of new technologies	4,21	4,88	65	41
Country's technological development	2,77	4,93	67	22

Source: Annual report on Croatian competitiveness 2002-2003, National Competitiveness Council, Zagreb, 2003

Table 2
Results of the survey: Global competitiveness report 2002-2003

According to managerial responses in the survey, the level of companies' investment in research and development is rather low, whereas the innovation is of insignificant importance for companies' revenues. According to entrepreneurs, the state support for research and development as well as collaboration of business sector with universities is inadequate.

Croatian managers that contributed to the survey have stated that licences are a good way of obtaining new technologies. However, licences are a way of obtaining obsolete technology, whereas the advanced technology could be obtained by foreign direct investment or through own research.

The assessment of the in-house research and creation of new products, acceptance of new technologies and technological development of production process is rather satisfactory. Although managers have a positive attitude towards the quality of research-scientific institutions and Croatia is ranked on 37^{th} place, the cooperation with local universities is assessed as poor (rank 56).

Entrepreneurs assessed as very poor the contribution of foreign investment in using new technology. However that refers to evaluation of the existing FDI in Croatia, and not the FDI potentials in high technology sectors. The poorest mark in the survey is linked with the general technological development of the country, ranking Croatia on 67^{th} place, most probably due to obvious falling behind regarding new investment in technologically demanding production segments.

These survey data, together with R&D and information and communication (ICT) indicators contribute to the technology index, as defined in the Global Competitiveness Report, by which, with a rank value of 43 Croatia was surprisingly placed significantly above the average rank value of indicator of potential for future growth (rank 58). However, as evident from Table 3, that outcome is far behind the values of technology index of Czech Republic, Hungary and Slovenia, ranked 20, 21 and 25 respectively.

The technology index in Croatia was pushed up by rather well ranking by the hard data on innovations (rank 43) and ICT (rank 37) as well as on survey data on technology transfer (rank 35). On the other hand, survey data on ICT (rank 51) and moreover on innovations (rank 78) indicate that rather advanced communication technology infrastructure and a significant innovation potential do not transmit to innovative high-tech business sector.

Table 3
Technology index and its components – rank values

	Czech Republic	Hungary	Slovenia	Lithuania	Croatia
Technology index	20	21	25	40	43
Innovation sub-index	42	34	24	33	50
Statistical data	48	37	23	34	43
Survey data	27	32	30	51	78
ICT sub-index	28	29	26	40	37
Statistical data	30	31	22	39	38
Survey data	26	21	33	49	51
Technology transfer	4	6	38	32	35

Source: National Competitiveness Council (2003), Annual Report on Competitiveness in Croatia 2002

DINAMICS OF RESEARCH AND DEVELOPMENT ACTIVITIES IN CROATIA 1997-2001

According to the research of the State Bureau of Statistics, in the period 1997-2001 the expenditure for research and development considerably increased; from 0.77% GDP-a in the year 1997 to 1.23% in 2000, to decrease again in 2001 to 1.09%. The increase of the R&D intensity throughout the observed period is a consequence of nominal increase of R&D expenditure by 86% (50% in real terms) and the increase of GDP by 32%.

Table 4
Gross domestic expenditure on research and development 1997-2000

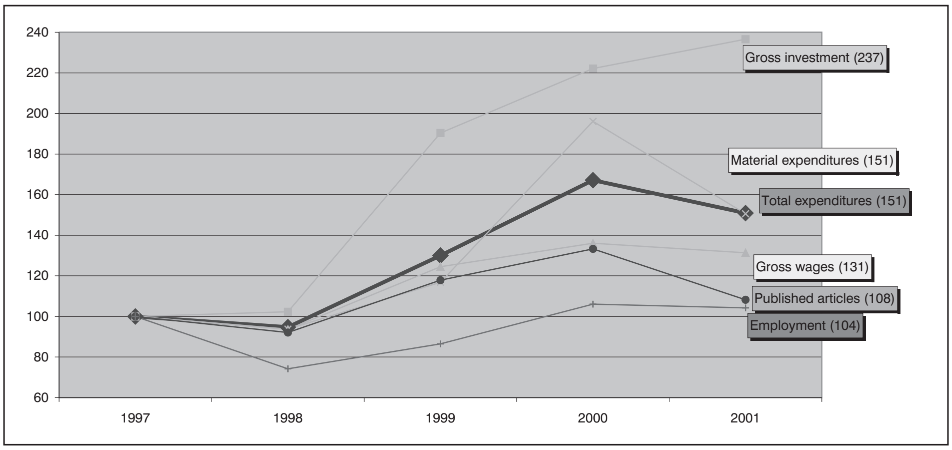
	1997	1998	1999	2000	2001	2001/1997
current prices						
Nominal expenditure (000 Kn)	958.351	981.215	1.397.761	1.881.839	1.780.379	1,86
Business sector	311.182	343.540	609.337	847.874	739.868	2,38
Government sector	326.218	260.683	298.602	405.382	403.311	1,24
Higher education	320.951	376.992	489.822	628.583	637.200	1,99
deflated (1997 prices)						
Real expenditure (000 Kn)	958.351	905.180	1.242.242	1.597.383	1.442.042	1,50
Business sector	311.182	316.919	541.540	719.711	599.266	1,93
Government sector	326.218	240.482	265.379	344.105	326.667	1,00
Higher education	320.951	347.779	435.323	533.567	516.109	1,61
memo: GDP (mil Kn)	123.811	137.604	141.579	152.519	162.909	1,32
Share in GDP	0,77%	0,71%				
Structure:	100,0%	100,0%	100,0%	100,0%	100,0%	
Business sector	32,5%	35,0%	43,6%	45,1%	41,6%	

Source: "Research and development" 1997-2000, State Bureau of Statistics

Note: According to survey expenditure for research and development involve all activities for this purpose ("in-house" IR) in business sector with more than 100 employees. Croatian statistical analysis is conducted according to Frascatti manual and obtained data are in greater amount comparable with data from OECD countries.

The R&D expenditure growth of 138% (93% in real terms) in the period under review increased the share of this sector in total expenditure from 32% in 1997 to 42% in the year 2001.

The question arises if such increase in R&D activities is sustainable and credible.

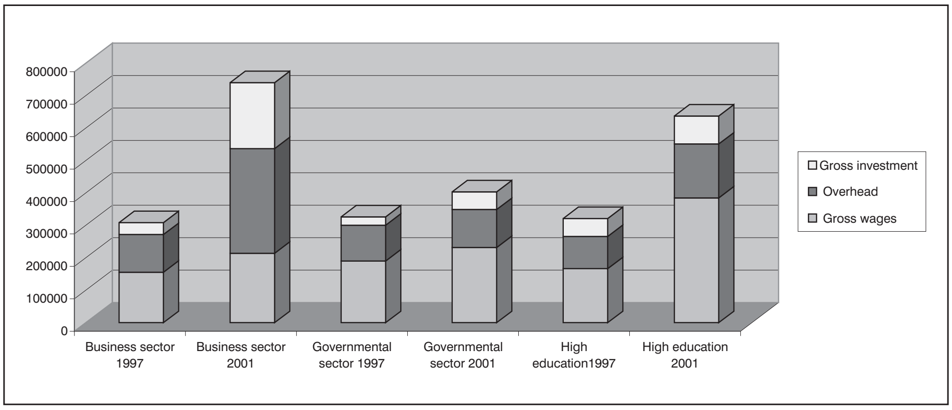


Source: "Research and development" 1997-2001, State Bureau of Statistic

Figure 2
Croatia: real indexes of research and development basic indicators 1997=100

Data on employment and published papers indicate a very slow growth of intrinsic research activities compared to a high growth in financial indicators. The noticed increase of R&D expenditure is a consequence mostly of the increase of new investments in R&D facilities in the business sector, which can be considered as a temporary phenomenon of few significant investment projects There was also a significant increase in salaries within the higher education sector in the period under review that can not be coupled by the same increase in real R&D activities.

Figure 3
Gross domestic expenditure according to sectors and types of expenditure



Source: "Research and development" 1997-2001, State Bureau of Statistics

Hence the developments of R&D activities are still not satisfactory. While further growth is needed in order to achieve the average share of expenditure for research and development in GDP as in the OECD countries, there is also a need to complement the increase in R&D investment with increase of employment and R&D activities.

POSSIBLE CHANGES IN THE SYSTEM OF GOVERNMENT STIMULATION OF RESEARCH AND DEVELOPMENT ACTIVITIES

A question is posed how to stimulate scientific technological research in order to achieve the technology-led growth. There is no unique answer. Optimal measures for realization of this goal depend on economic power of the country, tradition in supporting scientific technological development, scientific and technological infrastructure, as well as society's visions of scientific technological development. In any case, it is necessary to develop the system of organization, financing and evaluation of government supported research and development activities, especially of the interest for business sector.

Theoretically, the optimal share of government in project financing is determined as a share that considerably decreases the uncertainty of project realization[2]. Alternatively, the share of government in supporting the projects regarding the technology development should be proportional to the public content of this project. Both approaches have a justified logic, but could be mutually contrasted, while government subventions decrease the private risk in technology development. Main reasons for increasing the collaboration between government and private sector in R&D financing are:

- A need of a country to support the development by enhancing the economic base, i.e. technological development, as a part of efforts in order to increase the competitiveness in the global markets;
- Government financing is limited by a need of curtailing the overall public expenditure;
- Strengthening the private sector activities in scientific and technological research;
- A transfer of R&D activities from universities and public institutes to industrial institutes that better cope with the R&D demand of the industry.

The systems and policies of scientific and technological research very much diverge in different countries. The scientific-research system of major countries, beside direct public financing includes the system of private scientific foundation, government supported commercial research and partnership financing. The aim of research financed by different parties is generally different, from non-commercial research on government universities to work on technological projects financed by ministries of economy, with companies as the end users.

Germany is a good example, where large research organizations are financed by government under the responsibility of the Federal Ministry of Education and Research, additionally supported by scientific programs. However, the largest part of technological research, especially in the sector of small and medium enterprises is financed by the Ministry of Economy and Technology. The central role for supporting the scientific technological development is assigned to two institutions; Max-Planck-Gesselschaft (MPG) and Fraunhofer-Gesselschaft (FG). Whereas the MPG deals with basic research in the field of strategic importance for the country's future, the FG activities are concentrated on research that transmits into new products, processes and services, with some 40% of income from contractual research for the industry. Hereby the success of scientific-research work is evaluated according to the research type i.e. the basic research is evaluated through reviews and bibliometrics, whereas the evaluation criteria for applicable research are indicators of established commercial cooperation.

Generally, the allocation of government funds for R&D depends on system organization, model of financing and type and field of research. The traditional concept of quality, based on scientific competency, i.e. scientific contribution is applied for basic scientific research. Researches linked to projects or programs with defined goals and tasks are evaluated, in general *ex ante* while choosing, respectively financing decisions but as well, *ex post* control of set goals realization. The survey research with precise questions of research impact evaluation is used in the case of research with a precise purpose and known end users. Impact evaluation on the level of activities, total economy or socio-economic goals poses problem due to long-term and complex nature of these impacts and is conducted for evaluations on higher levels, respectively for financing large research programs.

Sometimes it is possible to avoid the unreliable direct estimation of success in a demanding process of choosing the projects and programs. Norway is the example of very instructive evaluation experience of innovative research in industry. After roughly a half of the projects of the support scheme to new scientific-technological projects ended unsuccessfully, the classical project evaluation has been replaced by the "implicit" evaluation based on 50% project co-financing. Namely, it was assumed that companies themselves will assess the best where to invest their own funds and co-financing based on that criterion is therefore the best way of assignment the government support. According to the Norwegian experience, the success of projects is greater if the governmental financing is lower. This is a good example and shows to which extent the supporting tools have impact on project realization.

CONCLUSION

Research and development activities are very important for economic development based on knowledge and innovation. In Croatia there was a traditional, rather rigid model of organization, financing and evaluation of research activities in public universities and institutes. While contracted in the 90ties, R&D activities in the business sector increased in the recent years, mostly in pharmaceutical industry, telecommunication and computers and in food industry.

Although there is a negative attitude of Croatian managers towards overall Croatian technological development and collaboration with scientific institutions, a more positive attitude exists towards licences, in-house research and creation of new products and acceptance of new technologies. While Croatia is not inferior to the most successful countries in transition in regard to general indicators of R&D expenditures, there is still a lag behind the developed countries, especially in R&D in business sector.

Government support of research and development activities of business sector in Croatia is still to develop. There are programs of co-financing the risky and new projects presumably in technologically intensive activities within the TEST and RAZUM programs of the Ministry of Science and Technology. Apart from that, there are certain support programs within the activities of the Ministry for Crafts and Small and Medium Enterprises. An important step in stimulating business R&D activities was made in 2003 by implementing special tax benefits for research and development expenditure. Also the Science and Technology project was proposed by the Government of Croatia (STP) with the objective to improve business infrastructural environment for science and technology and to reorient them to benefit the economy.

It will be necessary, in the future to considerably develop new mechanisms, especially from the aspect of organization and financing the research system, support the cooperation between government, public and private sector involved in R&D as well as through evaluation of research programs and projects. This would be possible only with carefully planed improvements in the institutional framework, as well as in financing R&D activities in the way of developing and supporting the pluralism of organizational forms and types of research, develop partnership models between science and education system with economy, as well as research activities in private sector.

FOOTNOTES

1 Research and Development Policies in the Southeast European Countries in Trasition, Republic of Croatia, Institut for International Relations, Zagreb, Editor: Nada Švob Đokić, Zagreb, 2002, p. 48.

2 Which is already in earlier phases of new technologies development.

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Ilian PETKOV ILIEV

Judge Institute of Management
Trumpington Street, Cambridge CB2 1AG, UK
Phone: +44 77 863 73 965, Fax: +44 1223 339 701
E-mail: pi204@cam.ac.uk

Domagoj RAČIĆ

The Institute of Economics, Judge Institute of Management
Trg J. F. Kennedy 7, 10000 Zagreb, Croatia
Phone: +385 1 2335-700, Fax: +385 1 2335-165
E-mail: dracic@eizg.hr
and
Judge Institute of Management
Trumpington Street, Cambridge CB2 1AG, UK

VENTURE CAPITAL FIRMS AS PRODUCTION NETWORK PARTICIPANTS IN TRANSITION ECONOMIES

INTRODUCTION

Innovative SMEs play an important role in modern economies. They are characterized by higher rates of employment and output growth than other SMEs and large enterprises. Furthermore, innovative SMEs perform a vital function in corporate production networks, by introducing and assisting in the development of new technologies, diversifying the technological risk of corporations, and serving as a channel for technology transfer from higher education institutions (HEIs) to industry. This role in production networks often goes beyond an arms length relationship between the SME and the corporation, and may be characterized by persistent and intensive linkages.

Such linkages need to be promoted by appropriate network organizers – a major actor who assumes the lead organizing role. In the case of innovative SMEs, their creation and development and inclusion into production networks is often facilitated by the entry of venture capital firms (VCs) in innovative SMEs. VCs are able to do so not only by providing firms finance to facilitate their growth, but also by assisting the development of firms' growth strategy, and facilitating entry into corporate production networks and technology transfer from HEIs to industry. Thus both directly and indirectly VCs can act as important participants in networks, and possibly as network organizers.

This paper is aimed at (i) providing an overview of what is known about the role of VC in developed economy production networks; (ii) comparing this to the situation in CEEs; and (iii) identifying particular factors that may be responsible for differences in the role of VCs between CEEs and developed economies. A subsidiary aim of this contribution is to stimulate further research into the topic of VC role in production networks. Better understanding of the constraints VCs face in CEEs will facilitate the identification of specific policies aimed at increasing the flow of knowledge and technology between the different actors in CEE production networks. This will ultimately contribute to sustainable growth in productivity and employment in CEEs. The paper has relevance for a number of theoretical debates, including but not limited to the literature of entrepreneurship, theories of venture capital, strategic management theory, and policy studies of transition economies.

PRODUCTION NETWORKS: AN OVERVIEW

The participants in production networks

The growing complexity of inter-organisational relationships puts emphasis on the importance of networks within which the firms are embedded (Gulati, 1998; Galaskiewicz and Zaheer, 1999), and links the explanation of a firm's conduct and performance to the examination of the structure and types of relationships it enters into. A firm's network of relationships brings about both opportunities and constraints (Gulati, Nohria, Zaheer, 2000). Such relationships may enable better access to information, resources, markets and technologies, reaping of the advantages from learning, scale and scope, and achievement of strategic objectives such as risk sharing and outsourcing non-strategic production activities, getting windows on new technologies, and sharing organisational competencies held by different participants in the network. However, network membership may also lock firms into unproductive relationships, sub-optimal technological trajectories, or hinder co-operation with other viable firms. Strategic networks are a subset of production networks, and overlap with other types of relations, such as static supplier-customer networks. They differ especially in terms of their emphasis on relational contracting (Richardson, 1972) and on knowledge-intensive transactions that make arms-length contracting unfeasible (Freeman, 1991). Furthermore, where knowledge-intensive transactions are concerned, the focus by the network participants is on sustaining competitiveness over time. This favours long-term relationships, as the necessary knowledge complementarities between organisations take time to develop, are not limited to once-off transactions.

At the sectoral level, the intersection between the different networks that are involved in the process of building sectoral capabilities involves various actors and networks. According to Gristock (2003), in addition to domestic and MNE firms, such networks and their interactions are influenced by regional/local and state governments, research and development or educational institutions, international agencies and other intermediary bodies. Effective networks often involve a major actor who assumes the lead organising role. Where the integration is facilitated by an organisation or group with a particular strategy (rather than a market or set of markets), such an organisation becomes a *network organiser*. Theoretically, any actor with the necessary capabilities and resources can be a network organiser. However, given the requirements in terms of financial resources and management capabilities, global production networks are primarily focused around large multinational enterprises (MNEs). National and regional networks may be focused on large local actors such as domestic corporations, Higher Education Institutions (HEIs), or MNE controlled enterprises[1] (Yoruk, 2002).

Linkages between large corporations and SMEs

Advancements in information and communication technologies (ICT) have allowed the development of management information systems, which in turn have facilitated the decentralisation of production and the formation of global production and distribution networks, with the retention by corporations of control of the production process (Ackroyd, 2002)[2]. The new technologies enable the breaking up of value chains into smaller components that can be obtained from independent contractors (Kaminski and Smarzynska, 2001) or established partners with whom relational contracting prevails (cf. Richardson, 1972). At the same time, the importance of regional clusters of firms engaged in similar activities has become apparent, partly due to the increased value of unique competencies and tacit knowledge, as codified knowledge becomes increasingly commodified through the increase in global communications (Hirst and Thompson, 1996; Lawson and Lorenz, 1999; Keeble et al., 1999; Lawson, 1999). The combined result is that enterprises are able to participate in *both* international and regional production networks, and are thus able to access resources, markets and competencies globally, while the value of localised competencies increases. This view is supported by research showing the growing value of science-based products[3], the exports of which have doubled from 1970 to 1995, while the share of scale-intensive exports in world trade has remained the same (Guerrieri, 1999).

The development of production networks due to technological advancements and the penetration into new markets entails the simultaneous differentiation of, and functional alignment of partners. Due to increased competition, firms are encouraged to focus on their core competences and specialise in particular products or technologies where they can outperform their competitors. However, the effectiveness of such a strategy relies on the achievement of economies of scale, which in most economies implies a need for access to global markets. Especially in the case of knowledge-intensive production, the size of domestic markets may be limited, again reinforcing a need for access to global markets. Major global firms engage layers of networked independent or semi-autonomous strategic partners and subcontractors that enable them to reconcile their needs for innovation, flexibility, risk sharing and efficiency. The co-operation through strategic alliances includes risk sharing and/or pooling of resources in order to stimulate organisational learning and/or utilisation of the partner's or commonly developed resources (cf. Child and Faulkner, 1998). Firms endowed with greater resources and competencies outsource the functions of non-strategic importance, diversify risk and achieve a stronger focus on their core competences. Simultaneously, they achieve access to a larger pool of competencies in their wider network, and consequently a greater exposure and access to external innovations. When it comes to smaller network members, participation in global value chains provides them with growth opportunities, which enable them to accumulate resources and competences, to access resources held by the larger members (such as marketing, distribution, as well as R&D conducted elsewhere in the corporate network), and move along the value chain and technological trajectories.

The fragmentation of value chains correspond to specialisation, generation of specific knowledge and innovation by autonomous and diverse agents. The focus of modern corporations on their core competences, coupled by the interconnectedness within the network mean that the firms' behaviour and strategies are interdependent. Firms develop strategic relationships, co-ordinate particular actions and engage in collective learning. Functional integration leads to selection mechanisms that control the level of diversity and determine the dominant technological solutions in particular situations. Viability and effectiveness of production networks require both the facilitation of diversity through innovation, and appropriate selection processes that enable acceptance of particular technological problem-solutions as standards which spur and channel further innovations.

The inclusion of innovative SMEs in corporate production networks holds a number of benefits for large enterprises. The outsourcing of many of the non-core corporate production activities takes place through SMEs. However, the need for continued coordination and the need for diffusion of innovations and standards throughout the networks implies high competence requirements on the SME members of corporate production networks. In turn, the relational proximity to innovative SMEs allows the network integrator to benefit from innovations taking place within SMEs. Furthermore, the presence of innovative SMEs allows the outsourcing of a number of R&D functions, effectively subjecting the corporation to the positive externalities of the risk-taking by entrepreneurs. Large enterprises may either be unwilling to take on the risk of experimentation with new technologies, or may be experiencing lock-in effects in old technologies. In either case, "large firms can prey upon the risk-taking of reckless small firms. Thus small firms provide an externality of recklessness" (Nootebaum, 1999:143).

As the most flexible parts of production networks, SMEs play a vital role in their development and functioning. Many SMEs engage in retail trade, cost-competition in standardised products and services, and generally little innovative content. Such SMEs are characterised by readily replicable capabilities, and thus their role within production networks tends to be small, limited to arms-length relationships, discrete transactions, with little or no strategic relationships with other network participants. On the other hand, a significant proportion of SMEs engage in innovative activities: 44% for small and 61% for medium-sized enterprises in the European Union (Radošević, 1999). Where the SMEs are involved in knowledge-intensive production, their role in production networks is likely to be more important and non-replicable. Innovative SMEs develop highly specific and inappropriable capabilities, and contribute to a diversification of the technology risk within production networks, and a general diversity in capabilities and technological trajectories within production networks.

While SMEs may have highly developed technological capabilities, they lack the complementary resources necessary to reach global markets independently. Participation in corporate production networks may allow them access to a number of complementary corporate resources, such as marketing, distribution, and mass production facilities.

The linkages between SMEs and larger enterprises are thus crucial for facilitation of supply of and the demand for product and process innovations, and for the corresponding flexibility of production networks. In support of this, evidence from the UK for 2002 (Hughes and Cosh, 2002) shows that close to 40% of all SMEs enter collaborative partnerships, while 60% of innovative SMEs do so. The same data shows that 60% of SMEs collaborate with firms in similar line, 47.8% collaborate with customers, 48.4% collaborate with suppliers, and 16% with higher education institutions.

THE ROLE OF VENTURE CAPITAL FIRMS IN DEVELOPED ECONOMIES

Facilitation of innovative SMEs

The growth in the importance of innovative SMEs has been at least partly facilitated by the growing role of Venture Capital (VC) in production networks. "[V]enture capital, by stimulating the creation and growth of technology-based firms, helps translate the results of research and development into commercial outcomes. In doing so, it plays a catalytic role for innovation" (EIB, 2001:2). Empirically, the impact of VC in developed economies can be illustrated in terms of contributions of VC-backed companies to employment and innovation. Employment growth in VC-backed companies in the EU is 15%, which is 7 times faster than the top European companies (EVCA, 1996), with similar results for the UK (BVCA, 1999) and higher for US (NVCA, 1999). In terms of the role of VC-backed firms in systems of innovation (SIs), the relationship here is complicated by the particular patterns of VC investment in an economy. US VC activity has been more focused on early-stage and technology-intensive investments than is the case in the EU, and is hence likely to account for a higher proportion of innovation levels. A study of the contribution of VC to innovation in the US economy for the period of 1982-1992 (Kortum and Lerner, 2000) suggests that VC-backed companies are responsible for a disproportionately large contribution to innovation – while VC accounts for 3% of corporate research and development, it contributes to 8% of industrial innovations. While historically VC in Europe has been focused more on low-tech late-stage investments, recent studies of the EU suggest that there is a convergence in these measures, with EU levels of high-tech investment increasing, and overall VC activity reaching 0.24% in 2001 (EC, 2002a)[4].

The standard view of VC is of a financial intermediary that fills a credit and equity financing gap left by traditional providers of finance such as banks and stock markets[5]. From a principal-agent perspective, such investments are most efficiently financed through equity investments, which allow close monitoring by the investors of managers, thus minimizing moral hazard effects. However, the small size of SMEs prevents access to organised equity markets[6], thus leaving an equity market gap filled by VCs as providers of equity capital to high-risk ventures based on the specialisation in intensive monitoring (Gompers, 1995, 1999; Admati and Pfleiderer, 1994). Thus VC is an organisational form appropriate for SMEs characterised by high-risk strategies and low collateral levels, and may act as a "half-way house" between the start-up phase and initial public offering (IPO) on a stock market.

However, the role of VCs goes beyond that of a "pure" financial intermediary, and this role varies for different types of actors. For investees, the role played by a VC ranges from a provider of finance to the provision of strategic management and network integration services. For large corporations, VCs provide access to a population of SMEs characterised by higher than average corporate governance mechanisms, which can provide options on emerging technologies, technology risk sharing opportunities, vertical and horizontal expansion opportunities. In addition, the presence of VCs in a corporate production network facilitates the divestment of non-core assets by corporations, simultaneously enriching the production networks, and facilitating a focus on core competencies by corporations. For science-industry relations, VCs provide a technology transfer route complementary to technology licensing, by facilitating the growth of technologies through university spin-offs that would not have entered industry otherwise. Thus far from being a "pure" financial intermediary, VCs can play an important role in national, sectoral or regional systems of innovation.

The "pure" financial intermediary view of VC is even more debatable, given that in practice the role of organized equity markets for VCs is limited. Even in developed economies the majority of VC exits occur through trade sales (sales of portfolio companies to a corporation). For instance, Europe-wide trade-sales accounted for 41% of exits in 2000, whereas equity market exits (IPO *and* sale of quoted equity) for the same period accounted for 24% for Europe[7]. The dominance of corporate buyers of

VC-backed companies opens the possibility that VCs may be affected by corporate growth strategies in their selection and development of portfolio companies. If that is the case, then VCs themselves may be said to be a part of corporate production networks, as they are an intermediating mechanism between corporate strategy and SME development strategy. This aspect of venture capital is difficult to quantify and there has been limited research in this area, but there are good reasons to expect that the impact of corporations on VC selection and development strategy is non-trivial. We explore next some aspects of the VC roles in production and strategic networks.

Corporate links with venture capital

Trade Sales

VCs realise the gains on their investments through the sale of the companies they have invested in. In principle, exits can occur through several channels – an IPO[8], a trade sale[9], a sale to another financial intermediary, sale back to the firm's management/founders, or a write-off. As noted above, while IPOs are the preferred exit route for VCs (as returns tend to be highest there), even in developed economies the majority of VC exits occur through trade sales. Both institutional factors[10] and sector-specific factors[11] increase the importance of corporations as an exit route.

The reason we emphasise the dominance of trade sales as a VC exit strategy is that there is a qualitative difference between an IPO and a trade sale. In an IPO the purchasers of shares in a listed company invest in expectation of "pure" financial returns, and are not necessarily concerned with the corporate strategy of enterprises per se. By contrast, corporations tend to purchase or divest companies in line with a corporate growth strategy, in which "pure" financial aspects of the transaction are not the main criteria. Rather, strategic aspects of the transaction, such as the "fit" of a purchased company in the buyer's production network, its place in a corporate expansion strategy, or its value as an "option on technology" may be the determining factors. Thus if trade sales are the dominant exit strategy, then corporate strategies will impact directly on the VC selection of investees, and on the post-investment development strategies. To illustrate, if a VC has to select between two investment proposals that are equal in all aspects (projected financial returns, management team, and so on), except for a different likelihood of an exit, then the VC will provide finance to the company that it believes has the highest probability for exit. Furthermore, once a VC investment is made, its role is not limited to passive monitoring of the investment, but involves the formulation or modification of a firm's development strategy. As enterprise development is not a linear and deterministic process, but a creative and indeterminate one, strategic choices made during the growth process impact the firm activities in a non-reversible manner. And, as argued above, such strategic choices are based on the strategic requirements of the expected corporate buyer.

This is an important observation, as it implies that VCs are not neutral selection mechanisms in the way financial intermediaries are usually seen. VC dependence on corporate demand for investees may impact negatively on the prospects of whole classes of investees, which could be sustainable in pure financial terms. The negative aspects of this filtering mechanism may be limited if the population of corporate participants in the VC industry is sufficiently diversified. However, if there is a "skewed" pattern of corporate participation in the VC industry, this filtering effect will be strong. We will see in the section on VC in CEEs how the dominance of MNEs of the VC industry results in such a skewed pattern of investment.

Corporate Venture Capital and Corporate Spin-offs

Beyond their role as buyers of VC-backed companies at the exit stage, corporations have two other direct channels of participating in the VC process – corporate spinout development and corporate venture capital (CVC). One mechanism behind corporate spinouts is corporate refocusing away from unrelated activities to core capabilities identified by management as strategic (Haynes, Thompson, Wright, 1999). Another source of corporate spinouts is the generation of non-core capabilities as a by-product of a corporation's R&D and other activities (McNally, 1997). In both cases the corporation possesses resources that are non-core to the company's focus. Their spinout as (semi)independent enterprises enables better management focus, while also generating extra income. The spinouts may continue to enjoy access to resources of the parent company, as well as benefiting from the inherited informal network of its employees[12].

Corporate spin-offs provide a high quality deal flow[13] to VCs, since these are companies with distinct competencies, experienced staff (especially on the technical side), but experiencing a lack of financial resources and management expertise. Hence the presence of VCs in corporate strategic networks allows corporations to benefit from the ability to dispose of non-core assets, VCs to increase their deal flow, and for the competencies and knowledge carried by spinouts to survive in the marketplace.

CVC represents a radical entry by corporations in the VC market. CVC may be direct (the establishment of a VC fund by the corporation), indirect (the corporation provides funds to a VC, and interacts indirectly with the investees), and joint (a corporation enters ventures jointly with a VC). Research suggests that corporate motives for engaging in CVC are mostly strategic, aiming at identifying new markets and new technologies that may improve the competitive position of the corporation, rather than aiming to capture direct financial returns from such investments (McNally, 1997:206; also cf. Teece, 1992 on foreign CVC in Silicon Valley). Furthermore, CVC may also expand demand for a corporation's products and services (Brody & Ehrlich, 1998). For the entrepreneur, a crucial characteristic of CVC is that "the small firm not only receives an injection of finance but also gains access to the resources of the investor, including managerial expertise, manufacturing capacity and distribution channels" (Mason & Harrison, 1999:16-17). Thus CVC may be seen as a complementary service to that provided by VCs to investees – if VC concentrates on corporate governance issues, CVC provides strong strategic elements to the investment.

CVC is assisted by VC firms acting as (i) referrals of venture opportunities to CVC programs, (ii) a channel for learning of young CVC programs, and (iii) use existing VC investments as a signal of venture quality (Sykes, 1990). VC firms are assisted by CVC by providing (i) a co-investor, with potentially more patient capital, (ii) a competent advisor during the due diligence process; and (iii) as a potential exit route for the venture (Sykes, 1990; Teece, 1992; Miles and Covin, 2002). Overall, CVC can be seen "as a means by which investing corporations gain access to the intangible, behavioural resources of the small firm, including its flexibility" (McNally, 1997:216).

Science – industry technology transfer

One common factor to many high-technology clusters (e.g. Silicon Valley, Cambridge – Massachusetts, Cambridge – UK) is the central role played by higher education institutions (HEIs) as a source of both technology transfer and entrepreneurs. The development of knowledge-intensive enterprises in these regions has been assisted by technology transfer from HEIs to industry. Recent research on the economics of science and knowledge has illustrated the need for assistant organisations in science- industry technology transfer. This is attributed to the presence of tacit knowledge in such environments (Ancori et al., 2000; Cohendet and Meyer-Krahmer, 2001), and the difficulty of transferring tacit knowledge across organisational boundaries, as well as inadequate incentive structures to facilitate such transfers (Dasgupta and David, 1994; Saviotti, 1998). Therefore as technology transfer from science to industry is not an automatic process, it involves complex transfer arrangements, which need to accommodate the flow of both tacit and codified knowledge across organisational boundaries, and the resolution of high levels of technological uncertainty.

In the context of the above several technology transfer mechanisms from HEIs to industry can be identified – technology licensing, contract research/consulting, and academic spin-offs (cf. Management Science "Special Issue", 2002; Antonelli, 2003). The determinants of industry demand between these channels are complex and related to several factors. For instance, high levels of information asymmetry between inventor and technology purchaser may prevent technology licensing from occurring, thus opening up the option of a spin-off as a way of developing the technology to a level at which it will be easier for the market to absorb it (Gallini and Wright, 1990; Lowe, 2002). The companies formed in this process are more commonly known as the "new technology based firms" (NTBFs), defined as firms created on the basis of exploitation of research from HEIs (EC, 2002b). As NTBFs are often engaged in process and intermediate product innovation, they are naturally integrated in corporate production networks, and ultimately absorbed by corporations.

Besides supplying finance, VCs may have an important role as a supplier of managerial services in the case of NTBFs. Academics are seen as generally lacking entrepreneurial and managerial skills, while they also face conflicts between academic career and business development requirements[14]. Thus, while the academic founder of the enterprise may be highly technologically competent, there is a need for the simultaneous development of the finance, marketing and strategy functions.

VC assists the creation of NTBFs through the channels identified in the earlier sections. What is different here is that the VCs are integrated in the strategic networks clustered around HEIs rather than corporations[15]. Several channels through which VCs interact with HEIs can be identified: (i) HEIs are a source of deal-flow for the creation of NTBFs through spin-offs and academic start-ups; (ii) HEIs provide a pool of consulting expertise and professional labour for high-tech start-ups; (iii) HEIs are a source of technology transfer to *existing* VC-backed enterprises; (iv) HEIs provide formal and informal[16] incubating facilities to high-tech start-ups. Beyond this there are a number of informal ways through which the HEI environment assists VCs in nurturing businesses, most importantly through the provision of a milieu of tacit-knowledge and innovation (Lawson and Lorenz, 1999).

There is by now an established literature on the technology transfer by universities through entrepreneurial spin-offs (e.g. Allen et al., 1992; Roberts, 1991; Management Science, 2002), and the importance of informal networks between different systems of innovation actors (e.g. Keeble et al., 1999; Lawson, 1999; Lawson and Lorenz, 1999). In terms of our focus on VC and production networks, this literature illustrates that VCs act as facilitators of technology transfer to production networks, assist the formation of strategic relationships between NTBFs and other network members, and may even act as network organizers and integrators.

Venture capital firms as network organizers

In developed economies, the role of VC is not limited to the provision of finance, but also includes involvement in strategic managerial decisions of its investees, and the facilitation of the integration of VC-backed companies in corporate production networks. Furthermore, VCs may act as intermediaries in the technology-transfer process from HEIs to industry, by basing their choice of investments partly on perceptions of the likely relevance of the technological area of a particular investment proposal. Finally, VCs assist corporations in the acquisition of highly competent enterprises, the shedding of non-core assets, and in seeking exposure to new technologies and markets through equity participation in innovative start-ups. In short, VCs play a crucial role in the process of selection, growth and integration of innovative SMEs in developed economy production networks, and technology transfer between various actors in these networks. In doing so, VCs increase the flexibility of these networks, as it facilitates the absorption, recombination and shedding of capabilities and resources necessary to maintain corporate competitiveness.

As indicated above, VCs can be thought of as network organizers, since “venture capital firms sit at the centre of extended networks linking financiers, entrepreneurs, corporate executives, head-hunter and consultants through which they are able to share information, organize deals and mobilize resources, and thereby stimulate entrepreneurial start-ups" (Mason and Harrison, 1999:22). Other networking services are the provision of access to potential customers and suppliers, the active search for a corporate partner and possibly buyer, as well as the linking of companies held in the same VC portfolio that may exhibit synergies. Furthermore, especially in highly fluid environments where issues of both technological capability and corporate governance are important, VC investment may act as a signalling mechanism of the *quality* of an enterprise, since it shows that the portfolio company has been through a due diligence process and has a corporate governance mechanism in place[17]. Access to VC backing signals the enterprise's commitment to a credible development strategy, which in turn reflects the VC's filtering mechanism. This information is relevant to potential customers, strategic partners and future investors. Thus in an environment characterised by high levels of fluidity and uncertainty, the presence of a filtering and management organisation such as a VC may act as a powerful network integrator, as it decreases uncertainty both on the corporate side and the SME side that may have prevented the formation of a network hitherto.

PRODUCTION NETWORKS IN CEE

Restructuring of production networks in CEE

In CEEs the production networks inherited from socialism have undergone a radical transformation. The transition period, characterised by macroeconomic shocks, privatization, radical institutional change, and the sudden obsoleteness of organisational competencies due to the change from a central planning to a market coordination mechanism have put large domestic firms in a defensive position (Radošević, 1998a, 1998b). Only a few firms in each country have been able to enter the global market with high value added products, despite the relatively high level of technological development of these economies during central planning (Radošević, 2002; Radošević and Yoruk, 2002; Yoruk, 2002). Moreover, such firms rarely have the resources or capabilities to serve as focal points for the development of production networks characterised by strategic linkages with domestic or foreign firms. Due to the lack of affordable sources of finance, and intensified competitive pressures from domestic and foreign firms, many firms underwent defensive restructuring, which was much more focused on cost reductions than on finding of new market opportunities, or the building of strategic networks. While the restructuring of the large firms has often resulted in the shedding of different industrial units, this has not led to the development of production networks characterised by durable and "thick" links between the different enterprises in an industry (cf. Radošević, 1998a; Stiglitz and Ellerman, 2000). Domestic corporations tend to rely on foreign suppliers in the procurement of knowledge-intensive products, rather than investing time and resources in developing local alternatives through alliances with local enterprises. Moreover, they often do not generate sufficient innovativeness and the volume of business that would justify focusing on core competences and developing more complex co-operation with subcontractors.

The arrival of MNEs into transition countries has led to some integration of local firms into global production networks (Linden, 1998; Van Tulder and Ruigrok, 1998; Kaminski and Smarzynska, 2001; Dyker and von Tunzelmann, 2002; Turlea and Merkuta, 2002)[18]. However, the benefits of MNE-centred networks accruing to domestic enterprises have been narrow. The networks being built are often restricted to the MNEs' subsidiaries with limited local subcontracting (cf. Radošević, 2002). The integration of local suppliers into the MNEs' global production networks has so far been mostly limited to low-value added activities[19] (Linden, 1998; van Tulder, 1998; Dunin-Wasowitz, Gorzynsky, Woodward, 2002), while the capability enhancements and technology transfer benefits accruing to domestic companies partnering with MNEs on innovative projects is limited (Sadowski, 2001). This is in line with international evidence suggesting that MNEs tend to concentrate innovative activity in their home countries (Patel and Pavitt, 1998), and that where investments do occur in high-tech investment, it is to exploit an *already existing* high level of innovation (Teece, 1996). The danger is that a dominance of MNE-centred production networks in CEE economies may lead to (i) the development of a dual economy, where the best SMEs are integrated in MNE networks with limited knowledge spillovers to the rest of the economy; and (ii) that local enterprises may become trapped in low-value added activities, with innovative activities limited to adaptation of global products to the local environment. Radošević (2000) suggests that CEE production networks and systems of innovation are in a state of flux, and today's network organisers will shape their future patterns. Furthermore, the ownership patterns after the privatisation of CEE industries and FDI entry modes impacts on the thickness of networks. Individual sale, especially to foreign buyers, destroyed linkages inherited from the socialist period, while greenfield FDI is integrated in *foreign*, rather than domestic production networks (Radošević, 2000). However, in the case of locally owned enterprises, the remaining local production networks have not been beneficial to new entrants – often due to defensive restructuring strategies. Consequently, the level of linkages developed by domestic corporations with SMEs is rather low, and characterised by low knowledge-intensity.

Innovative activities in CEE

Despite the decline in total innovative activity since the beginning of reforms, CEE systems of innovation (SIs) remain relatively robust. For example the proportion of innovative firms *as a whole* in the CEE is still close to or above that of some EU members (see Table 1). Furthermore, at least according to some indicators, candidate members' R&D systems are *more* productive in terms of patents to Gross Expenditure on R&D – "the ratio for patents/GERD suggests that the candidate countries produce three times as many patents per Euro of GERD as the cohesion countries" (EU, 2001:74)[20], while data on resident

Table 1
Shares of Innovative Firms in EU and CEE

Country	Share of Innovative Enterprises
Russia	6%
Romania	28.3%
Slovenia	31.9%
Italy	34%
Spain	37%
Luxembourg	37%
Poland	37.6%
France	39%
EU	**50%**
Norway	53%
Denmark	56%
Netherlands	57%
Belgium	61%
Germany	67%
Ireland	72%

Source: Radošević (1999); Period: 1996-1998 patent applications and science and engineers engaged in R&D also show levels at or above EU averages (World Bank, 2000). In terms of innovative capacity CEE SIs continue to score high. One way to reconcile this observation with the earlier discussion of the low levels of innovation in domestic industry is that there is a lack of (i) transfer of HEI based knowledge and capacities to industry; and (ii) integration of SMEs with both HEIs and large corporations.

Knowledge-intensive production involves high set-up costs, complex networks of production including not only firms but also HEIs, and the sharing of a vast array of complementary and interrelated knowledge sets generated by these participants (Antonelli, 1999). Thus the likelihood of the increase in knowledge-intensity of production networks in CEEs will be linked to the technological capabilities of the participants, as well as the presence of a network organiser (Radošević, 1998a). The absence of strong network integrators in CEEs has led to a general shift toward production characterized by lower levels of technological complexity and knowledge intensity (Radošević, 1998b). This impacts negatively on the ability of CEE corporations to compete in knowledge-intensive industries that require continuous innovation (cf. Radošević and Yoruk, 2001).

Table 2
Corporate Innovative Activity by Firm Size in CEE and EU

Romania		Poland		Slovenia		Russia		EU	
Firm Size	Share of Innovators	Firm Size	Share of Innovators	Firm Size	Share of Innovators	Firm Size	Share of Innovators	Firm Size	Share of Innovators
20-49	2.7%	6-50	16%	1-50	14.2%	<49	4.9%	<100	44%
50-199	9.6%	51-500	33%	51-250	29.9%	50-99	6.6%	100-500	61%
200-499	26.3%	501-2000	72.5%	250>	62.9%	100-199	12.4%	500>	79%
500-999	36.3%	2000>	87.5%			200-499	18.3%		
1000>	52.9%					10,000>	79.8%		

Source: Radošević (1999); based on the 1998 EU Community Innovation Survey, and various surveys in CEE

Table 3
CEE Active Enterprises Profile by Sector and Year of Creation

Year Created	Manufacturing	Construction	Distributive Trade	Transport	Hotels, Rest., etc.	Other Services	Enterprise Distribution By Size		
							0	0-50	>50
1995	12.6%	9.4%	43.9%	6.8%	4.6%	22.7%	66.9%	32.3%	0.8%
1996	14.1%	11.7%	36.8%	9.2%	5.3%	22.8%	60.1%	39.1%	0.8%
1997	12.2%	11.9%	37.4%	7.6%	4.4%	26.5%	65.9%	33.2%	0.9%
1998	10.8%	12.1%	37.6%	7.2%	4.7%	27.7%	68.7%	30.6%	0.7%

Source: Eurostat (2000)

The majority of new SMEs remain too small, too weak and too disconnected from both domestic and foreign corporations (Gabor, 1997; Bateman, 1997). While there is no dataset that allows a direct comparison between collaboration levels of SMEs in the EU and CEE[21], anecdotal accounts of CEE SMEs suggest that collaboration levels are significantly lower than the EU levels. Several studies of CEE systems of innovation conclude in particular that linkages between SMEs and HEIs are particularly weak, while linkages between SMEs and large enterprises are generally concentrated on collaboration with MNEs[22].

A comparison between data collected from innovation surveys for the EU and CEEs shows that while CEE large enterprises have similar levels of innovative activity to EU averages, the proportion of innovative SMEs in CEE is significantly less than EU levels (Radošević, 1999, illustrated in Table 2). In line with this, surveys show that the majority of new enterprises (of which SMEs compose 98%) are engaged in activities commonly associated with low levels of innovation, such as distributive trade and the hospitality industry (Eurostat, 2000, Table 3)[23]. It is likely that both current and historical factors are behind the low level of innovation in SMEs. Historically it is possible that the dominance of large industrial units of manufacturing during central planning at least explains the concentration of SMEs on low-innovation level services in the initial period of transition. At present this situation seems to be compounded by the lack of strategic network building efforts by large domestic corporations and lack of finance for SMEs, among many factors. SMEs have insufficient resources and capabilities to engage in innovation, and insufficient resources to reach external markets. On the other hand, domestic strategic and production networks remain underdeveloped, which is particularly related to the smaller role of SMEs in production networks, lower levels of innovation in these, little interaction between HEIs and industry, as well as the dominant role of MNEs as network integrators.

There is an increasing recognition by policy makers of the need for knowledge-intensive production to increase in CEEs to facilitate the integration of these economies in the European Union:

> "the cohesion of an enlarged EU will depend on the economies of the [candidates] being able to sustain high rates of growth through increased technological change... New mechanisms for supporting innovation and industrial upgrading will be needed if productivity growth is to be maintained" (EC, 2001:11).

In particular, "the major issue is whether new innovative firms are able to obtain finance for the start-up and early growth phase of their existence... [and] innovation finance, in the broadest sense, must be a priority for [CEE] governments" (EC, 2001:65)[24]. Development of a population of innovative SMEs' requires financial resources, as well as strategic management and network integration services, which they cannot easily access by themselves. Given the insufficient communication and co-operation between corporations and (especially innovative) SMEs in CEEs, there is an obvious lack of mediating institutions that would align their interests, facilitate innovation and the selection of the most appropriate solutions within production networks. Thus the issue of the present nature of VC involvement in CEE economies, and the identification of means of enhancing its role in CEE production networks becomes paramount to the discussion of the transition process in CEEs.

THE ROLE OF VENTURE CAPITAL IN CENTRAL AND EASTERN EUROPE

So far we have attempted to identify important characteristics in developed economy production networks that explain their success, and compare these to features of CEE production networks. We concentrated on the important role innovative SMEs play in developed economy production networks, and we identified this as a conspicuous gap in CEEs. In the first section we identified VC as an important actor that facilitates the creation and integration of innovative SMEs in developed economy production networks. In the remainder of the paper, we focus on the extent to which VC in CEEs plays this role.

The venture capital industry in CEE

Enterprise surveys (cf. Eurostat, 2002) show that for all CEEs "lack of funds" is perceived as the greatest problem, with "limited access to credit" in second or third place. Whereas only 14% of EU SMEs found "access to financing" a constraint, this was a primary problem for a massive 73% of CEE enterprises. Similarly, technical analysis of balance sheet data for CEE enterprises concludes that credit-rationing effects are strong in CEEs, and financial intermediary underdevelopment prevents enterprises from achieving their desired capital structures (Cornelli et al., 1996). Thus it would appear that the major benefit offered by VCs in CEE is the mitigation of the inadequate supply of finance to SMEs in financial markets. Without trying to diminish its importance, we are reluctant to concentrate solely on the provision of finance aspect of VC. As discussed, credit and equity market gaps do not explain the role of VC in developed economies. While in the short-run VC will continue to play the role of a substitute for more traditional forms of finance, attention should also be focused on the more sustainable role they can play as participants in production networks.

However, when it comes to facilitation of growth of innovative SMEs and the role of VCs in production networks, the effects seem limited. A significant difference between VC in CEEs and developed markets is the extreme concentration on late stage investments, old enterprises, and low-tech investments (Table 4 and Figure 1). Isolated from other factors, this should be surprising, given the relatively high levels of innovation and lack of alternative sources of finance would imply high levels of unsatisfied demand for finance by SMEs. Perhaps the deal-flow structure could give some indication on the reasons for this situation. So far a significant part of the VC deal-flow has come either from privatised enterprises, or the setting up of businesses explicitly modelled on developed economy strategies. The socialist legacy of underdeveloped sub-sectors of the economy, lack of market-oriented corporate strategies, and changes of consumer demand toward "Western" patterns, have meant that investment opportunities have been precisely in traditional industries, where the wholesale transfer of Western business models and technologies have led to satisfactory returns. In the words of one VC manager, "you are in a European risk environment where you can pioneer these tried and tested techniques. Steadily every feature and every lending structure makes its way to central Europe" (EVCJ, 2001:61).

A more ambiguous contributing factor could be the dominance of foreign-controlled VCs in CEEs. Whereas in developed economies VC firms are usually locally founded and staffed (which allows the utilisation of localised knowledge and informal networks), in CEEs VCs are an imported institution usually founded and managed by outsiders (Karsai, 2001). There is a tension here, since the dominance of the industry by outsiders is itself related to the lack of local management talent that could be used by VCs. But the cost of this is the under-utilisation of local networks, and the difficulty of embedding VCs into local networks.

The low proportion of innovative SMEs also implies that the statistical likelihood of the emergence of quality

Table 4

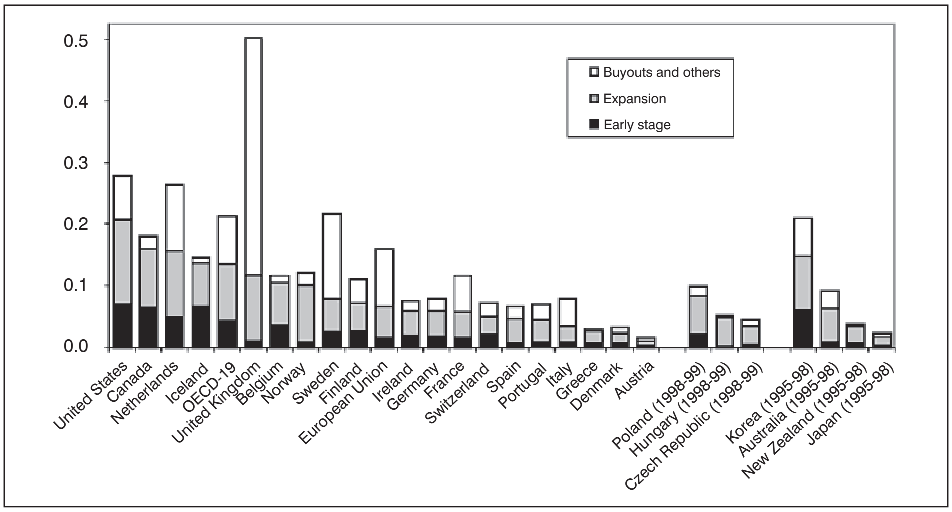
Private Equity & Venture Capital in selected EU and CEE economies

INVESTMENT COMPOSITION – 1st Half, 2000									
Country	Seed	Start-up	Expan-sion	Replace-ment Capital	Buyout	No Compa-nies (all stages)	Total Investments (×1000 €)	VC % GDP (annualised – H1×2)	% Europe Market
Europe	9.3%	35.1%	40.7%	5.7%	9.3%	4,630	€ 13,470,173		100.0%
Czech Republic	0.0%	11.1%	77.8%	0.0%	5.7%	9	€ 33,007	0.118%	0.2%
Hungary	0.0%	16.7%	66.7%	16.7%	0.0%	12	€ 8,651	0.034%	0.1%
Poland	2.8%	5.6%	80.6%	11.1%	0.0%	36	€ 116,276	0.134%	0.9%
Slovakia	0.0%	75.0%	12.5%	12.5%	0.0%	8	€ 1,404	0.013%	0.0%
Romania	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
INVESTMENT COMPOSITION – 1st Half, 2001									
Country	Seed	Start-up	Expan-sion	Replace-ment Capital	Buyout	No Compa-nies (all stages)	Total Investments (×1000 Euro)	VC % GDP (annualised – H1×2)	% Europe Market
Europe	7.3%	35.0%	46.9%	3.1%	7.8%	4,465	€ 11,125,502		
Czech Republic	0.0%	0.0%	100.0%	0.0%	0.0%	3	€ 10,240	0.037%	0.1%
Hungary	0.0%	16.7%	66.7%	0.0%	16.7%	6	€ 20,972	0.084%	0.2%
Poland	3.1%	37.5%	50.0%	6.3%	3.1%	32	€ 52,542	0.061%	0.5%
Slovakia	33.3%	33.3%	33.3%	0.0%	0.0%	3	€ 1,824	0.017%	0.0%
Romania	0.0%	0.0%	23.7%	76.3%	0.0%	38	€ 2,042	0.010%	0.0%

Source: EVCA, 2001

Figure 1

VC Investment – Stages of Investment as Percentage of GDP, 1995-99



Source: Baygan & Freudenberg, 2000

early-stage high-tech investment opportunities may be lower than in the EU. But perhaps just as importantly, the lack of *demand* for SMEs by corporate buyers on the exit side of the VC cycle may also be inhibiting early-stage and high-tech finance. As discussed earlier, VCs take into consideration the likely exit route from an investee at the time of the investment. Since at present the exit market for VCs is almost entirely composed of foreign corporations, the needs of international corporate production networks impact on VC selection of enterprises and their management. This may be contributing to the investment by VCs predominantly in companies that can fit into international corporate production and distribution networks in nodes characterised by low value-added activities.

Corporate links with venture capital

As discussed earlier, we can distinguish three general channels of interaction between corporations and VCs: trade sales, corporate venture capital and spin-offs. In CEEs the pattern of development of each of these is substantially different from that in developed economies.

Trade Sales

As discussed earlier, the dependence by VCs on trade sales as an exit route makes corporate strategies relevant in the selection of investments by a VC. In particular, if there is a lack of diversity in the potential corporate exits, this may lead to a strong bias toward a particular type of enterprises. This appears to be the case in CEEs. Table 5 below shows that trade sales in CEEs account for a larger proportion of VC exits than the EU average. Thus the influence of the corporate buyers on the VC's enterprise development strategy is likely to be much higher than in other developed economies. Furthermore, given the predominance of MNEs among the population of buyers, it is mostly the corporate strategies of MNEs that impact on VCs' exit strategies. We argue that the corporate strategies of MNEs operating in CEEs are an important *filtering mechanism* in the investment selection process of VCs, as the viability of an exit option depends now on the attractiveness of the investee for a trade sale to a foreign company.

In line with this, major VCs in CEE state that "[it is a] requirement for local companies to support both greenfield and privatized operations as foreign MNEs heavily invested in a range of sectors" (3TS Mission Statement). Similarly, "[DBG is] attracted to industries that are suitable for a consolidation strategy through acquisitions or

Table 5
Exit Strategies in CEE and EU – 2000 and 2001

Country	Divestment/Exit (by No of companies) – 1st Half, 2000						
	Trade Sale	IPO	Sale of Quoted Equity	Write-off	Other	Total No of Companies	Total Value of Divestment (×1000 €)
Europe	41.3%	8.0%	16.4%	10.6%	23.7%	1,495	€ 3,949,532
Czech Rep.	100.0%	0.0%	0.0%	0.0%	0.0%	1	€ 6,403
Hungary	57.1%	0.0%	28.6%	0.0%	14.3%	7	€ 34,481
Poland	84.6%	0.0%	0.0%	0.0%	15.4%	13	€ 27,553
Slovakia	0.0%	0.0%	0.0%	100.0%	0.0%	1	€ 81
Romania	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Country	**Divestment/Exit (by No of companies) – 1st Half, 2001**						
	Trade Sale	IPO	Sale of Quoted Equity	Write-off	Other	Total No of Companies	Total Value of Divestment (×1000 €)
Europe	26.5%	1.2%	11.4%	13.6%	47.4%	3,019	€ 5,329,789
Czech Rep.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hungary	0.0%	0.0%	0.0%	0.0%	0.0%	1	€ 2,784
Poland	40.0%	0.0%	8.0%	8.0%	44.0%	26	€ 52,326
Slovakia	n/a	n/a	n/a	n/a	n/a	1	€ 21
Romania	98.5%	1.5%	0.0%	0.0%	0.0%	67	€ 2,068

Source: EVCA, 2001

expandable through regional expansion" (DBG Mission Statement). Case studies for Hungary similarly suggest that the requirements of MNEs restrict VC investment strategies (Szerb and Varga, 2002), and the absence of media reports of trade sales to domestic corporations supports the view that the involvement of CEE domestic corporations in the VC industry is limited.

Thus the firms most likely to gain VC finance are those that can become large enough to provide a national/regional "platform solution" to foreign corporations seeking entry into the CEE. This type of focus makes a number of categories of investments unattractive for VCs. Insufficient *demand* for SMEs by corporate buyers may be hindering early-stage and high-tech finance. Investment in potentially viable innovative SMEs will not take place, because irrespective of their *financial* viability, the lack of an exit channel will prevent VCs from investing in such a firm. In turn, the lack of domestic innovative SMEs makes the development of competitive domestic production networks more difficult for reasons outlined earlier.

The above strongly suggests that the absence of domestic corporations from trade exits is detrimental to the development of national or regional systems of innovation. As MNEs in CEEs tend to invest in the context of a strategic expansion of their networks, they will be unlikely to invest in companies that duplicate innovative activities performed elsewhere in their network: if there is a corporate unit in one country that is already doing a certain task, it is unlikely that the corporation will invest at another location for the same activity. But what is duplication on a corporate level may be necessary for the development of innovative and absorptive capacity of domestic production networks. The development of competitiveness of domestic corporations in technologically intensive areas is linked to the development of linkages with other enterprises that can provide it access to a variety of capabilities and resources. An increased participation by the domestic corporations in the VC industry would create alternative exit routes for VCs and thus diversify VC demand for investment opportunities that can be fitted in domestic production networks. It would also embed VCs in local production networks, and increase the flexibility and variety of capabilities in domestic production networks.

Corporate Venture Capital

In terms of CVC, in the CEE context it is useful to differentiate between foreign and domestic sources of CVC. Instances of foreign CVC are some investments by the CVC arms of global corporations such as Intel, Microsoft, GE and Deutsche Telekom[25]. Given the known patterns of foreign CVC for the UK and US (McNally, 1997; Teece, 1992), it is most likely that foreign CVC in CEEs concentrates in late stage enterprises with high technological competencies, which fit well within corporate R&D strategies[26]. While there is anecdotal evidence of such investments in some high-tech firms, this has remained limited and linkages with the local VC sector do not appear to have developed. The lack of studies in this area prevents any judgement, but there are hardly any examples or indications that CVC by domestic corporations is significant in CEEs. This seems consistent with the apparent absence of the domestic corporate sector from the VC industry as a whole, which is itself linked to the underdeveloped nature of local production networks and domestic corporate strategies.

Corporate Spin-offs

As discussed earlier, corporate spin-offs are the result of the shedding of non-core activities at points of major corporate strategic refocusing, or the spinning-off of non-core results of continuous innovative activities at corporate R&D facilities. In the CEEs this category of participants in the VC industry is perhaps the most underdeveloped. The radical decline in innovative activity in domestic corporations as well as the lack of widespread modern corporate practices probably contributes to an absence of corporate spin-offs as a deal source for VCs. We base this statement on the lack of reporting by VCs, media and experts of corporate spin-offs as a source of a deal flow. However, it is possible that the continued development of domestic corporations in CEEs and increased awareness of novel innovation management techniques will lead to the emergences of corporate spin-offs in the future. Perhaps in this regard a more pro-active approach by VCs aimed at increasing domestic corporate awareness of the possibility of capturing value through spin-offs could accelerate the emergence of such corporate practice.

Venture capital and science-industry relations

R&D expenditures in CEEs have undergone radical reductions during the transition period (cf. EU, 2002). The prevalence of defensive restructuring of enterprises negatively affected the in-house R&D facilities of enterprises (which were often reduced, outsourced or even terminated), and more generally, diminished their innovative capacities. Along the way, the capacities of companies to transfer, absorption, application or modification of new technologies and cooperation with research institutions also suffered. On the other hand, public research institutions have been affected by the budgetary constraints. The need for additional funding has not been channelled into more sophisticated science-industry relationships, which seems paradoxical. Namely, the budgetary cuts in HEIs may have *increased* the need for academic entrepreneurship as a way of providing additional or alternative sources for income both for individual academics and organisations to which they belong. These problems have been exacerbated by the lack of appropriate incentives, cultural differences, as well as the lack of mediating institutions and networks between science and industry (cf. EC, 2001; De Koning and Deeds, 2003). Given such conditions, it is not surprising that the relevance of the science-industry relationships to the performance of the economy in CEEs is both under-researched and insufficiently understood at the policy-maker level. Such issues have recently been touched upon in discussions on innovation policy in the context of EU accession (EC, 2001; EC 2003). However, the processes of utilization of channels available for technology transfer, overcoming of the barriers actors face, and implementation of policies to improve this aspect of systems of innovation are still largely ineffective. The interaction processes among science and industry which are aimed commercialization of research, dissemination of new technologies and building technology capacity of firms could be strongly assisted by VC, as a mediating institution that provides both the financial resources and managerial services, and is positioned within broader production networks.

Given the intense linkages between VCs and HEIs in developed economies, the lack of such linkages in transition economies is a source of concern. One reasonable hypothesis to explain this is that the mobility of academics between HEIs and the private sector is inhibited by the absence of incentives and a supporting culture. The severing of the linkages between transition countries' HEIs and the newly privatised enterprises has inhibited the commercialisation of university research, as well as removing the channels through which industry could subcontract R&D research. Some of the constraints identified in a developed economy context (e.g. Casper and Murray, 2002) seem to be even more relevant in the CEE context: (i) potentially good business ideas arising from university research are not formulated and do not leave the academic system; (ii) there is a limited supply of entrepreneurs within the universities; (iii) there is insufficient access to capital for the funding of start-ups; (iv) scientists with ideas cannot find adequately educated entrepreneurs; (v) high information asymmetries between investors and scientists mean not only lack of understanding, but lack of awareness of existence of good business ideas.

Regarding the need for an increased interaction between VCs and HEIs in CEEs, a possible objection would be that CEE knowledge institutions are unlikely to generate similar levels of world-first innovations as their counterparts that have been instrumental in the development of high-tech clusters (e.g. Stanford University, Massachusetts Institute of Technology, Cambridge University). However, the benefits of HEI spinouts do not lie only in generating "world-first" innovations, but in the inward transfer of innovative technologies available internationally, their adaptation to local market needs, the provision of consulting services, and other innovative activities besides radical innovation. The issue underlying technology transfer between knowledge institutions and industry refers to the leading role that knowledge institutions can play in their *domestic* environment. In this sense HEIs will generally be the institutions whose tacit knowledge can catalyze the technology transfer of world-first technology to domestic industry. The countries that lag behind in terms of technological development should invest relatively more in embodied technologies (including their adaptation to local conditions), as well as on activities like reverse engineering and product and process imitation than on R&D (cf. Radošević, 2003). The role of NTBFs in facilitating such transfer outside the context of developed economies is gaining increasing attention. In such contexts the NTBF's role as a challenger and source of new technologies is even more pronounced (Fontes & Coombs, 2001).

In addition to upgrading the competitiveness of domestic corporations, the science-industry collaboration has as a potential by-product the creation of innovative SMEs, which is beneficial not only to the economy as a whole, but also to potential link-ups with the VC sector. The improvement of linkages between science and industry, through VCs among other type of intermediaries, can improve the flexibility of production networks (i) directly, by increasing the variety of actors in the production network, through the creation of NTBFs; and (ii) indirectly, by shortening the organisational route of the identification and absorption of world-level technological developments.

Barriers to deal flow[27]

The lifeline of any VC firm is the deal flow, the investment proposals that are made to VCs. The deal flow can indicate the economic prospects of a region (Peeters, 1999:121), while it allows VCs to optimize their portfolio composition. In the context of CEEs an increase and diversification of the deal flow will aid the maturing of the VC industry, with the emergence of differentiation among VC providers.

The constraints on deal flow that have been identified in CEEs can be divided into several groups (developed from Iliev, 2002a). Some are related to the rare emergence of SMEs with innovative products and/or significant growth potential that could be nurtured by VC involvement. This is due to:

- **exhaustion of the privatization pool** – the completion of privatization in most CEEs has terminated the initial deal source that attracted many VCs to the region;

- **lack of linkages with HEIs** – as discussed, technology transfer policies remain in their infancy, and academic entrepreneurship appears to be particularly underdeveloped. In the absence of adequate incentive structures and organisational support, HEI spin-offs are unlikely to develop in significant numbers.
- **limited number and quality of corporate spin-offs** – as discussed, investment opportunities arising from corporate spin-offs are limited in number. Available spin-offs mostly stem from non-strategic corporate activities (rather than R&D). They are often found in traditional industries and require defensive restructuring before expansion can be attempted.

Another group of constraints occurs due to the lack of available financial and managerial resources necessary for SME creation and growth and stimulating VCs' interest and involvement. These include:

- **lack of business angels** – business angels are (serial) entrepreneurs that contribute small sums of finance and managerial skills to a start-up. Some EU estimates of business angel investments put it at higher levels than formal VC[28]. Access to business angel finance allows start-ups to grow to levels at which VCs can become involved. Their absence in CEEs[29] limits not only the funding available to start-ups, but also the managerial resources and referral opportunities available to them.
- **lack of established referral networks** – the traditional referral sources (such as accountants, investment bankers, lawyers, past customers and other VCs) are types of actors who are also new entrants to the CEE context, hence their ability to act as a referral source is limited;
- **lack of managerial track record** – the short period from privatisation / enterprise development means that enterprise managers have a limited track record, which complicates management team evaluation for the VCs (Bliss, 1999);
- **VC managers' background** – lack of domestic senior managers for VCs may be contributing to the lack of connections between VCs and domestic formal and informal networks, while standardised strategy of multi-country VC firms may be contributing to the setting of minimum investment levels beyond the size of a big part of the investment opportunities and sub-optimal development strategies;

- **low wealth levels** – low entrepreneur wealth-levels lead to lack of seed capital and collateral for larger start-ups, as well as sub-optimal personal savings portfolios;
- **lack of equity financing culture** – a major constraint identified by VC managers is the unwillingness of entrepreneurs to part with equity, and unreasonable expectations from VCs.

CONCLUSION

We have attempted to direct attention to a previously under-researched aspect of CEE economies – the role of venture capital and VC-backed companies in corporate production networks. This was done by firstly identifying relevant aspects of developed economy production networks, followed by a comparative analysis of CEE production networks. In particular, we emphasized the importance of innovation within corporate production networks, and the role played in this by innovative SMEs. Innovative SMEs need to be involved in production networks to access complementary capabilities held by other actors, such as marketing channels, mass production facilities and distribution networks. Firms with larger resources and stronger competences actively seek access to novel technologies either to protect current market positions, to gain access to new markets, or to diversify the technology risk. In this context, VCs are an important production network actor by identifying viable enterprises, and assisting the entry of these in production networks; assisting corporate strategic refocusing on core capabilities by absorbing corporate spin-offs of non-core capabilities, assisting corporate exposure to new technologies, and actively seeking SMEs that will be absorbable by production networks. Furthermore VCs have an important role in facilitating technology transfer in science-industry relations, where they support the growth of academic spin-offs, provide strategic management functions, and facilitate the integration of these into corporate production networks.

In the context of CEEs, research indicates that domestic production networks are largely underdeveloped, and MNEs are the dominant network organisers. Consequently, while the entry of MNE corporations into the CEEs has led to some integration of local suppliers into global production networks, the networks being built are often restricted to MNE companies' subsidiaries with limited local subcontracting. At the same time, domestic production networks are underdeveloped, with little participation of SMEs, and in general low levels of innovation. We argued that this situation both results from the traditional absence of SMEs from domestic production networks, and diminishes the likelihood of the emergence of a population of innovative SMEs. The absence of linkages between innovative SMEs and domestic corporations impacts negatively on the competitiveness of domestic production networks, and their ability to respond to external shocks and new opportunities. We also argued that it is unlikely that SMEs within MNE production networks will develop substantial levels of innovation.

We also argued that the underdevelopment of science-industry technology transfer policies contributes to an absence of a population of NTBFs. This can be linked to the lack of clear policy guidelines, incentive structures and a facilitating environment for the development of academic entrepreneurs, as well as to the lack of demand for innovative SMEs by domestic industry, and low linkages in general between domestic corporations and HEIs. Low levels of science-industry technology transfer in general, and of NTBFs in particular, restrict further the levels of innovation and linkages with innovative SMEs in domestic production networks. This again contributes to low levels of competitiveness and flexibility in domestic production networks.

In the context of the VC industry, underdeveloped linkages with innovative SMEs and HEIs of domestic corporations are manifested by the dominance of MNEs as trade buyers and sources of corporate venture capital, an absence of corporate spin-offs as a source of VC deal flow, and a lack of linkages between VCs and HEIs. The net result is that VC selection of investments is biased towards SMEs that will fit in MNE production networks, at the expense of companies that may bring new technologies to the domestic industry, while the potentially important role of VCs in stimulating science-industry technology transfer is not realised. The converse is that increased VC participation in domestic production networks and linkages with HEIs can increase the level of investment in innovative SMEs, levels of technology transfer from HEIs, and consequently increase the competitiveness of domestic production networks.

The identification of these two general areas of barriers to the development of the VC industry – the absence of domestic corporations from the VC industry, and underdevelopment of HEI technology transfer policies – allows us to begin the indication of policy options aimed at increasing the number of innovative SMEs, and improving their access to VC finance.

In terms of the need to stimulate the participation of domestic corporations in the VC industry, a first step would be to increase awareness by domestic corporate managers of novel innovation methods, and the role of VCs in these. Demonstrative and awareness programs through local chambers of industry and business schools are one low-cost way achieving this. More substantively, given the existence of a number of policy programs aimed at stimulating linkages between corporations and SMEs, such programs can be used to leverage sub-programs focused on stimulating VC-domestic corporate relations.

The area of science-industry technology transfer is perhaps richer in policy alternatives, given the high public involvement in HEI policy. Overall, we have identified a need to streamline the technology transfer process, and an awareness of the full scope of technology transfer channels available to an HEI. Of crucial importance is the establishment of incentive structures that will promote the emergence of academic entrepreneurs, supportive organisations for NTBFs, as well as an increased awareness of this area among academics and industry participants. Simple measures such as organising business plan competitions, and stimulating interaction between business schools, science and engineering departments, and local VCs can prove surprisingly effective in both increasing awareness of the possibilities for HEI spin-offs and directly resulting in viable enterprises. More resource intensive measures are the establishment and increased efficiency of business incubators, science parks, and technology centres, which again could benefit from a proactive approach aimed at attracting the attention of VCs. Beyond this, VC funds backed by public funds (by national governments, or institutions such as the EBRD) could include in their mandate incentives for VCs to finance HEI spin-offs.

We emphasise, however, that the above is aimed merely to serve as suggestive of some policy directions, and are not to be seen as restrictive and exclusive of other measures. The formulation of detailed policy options depends on individual country conditions, a precondition for which is the conduct of further detailed research in the areas outlined earlier. We hope that this contribution can facilitate the formulation and conduct of such research, and consequently the development of effective policy measures, in the ultimate aim of stimulating the knowledge-based economy in CEEs.

FOOTNOTES

[1] In this case the local network would overlap with a multinational's network to the extent that the network members' activity is directed to the multinational.

[2] According to Ackroyd (2002:190), "as the hubs of international networks, major companies form spheres of influence and power over numbers of affiliated and collaborating business units. Such organizations may be delayered internally, but they are not depowered either internally or externally".

[3] Science-intensive products are one example of such localized competencies, since the knowledge behind such products is not easily codifiable and requires highly specific capabilities, and is therefore not easily imitable.

[4] The recent changes in the EU venture capital industry can be attributed both to a maturing of the industry, and an increased public support for entrepreneurship and science-industry technology transfer. However, it is important to note that there are significant differences between different EU states in the structure of the VC industry, as well as between regions.

[5] Following the credit-rationing literature (e.g. Stiglitz and Weiss, 1981), lending is constrained by adverse selection (information asymmetry to the rationing of low risk lenders) and moral hazard effects (information asymmetry *after* lending leads to risky lender behavior) constrain the amount of credit available to borrowers. This effect is especially pronounced for firms characterized by knowledge-intensive production, due to low levels collateral and high levels of information asymmetry.

[6] In the case of CEEs this problem is compounded by the *absence* of mature equity markets.

[7] Paradoxically the UK, with the most developed equity market in Europe, trade sales accounted for 55% of exits in 2000, while equity market exits only accounted for 27%.

[8] Initial Public Offerings (IPOs) is the first-time sale of a company's shares on a public stock market.

[9] Trade sales occur when corporations purchase investees from a VC.

[10] For instance the traditionally bank-centered financial systems in continental Europe. See Karaomerlioglu and Jacobsson (2000) for a discussion in the context of the Swedish economy.

[11] See Casper and Kettler (2001) for a discussion of the role of VCs and pharmaceuticals in biotech startup development.

[12] Often the management of a spinout will continue to be employed or associated with the parent company. In this sense the degree of separation between the parent company and the spinout varies from case to case.

[13] The deal-flow is the stream of viable business proposals received by a VC. A high and diverse deal-flow allows a VC to construct a viable investment portfolio that maximizes the use of a VC's competencies.

[14] For instance academic advancement requires the publication of research results, while the strategic requirements of the firm may require secrecy for these results.

[15] Of course we are only creating typologies here for ease of analysis. In reality, VCs are members of multiple networks, including HEI *and* corporate strategic networks, and to the extent that this is the case, this increases the value added they can provide an investee.

16 An example of informal incubating facilities is the laboratory of an academic that is used to assist the development of a NTBF product.

17 Here the reputation of a particular VC becomes of crucial importance.

18 The greater propensity of MNEs than domestic corporations to build up links with local players is somewhat counterintuitive, since outside players are likely to face greater costs in establishing such networks than domestic enterprises.

19 Still some MNE investments are characterized by significant and growing levels of innovative activity conducted locally. Even those foreign-owned enterprises that conduct R&D and/or interact with HEIs do not have interaction with any other domestic actors, thus limiting the potential for technology transfer to the domestic economy resulting from MNE entry (Biegelbauer et al., 2001).

20 The EU study on this issue concludes that "domestic technological activity is relatively more developed in the CC5 [Czech Republic, Estonia, Hungary, Poland, Slovenia] than in Greece, Portugal and Spain" (EU, 2001:73).

21 The European Innovation Scorecard surveys (EC, 2002) have included an "SME innovation cooperation category", but most of the candidates have not returned data on these. Better response rates to future surveys should allow an insight into these issues.

22 The studies concerned are (for the respective country) Czech Republic (Mueller, 2001), Estonia (EIFS, 2001), Hungary (Havas, 2001), Poland (Kozlowski, 2001), Slovenia (Bučar, 2001), and were commissioned by the European Community's Directorate General Enterprise.

23 More recent evidence from Poland (Niedbalska, 2002) shows that proportion of innovative enterprises as a whole has fallen from 37.6% for 1994-96 to 16.9% for 1998-2000, and it appears that the number of innovative SMEs within this aggregate has also fallen. This is attributed by the author to the negative economic climate in Poland in the late 1990s.

24 This emphasis is in line with the commitment by the EU to close the "knowledge gap" with the US (the 2001 Lisbon Declaration), while the 1998 RCAP (Risk Capital Action Plan) focuses specifically on the stimulation of the venture capital industry.

25 Based on information provided on the company websites and news media.

26 See for instance the mission statement on Intel Capital's website (www.intel.com/capital).

27 We engage with this issue at the end of our discussion, to indicate some other factors inhibiting VC deal flow that go beyond the issues discussed earlier.

28 The website of the European Business Angel Network (www.eban.org) gives a good introduction to the issues linked to informal venture capital/business angels. Even though it is an issue of high relevance for the prospects of VC in CEEs, it is not an issue that can be discussed at length here.

29 Privatization and restructuring of CEE economies has created a new class of entrepreneurs, some of whom amassed considerable wealth. However, the experience gathered in such processes is not readily transferable to the SME development outlined here, which partly explains their reluctance to act as business angels or providers of VC.

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Prof Marina DABIĆ

Assistant Professor of Management
Organizational and Informational Department
Faculty of Mechanical Engineering, University of Osijek
Trg Ivane Brlić Mažuranić 18, 35000 Slavonski Brod, Croatia
Phone: +385 35 446-718, Fax: +385 35 446-446
E-mail: marina.dabic@sfsb.hr

TECHNOLOGICAL MANAGEMENT: EXPANDING THE PERSPECTIVE FOR CROATIA

MANAGEMENT LITERATURE RESOURCES

A growing body of literature has focused on the understanding of culture management, so as to unlock the hidden values of knowledge resources available in an organization and its intellectual capital formation (Harvey and Denton, 1999). The causal connections between individuals, organizations and national systems are explored in those theories with the emphasis on public policy, governance, accountability, environment and social and technological change processes. "Organisational culture" becomes both a lever of change and a mechanism for achieving performance improvements, although the validity of these assumptions often takes the form of a self-fulfilling belief, rather than an empirical proof (Legge, 1987; Wilson, 1992). Nevertheless, it is broadly assumed that organisations with a unifying "mission" and a positive set of "core values" emphasising flexibility and innovation will be more responsive to changes in their competitive environment (Tyson, 1995, p. 123; Ulrich, 1997, p. 183).

Various authors have queried the tendency to borrow management practices indiscriminately from the West, proposing instead the development of more appropriate approaches (e.g., Blunt and Jones, 1992, 1997; Jaeger and Kanungo, 1990; Kamoche, 2000; Kiggundu, 1989). By focusing on the concept of knowledge we aim to undertake a critique of the on-going debate on this discipline as well as to point to new research directions in the hitherto much neglected Eastern European context. We aim to contribute to a better understanding of the dynamics of international management by examining this terrain through the conceptual lens of technology diffusion with particular reference to the knowledge that resides in people.

R&D MANAGEMENT

Major recent contributions in regard to the management of R&D are the concepts of: "third generation R&D" brought together by the consultancy firm Arthur D Little

(Roussel et al., 1991), portfolio management theory of R&D projects (Roussel et al., 1991 and Cooper 1997) and the methodology of technology foresight. These provide difficult but convincing tools for managing an activity that has caused much anguish in the past, and they enable constructive dialogue to take place between R&D and the rest of the firm.

The recent trend moving from R&D management to management of technology could be connected to the change in the understanding of the source of technology and therefore of technological opportunities. In the 1960s and 1970s, in-house R&D was considered the main source of technological innovation (Rousset et al., 1991). In the mid-1980s, following hundreds of papers and books related to the economics of innovation and technological change, many sources were identified for innovation: alliance modes (R&D joint ventures, consortia, license swaps, etc.), subcontracted R&D, acquisitions, etc. In the management literature, the concept of technology portfolio emerged (Pappas, 1984).

Also, there has been a change in the status from operational to a more strategic positioning. In the past, top management delegated technical choices within the R&D department (Pavitt, 1984). The only involvement of top management was to set a target of R&D effort as a percentage of the turnover. It was the responsibility of R&D managers to optimize this resource allocation. The management of technology gained strategic content which justified growing involvement of top management in technical decisions.

Rogers (1983) suggests that key influences on the adoption of an innovation are its perceived attributes, its relative advantage over alternatives and its compatibility with current systems. Thorelli (1986) emphasizes the importance of peer networks in the diffusion of innovation, while Teece (1986) underlines respectively the critical importance of complementary assets and management learning in making effective the potential gains of an innovation.

MANAGEMENT OF TECHNOLOGY

"MOT is about knowing how to express technology, how to bringideas to work in the world, and how to think about the way technology is designed and how it functions".

David J. McGrath

The management of technology (MOT) has been under the strong influence of the engineering-based disciplines.

The field's structure was inherited from research and development (R&D) management and the mainstream in the literature initially dealt with topics such as project evaluation and selection, R&D organization, technology forecasting, etc. A strong emphasis was put on the management of technological assets. Economists helped to analyze public policy issues and to explore differences in management of technology according to industry, size or country. Management of technology would benefit from a stronger influence of such as accounting and control, finance, marketing, human research management (HRM), organizational behaviour – through a restructuring of the field.

Figure 1. suggests that over the time, the scope and the field has expanded to increasing range of managerial issues and include more and more topics.

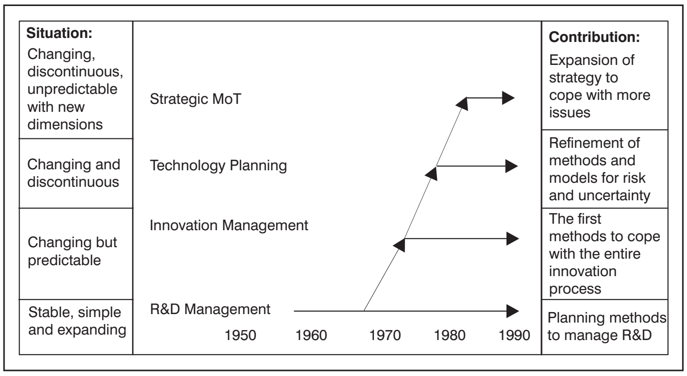


Figure 1
Conceptual framework for the evolution of MoT

Figure 2
Summary of the four schools of MOT

	School 1: R&D management	School 2: Innovation management	School 3: Technology planning	School 4: Strategic MoT
Perceived situation in business environment	Stable, simple and expanding	Changing but predictable	Changing and discontinuous	Changing, discontinuous, unpredictable with new dimensions
Scope	Manage R&D resources	Manage innovation in the entire company	Manage technology across the company	Manage and integrate technology with other aspects
Issues	People, ideas, funds and culture	Conception, invention and exploitation of technology	Analyse and plan the complex process of technological development	Deal with all the dimensions of technological evolution
Elements	Technology forecasting budgeting	Delphi forecasting, technology forecasting, project management and the innovation process	Scenario forecasting, technology analysis and planning	Strategic MoT, organisation technology, approach to MoT and integrated MoT

What is important to note is the interaction among individuals as an important element in the mechanism of MOT. The first question that should be addressed is why firms look for MOT. Recall that our assumption is the inducement to introduce a MOT is related to the inadequancy of the old technology to solve technological problems – from the economic and technical point of view – faced by the firm.

THOUGHT ON TECHNOLOGICAL MANAGEMENT

Badawy (1998) defines technological management as the practice of integrating technology strategies with business strategies in a firm. This definition is focusing on the strategy field, especially the resource-based view and positioning, with business operations and dynamics. A broader definition of technological management is used in the Master of Technology Management program at the University of California, Berkeley, and defines technology management as a set of activities associated with bringing high-technology products to the marketplace. Technological management can be described as the ways in which markets change due to the influence of technology, how innovative ideas are developed and introduced to the market, and how managers can increase the innovation performance of their organizations.

Dankbaar is using "technology management and management of technological change as synonymous expressions". According to Chanaron and Jolly (1999), R&D management, the management of technology and technological management differ through their "stakes, stakeholders and scope" – they suggest the name the 3S model. Stakes assumes that any management function should take technology as an input shaping both its strategic vision and its operational procedures and methods. Those terms also differ in terms of the type of firm, the people involved in daily practice or involved in decision making. Finally they differ through managerial issues.

According to Antonelli (1999, p. 245), the technological knowledge used by firms draws upon four different forms of knowledge. There we can have four components of technological knowledge: internal and external tacit knowledge and internal and external codified knowledge. An important contribution to the subject comes from knowledge management. In the "new economic growth theory" various scholars (Aghion and Howitt, 1998) shifted their focus from traditional, tangible capital assets in the neo-classical model to intangible knowledge assets accumulated through science and technology investments. Technological knowledge was thought to be a source of strategic competitive advantage to a firm (Drejer, 1997; Hamilton, 1997). These studies focused on firms' operations, including cost efficiency; technological diversity and trajectories (Dosi, 1982; Dussauge et al., 1994); operational efficiency, product and process management (Davenport, 1993; Kfir, 2000); technology marketing, competitive strategies (Prahalad and Hamel, 1990); technology diffusion and transfer (Rogers, 1983; Dabić and Banerjee, 2003; Harvey et al., 2002); and strategic alliances (Dussauge et al., 1994).

The continuing move towards technological management is connected with understanding that technology has impact on all management functions.

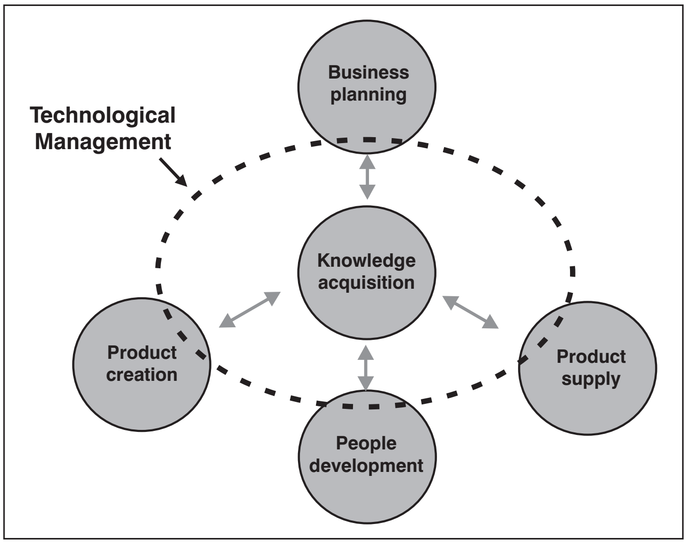


Figure 3
Technological Management and the five key business processes

CROATIAN' BUSINESS ENVIRONMENT

There is a general consensus that macro-environment variables have a major impact on the development of knowledge management policies and practices (Mills, 1998; Sissons, 1999). The collapse of communism in 1989 gave rise to a period of dramatic political and economic change, which has been an uncertain time for the countries in transition. The process of change from command to market economy in the transition states has been compelling – certainly, for its participants, but not less so for the western agents who have tried to provide expertise and assistance; clearly, for management practitioners in general, but particularly for specialists in technology and knowledge management.

This paper focuses on Croatia, as a former socialist republic, because it offers some of the greatest opportunities of all transitional economies. Further, continued legislative efforts to open Croatia to foreign investment are increasing its attractiveness to foreign businesses resulting in a stream of significant investments since its post-war independence, reaching over 1 billion U.S. dollars in 2000 alone (Ministry of Economy, 2000; UN, 1999). The investment in Croatia has been driven in part by the country's industrial growth that has been 6% for the past 3 years (the industrial sector employs 25% of the workforce and accounts for 95% of exports) (Ministry of Economy, 2000).

Since declaring independence on June 25, 1991, Croatia has struggled through years of war and United Nation protection in its movement from a planned economy to a market economy. From an economic standpoint, Croatia has officially embarked upon economic reforms aimed toward the development of a market economy.

After years of research in a variety of industries and on several continents, some modern managerial principles are emerging. It doesn't matter where firms begin (e.g., quality, reengineering, benchmarking, systems thinking, learning networks, restructuring, etc.) But there needs to be one compelling force which binds the entire organization together – one that creates a common language and shared purpose. More often than not, however, change management strategies have been met with covert tactics which undermine long-term progress. Moreover, people are not inclined to share their ideas and expertise with others if they feel that their own jobs are in jeopardy. While the formal constraints governing the market have been relaxed, Croatia's economic transition is far from complete. While market transaction mechanisms, free competition, limited governmental intervention and open access to information are characteristic of developed Western markets, barriers to these key economic aspects remain in Croatia.

Pressure for change has come from the deep worldwide recession of the early nineties causing firms to look closely at all classes of expenditure, and also from rather belated recognition of technology and innovation as competitive elements. It has been recognised that although competition does indeed take place on the classic grounds of efficiency, price, promotion and marketing, ownership of a technology can also give a profound advantage. The task of R&D is to continuously renew firm profitability through technical advances.

NATURE OF THE TECHNOLOGY-DIFFUSION PROCESS TO AND FROM THE CROATIA

Croatia has not featured much in the mainstream management debate, and not surprisingly, this has been repeated in the debate on technology with regard to the Central and Eastern European (CEE) context. In this section we define the constitutive constructs of our conception of technology and proceed in the following section to set out the nature of the technology (knowledge)-diffusion process to the CEE context. Rather than use the word "transfer" that in common parlance refers to a uni-directional approach, we view the process as one of bi-directional diffusion. In developing a model of technology-creation and diffusion we recognize that the coherence and eventual success of such a model will depend on a number of factors, which we discuss in the sections that follow.

The main problem for mostly firms in transition countries, as well as for firms in Croatia, comes from answers how to know what they actually know and to exploit this knowledge in a systematic way (Hibbard, 1997). Many experts on the transition processes of CEE economies to free-markets feel that technology transfers from outside these economies will play a major role in speeding up the transformation process (Salvatore, 1993; Cheney and Kozlowski, 1994; Peng and Heath, 1996; Witt 1998). Orlowski, (1998) argue that foreign ownership has a positive effect on innovation because of the resources that foreign parties are able to draw upon and contribute to the domestic firm. These resources consist of finance, technology, knowledge and managerial expertise. For the most transition countries technological integration is a priority job in the "catching up process" (Radošević, Dyker, 1996). As they point out, technological integration is a process whereby the given economies are assimilated into dynamic learning patterns of international firms. Technological integration therefore means that the host economies and their constituent firms are not just passive recipients, but rather active adapters and sources of technological knowledge.

In reality, the diffusion of technology is governed by a variety of systems ranging from highly sophisticated ones in some CEE countries with well-established mechanisms for attracting and managing foreign direct investment to the more chaotic (and often non-existent) ones in more centrally controlled countries. This section considers the directionality of the diffusion and learning process, and the circumstances under which the diffusion of knowledge between CEE and foreign organizations can be made more mutually beneficial. Beamish (1994) notes that there has been little research into the performance problems of joint ventures in developing countries, and how they can be improved. We find this neglect applies as well to other forms such as part or wholly-owned subsidiaries, in particular within the Eastern European context. This view is a legacy from the earlier days when the emphasis was on technology transfer and the resource-dependency perspective that cast transition country subsidiaries as dependent on the parent for nurturance (Kamoche, 1997). As we have argued above, however, CEE presents serious risks for investors who ignore its complex legal, cultural and social context.

This leads us to the following proposition:

Proposition: The neglect of the CEE context in the knowledge diffusion debate in part reflects a mistaken belief that you can copy Westerners model and apply it effectively in transition countries.

This is often broadly described as local knowledge and is an important ingredient in successful business relations. Similarly it is useful to consider mutual long-term need while assessing the success of knowledge-diffusion activities just as it is important in assessing the viability of strategic alliances (e.g., Lane and Beamish, 1990). While this mutual need is mainly viewed in terms of what the joint partners hope to gain from each other, we argue for the need to recognize what they can also contribute to the partnership. In a similar vein, Grant (1996:111) argues that knowledge transfer involves both transmission and receipt. This shifts the discussion away from "appropriative learning" (see also Loveridge and Mok, 1979) whereby one party extracts benefits while offering little in return, to what we might call "symbiotic bi-directional learning". For this to be sustainable there should be a firm commitment by both parties to contribute to the learning process.

Research has identified various obstacles to the knowledge diffusion process. For example, citing the case of Italian firms, Kogut and Zander (1993) contend that outward direct investment is hampered by the difficulty of transferring social knowledge – knowledge grounded in close ties within networks. While it appears plausible to argue that it will be more difficulty to transfer social knowledge (which includes tacit knowledge) than more codified forms, their findings showed that the more tacit and the more complex the technologies, the more likely the transfer to wholly-owned subsidiaries. As the technologies become more codified and more easily taught, the more likely the transfer is to third parties.

This leads us to the following proposition:

Proposition: The heightened levels of interaction in wholly or partly owned subsidiaries provide opportunities for the transfer of tacit knowledge.

It cannot be taken for granted that the diffusion process will necessarily result in the partner firms absorbing the new knowledge and successfully applying it to commercial activities. Obstacles include resistance to change by managers: Croatian managers may resist the perceived imposition of ideas – the Not-Invented-Here (NIH) syndrome (Katz and Allen, 1982). The Western partner in turn may be reluctant to share because of concerns about inadequate intellectual capital protection, the risk of knowledge spillage or the belief there is little to learn from the Croatian or CEE partner. Appleyard (1996) argues that firms are more inclined to justify inter-firm disclosure if they expect the partner firm to reciprocate with useful knowledge or some other form of compensation such as a licensing fee. Barriers can also result from ignoring the various dimensions of the institutional context. The "stickiness" (von Hippel, 1994) of the knowledge can also present barriers to diffusion, particularly where the tacit form is highly firm or context-specific, and where there is an arduous relationship between the source and the recipient (Szulanski, 1996). Lane and Beamish (1990) note that managers in East Eastern Europe complained they were denied promotion opportunities in MNCs, and opted for parastatals, local firms and starting their own businesses.

HARNESSING TECHNOLOGY TO ENHANCE THE (FUTURE) COMPETITIVENESS OF THE FIRM

Developing a keen understanding of individual transition European countries and firms would be difficult in and of itself, but to develop an operating system for the entire set of transition countries would be an inordinately difficult process to undertake. But, without such an institutional perspective each transfer of technology with knowledge would be relegated to an *ad hoc* one-of-a-kind decision process. Developing a frame-of-reference to transfer knowledge is imperative in such institutionally complex cultures.

Thus, an MNC unfamiliar with the challenges of investing in CEE is likely to encounter significant obstacles in recognizing learning opportunities and acknowledging the value of new knowledge. This might explain the tendency to fall back on familiar routines resulting in the adoption of inappropriate practices. Similarly, the CEE partner with little experience of strategic alliances with foreign investors (or for that matter local managers with little or no prior contact with foreign investors) may fail to benefit from what appear to them like esoteric knowledge. There is further evidence for this contention is Dyer and Singh's (1998) finding that even though Toyota had a well-established partnering capability; it encountered serious difficulties working with US suppliers who had not developed such a relational capability.

Cohen and Levinthal's (1990) concept of "absorptive capacity" is useful in helping to elucidate the way firms actually benefit from new technology acquired or generated through their internationalization processes. We suggest that HRM managers in Croatia can and do retain sufficient discretion for strategic choice under the institutional pressures in a country. Thus, the more congruent are HRM strategies and technology diffusion processes with the institutional expectations of firm, the higher the probability of their successful implementation (see also Scott, 2001; Oliver, 1991; Powell, 1990; Goodstein, 1994).

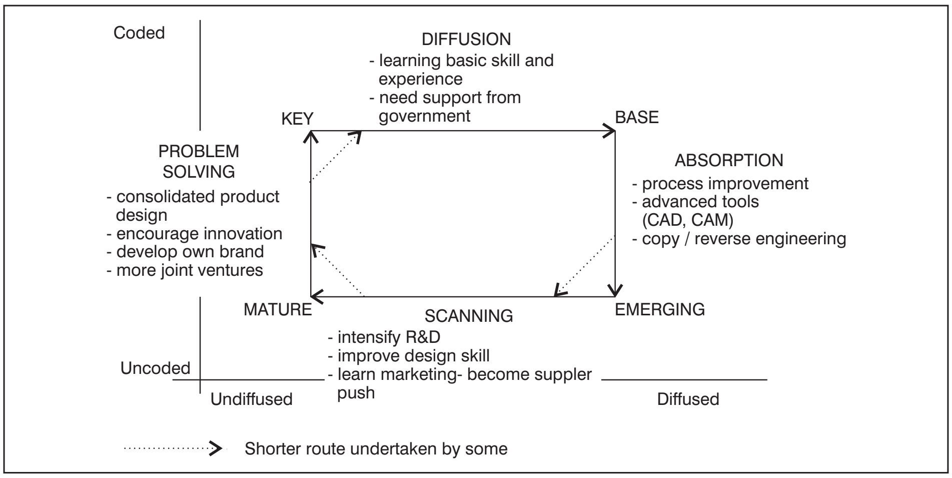
They argue that the development of absorptive capacity is history or path-dependent, which implies that the ability to recognize and utilize new technology is a function of pre-existing levels of knowledge; again "C" space can be useful here. This is consistent with Dierickx and Cool's (1989) notion of "time compression diseconomies", which shows how a firm can derive a competitive advantage from having invested in resources over a period of time. Hence, an MNC unfamiliar with the challenges of investing in Central Eastern Europe is likely to encounter significant obstacles in recognizing learning opportunities and acknowledging the value of new technology.

The second key point in Cohen and Levinthal's analysis is that lack of investment in an area of expertise might prevent the future development of a technical capability in that area. In practice it means that neglecting to invest invites the sort of "decay" that Dierickx and Cool (1989) suggest afflicts all asset stocks if they are inadequately "maintained". Investing in some organizational capability, be it technical, production or human resource management ultimately helps strengthen the firm's absorptive capacity in that particular area of competence. Training is a good example. Over the last decade, in line with the notion that the management of people can be a source of competitive advantage (e.g., Schuler and Jackson, 1999), people are now increasingly thought of as a resource. By investing in individual and team-based skills that expand the organization's knowledge base, the organization in turn enhances it ability to create and absorb new knowledge through the better skilled workforce in a virtuous cycle. In conceptualizing partner firms' absorptive capacities, it is worth bearing in mind Lane and Lubatkin's (1998) contention that their ability to learn from each other is jointly determined by their relative characteristics.

As such, a more appropriate heuristic might be "relative absorptive capacity" (Lane and Lubatkin, 1998). This has important implications for Western-CEE partners with potentially vastly differing knowledge, knowledge-processing systems and dominant logics. While these considerations might appear to present substantial obstacles to knowledge diffusion to-and-from CEE countries, we hope that this discussion and the propositions we have put forward will pave the way for further research into how such diffusion and learning activities can best be accomplished.

Based on a study undertaken at the University of Strathclyde (Greenwood, J. C., 1996) the following is a brief summary in this regard:

Figure 4
Stages of Technology in the C-Space



Source: Banerjee and Abidin, 1997

Evidence suggests (Kim, 1997) that firms improve their technical knowledge further in the next stage of the C-space (absorption) by employing advanced manufacturing tools and technologies. For example, in an effort to start on product development, many firms attempt copying and reverse engineering. This mainly internal-learning process helps to re-design systems.

In the next stage (scanning) firms can further intensify their research and development. They can improve their design skill and begin their own marketing by becoming supplier-push. Within the final stage of problem solving, firms consolidate their product design further, foster innovation, develop their own brand of products by coding technology and engage in joint ventures on an equal footing.

Some transition economies have achieved a shorter route to the north-west corner of the "C-space" (Kim, 1997), but external agency supports have been vital for such quick migration.

Another important fact here is the support from external agencies such as government, academia, R&D institutions and other local and international agencies which has been available to precipitate the migration of these firms along the technology value chain towards the north-west corner of the "C-space". External agency support played a significant role in this process – examples of these may include government encouragement and sponsorship of initiatives such as "Chaebols" in Korea and technology parks and technology clusters found in many (Carrie, 2000) developed and developing economies. The primary aim of many of these initiatives is to accelerate the learning cycle of the human capital of the participating industrial firms.

THE TECHNOLOGY MANAGEMENT CORE CONCEPT

Researchers will have difficulty in searching for an appropriate model of MOT in Transitional economies such as Croatia, as the underlying assumption is that these countries have a substantial background in engineering/ management and business. Shenhar (1991) provides more insight in his "research model" which identifies six subsystems on which research in MOT may be focused. These subsystems (human, project and process, organizational, resource, technology and strategy) provide appropriate categories to model technology management at any level. The role of managers of technology help define the learning outcomes of a model in technology management. Observations such as "managers of technology are greatly concerned about properly utilising the existing technology and future technology advantages" (Andrade, p. 79 in Crocco, 2003) emphasise the need for adaptability in a changing technological environment. Another consistent theme is the need for strong leadership of multifunctional teams which cut across traditional boundaries of an organisation (Cardullo, 1996; Khali, 1993; Hauck, 1999).

CONCLUSION

Taken all together, it can be concluded that technology management is more than just the interdisciplinary intersection of engineering and business. Technology management is a balancing act. To be effective, managers of technology must demonstrate not only solid knowledge in engineering and business but they must also possess basic skills in human interaction, leadership, teamwork and problem solving. Therefore, organisations are beginning to recognise that technology-based competitive advantages are transient and that the only sustainable competitive advantages they have are their employees (Black and Synan, 1997). This development has forced steep learning curves as organisations struggle to adapt quickly, respond faster, and proactively shape their industries (Bhalla, 1987). Critical MOT knowledge and skills required for a modern business include: designing, planning and introducing new product and process; organization of business functions, including inter-departmental relationships, customer services, supply chains, quality services and manufacturing operations; and manufacturing and operations management; knowledge of strategic management of technology; innovation management in relation to technological, business, international and national environments. Therefore, new technology and the transfer of such within the organization to its divisions are of utmost importance in transition country like Croatia. Obviously, the key for a successful "catch up" strategy will be how to manage knowledge and technology across a related set of business activities (Hamel and Prahalad, 1990; Harvey et al., 2002).

Therefore, we would like to emphasize main implications for our paper:

1. While the mission of traditional management disciplines is to deal with an array of specific resources, technological management does not have to allocate resources. It rather aims at capturing and mastering the shaping effects of technological variables on businesses.
2. Technology is not restricted to the field of technical functions. Technological management is targeting a much broader view. It deals with stakeholders who so far have not employed and are even scared of technological variables, such as marketers and finance experts.

3. A firm does not necessarily need an R&D department to have to manage technical issues. Therefore, technological management is not only a high-tech business fashion but it also concerns low-tech businesses where the diffusion of new technologies might have a significant impact.
4. When adopting such an approach to technological management, we are stating that managers as well as practitioners and academia should be educated and trained in such a way that they should be able to identify, analyze, understand and evaluate the co-evolution of technology and management. They should also be able to fully integrate technological change in their decision-making process at both strategic and operational levels. Technological management includes multiculturalism and diversity education and in particular in both engineering and management schools. It calls for an integrative and systemic approach in graduate and post-graduate education with enough technology-oriented disciplines in business schools and enough managerial education in engineering schools. It might require the co-development of programs by engineering schools and business schools.
5. The transfer process involves not only communications and learning among firms but also management and culture creation within the firms. The development of technological competence takes time to accumulate and support of other intangible factors such as absorptive capacity, infrastructure and organisational culture.
6. MOT is seen from different viewpoints such as learning or acquiring from partners to achieve a specific strategic goal(s). As results from discussions with senior management in Croatians firms suggested that senior managers are not always directly involved in MOT, more emphasis is given to HRM and marketing planning.
7. With their limited resources, the survival of local firms in CEE/Croatia will largely depend on their technological development.

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Jonathan COOPER

director
Ascendant Capital Advisors, d.o.o.
Varšavska 14, 10000 Zagreb, Croatia
E-mail: ascendant@ascendant.hr

FROM THE LAB TO THE CUSTOMERS: HOW TO TURN INNOVATIONS INTO PRODUCTS AND PROFIT

INTRODUCTION

It's very interesting when someone from the commercial side, such as myself, has the opportunity to interact with people coming from the university and government side. There is a link between these two groups, or three groups, in Croatia, but not as strong as it could be, or hopefully will be in the future.

Today I'm going to speak a little bit about a very broad topic: From the Lab to the Customers: How to Turn Innovations into Products and Profit. When I chose this topic, I thought it'd sound pretty interesting. When I sat down to begin my presentation a week later, I realized it was very encompassing, and I could hopefully, or someone could write a book on this topic.

So, what I have done, rather, is to break the presentation down into three main parts. First is generating the idea, talking about how that process can take place, how do you come up with an innovative idea or an innovative product. Then I'll talk very briefly about planning the business, and finally about launching the product.

And, as we go through this presentation, I'm going to use a company called Dok-Ing d.o.o. as an illustrative example. Dok-Ing was a portfolio company in the venture capital fund that I used to be the director of.

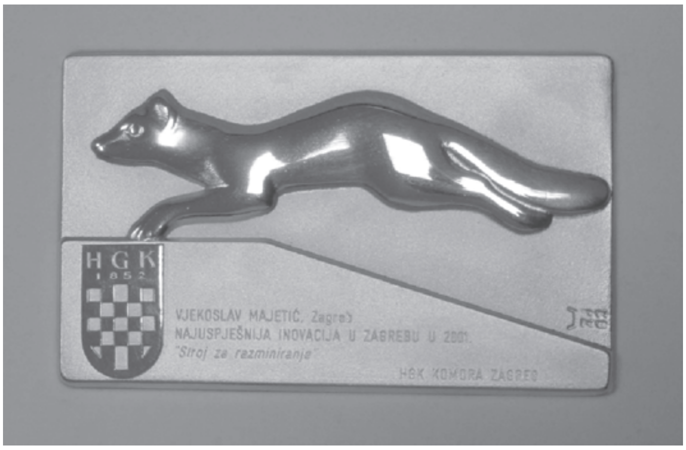
Very briefly to give you some context about myself. There are some data up there, but I was the director of the SEAF Croatia investment Fund. We are a venture capital fund, I should say, established in 1997. That fund has made seventeen investments in Croatia, not only in innovative companies, but also in other sectors, but I would say that five of the seventeen investments were what we could consider as innovative companies.

GENERATING THE IDEA

The company I would be profiling in my presentation, again, is called Dok-Ing. Dok-Ing is a Croatian company and one of the largest land mine removal companies in Croatia. Unfortunately, that is a problem that Croatia has. But, it provides a competitive advantage, quite frankly, for this company, because this company was able to develop its products in a very real world setting. In addition to land mine removal services, taking land mines out, the company also manufactures several different types of land mine removal devices, including the MV-4, which is a world class, 5-ton, remote controlled mechanized demining machine that has been sold and exported throughout the world. This machine is a product of five years of innovation and development. Last year it won an award, as being the top demining product in its class. That was based on the World Bank study out of Geneva. Since that came out about fourteen months ago, these guys have really been accelerating their sales, it's been very, very exciting. Also, to put in a bit of context, my fund invested in Dok-Ing in January 1998. The company had two employees and less than $100,000 in revenue. These were tow guys that literally were in the garage, the shed behind the founders' house tinkering with this product. Today the company has about 122 employees. It did over $6 million in revenue last year.

This is a picture of the MV-4. This is the machine, their mark key machine, they do make other demining equipment. This whole product was developed, designed in Croatia. They do buy the engine from a British firm, and buy the hydraulics from a German firm. Everything else is made in Croatia, and assembled here, including the electronics which are quite sophisticated on the machine.

Dok-Ing also received the Croatia Chamber of Commerce award for most successful innovation for that machine, back in 2001 (Picture 1).



Picture 1

In 2001, Dok-Ing received the Croatian Chamber of Commerce award for most successful innovation for the MV-4 Mini Flail de-mining machine

Let's talk more in detail about generating the idea from (Table 1). Where the good ideas come from? Well, clearly, previous experience of the entrepreneurs, or of the innovators. You also get quite a few ideas that come out of research labs at the university. You also get a lot that come out of military research, not necessarily in Croatia, but in other countries, certainly the United States. Government sponsored projects are big breeding grounds for ideas. And then corporate setting companies need to create an environment that fosters innovation and creativity. But, companies obviously are great innovators, well, existing companies.

Table 1
Generating the idea

Where do good ideas come from?

- Previous experience and observation
- University labs and research
- Government sponsored projects
- Corporate setting companies need to create an environment that fosters creativity and innovation

⇩

How to develop the idea?

⇩

- Entrepreneurial initiative
  - ✓ Working independently or in conjunction with a government, university, or corporate entity
  - ✓ Use the garage, back yard, or kitchen sink!
  - ✓ Nights and weekends – the 20 hour work day!

- University or government support
  - ✓ Lab time and access to advanced facilities
  - ✓ Student participation
  - ✓ Research and Development grants
  - ✓ Administrative support
  - ✓ Legal advice
  - ✓ Accounting advice
  - ✓ Preferential treatment regarding local innovative companies bidding for government contracts
  - ✓ Must be made accessible to innovators in a clear and transparent manner
  - ✓ Must allow innovator to maintain legal and economic rights to all or most of innovation!

- In – House Corporate Development
  - ✓ Allocation of financial and operational resources to the project
  - ✓ Often need a more senior level employee to "champion" the project
  - ✓ An indication of financial gain must be evident!
  - ✓ Incentivize the employee(s) to make the project a success
  - ✓ Create an atmosphere that fosters an innovative environment
  - ➢ Example: IBM "Research Fellows" program

How do you develop this idea? Well, with the university or government support, you can give lab time and access to advanced facilities to companies. That's quite clear. Student participation. What do I mean by this? I went to university in the United States. I was a business student, but many of my friends were engineers. Almost all of them, if not all of them, at some point during their university career were working with companies that were working in conjunction with the university on some type of research project. And that was usually something they would do in the weekends or the evenings to make a bit of extra money, but is also gave them real world practical experience, and the projects they were working on were quite advanced. Research and development grants. These are key part of real grass roots innovation projects. Venture capitalists don't like to invest in pure ideas, they like to invest in products that are a bit more developed, markets that are a bit more developed, so what you really need is a some kind of grant financing to work on these really base idea projects. You can also offer administrative support, legal advice, accounting advice. Legal advice is key especially when we talk about intellectual property rights and intellectual property protection.

Next point: preferential treatment regarding local innovative companies bidding for government contracts. This is a very key issue. Our company Dok-Ing, I'll talk about that in a minute, they would not have got into the level where they are today if they had not received some preferential treatment in getting contracts from the Croatian government and from the Croatian Mine Action Center because they were a Croatian company. These kinds of advice and assistance must me made accessible to innovators in a clear and transparent manner. The innovator must also be allowed to maintain legal and economic rights to all or most of innovations. I have an example here of Marc Andreesen. Marc Andreesen was a 19-year-old computer programmer at the University of Illinois in 1995. He was paid 5 dollars an hour to develop data base for tracking students and their schedules. Instead of doing that he was goofing around writing a program for the Mosaic, which was the first graphical interface web browser. The university did legally have a right to the ownership of that program. They did take it over and they licensed it for $22 million to a company called Spyglass, and Mr. Andreesen got nothing. Luckily, the story has a happy ending because he was contacted by a venture capitalist named Jim Clark, and they went out and wrote a Netscape web browser and started a company Netscape. Now, he is luckily a very wealthy man. But at the time, he was very disappointed because his innovation, his program was taken from him.

In-House Corporate Development – how does this potentially work? Clearly the company has to allocate financial and operational resources to the project. They often need a more senior level employee to "champion" the project in the company. They probably also need this within the government's or university grant setting situation. I know dr. Salomon[1] is very, very active in working with innovative companies through BICRO, and clearly it's important that he or one of his staff champions these projects and pushes them through. An indication of financial aim must be evident. Let's be honest, if it is an interesting intellectual process, that's great, but really we need to be funding up projects or ideas that have commercial applications, can eventually become commercially viable opportunities. Incentivize the employees to make the project a success. The people who are doing this work need to feel like if this works out, they are going to, frankly, make money. That's what motivates a lot of entrepreneurs and a lot of innovators, and they need to see that there is an opportunity for them to gain, if they are successful, in the future. And finally, to create an atmosphere that fosters an innovative environment. An example here is the IBM "Research Fellows" program. IBM has huge men of resources, of course, but they have about, I think about a 150 designated research fellows. These are employees that are similar to tenured professors. They cannot be fired. They are given budgets and small stuffs and their whole job at IBM is to think of new ideas and new innovations for IBM, for their customers.

Another way of generating the idea is entrepreneurial initiative. Here, these people are usually working independently, perhaps in conjunction with a government, university, or corporate entity, but they are primarily working on independent basis. They are using the garage, the back yard, or the kitchen sink as their development area, so to speak. Nights and weekends are very important – 20 hour work day. I know several people who have full time jobs, and evening and weekends they are trying to develop new ideas, new businesses. This is one of the key ways that innovations are developed.

Going back to this company of Dok-Ing. The example here: in 1996, the innovator and entrepreneur, Vjekoslav Majetić, who, by the way, is this gentleman on the left with the moustache (Picture 2). He wanted to apply his engineering skills to solving a significant problem for

Croatia, which is land mines. His initial motivation was humanitarian, absolutely, but he's built an innovative company that has also been a big commercial success. He's also a great promoter.

Picture 2
In 1996, the innovator and entrepreneur, Vjekoslav Majetić, wanted to apply his engineering skills to solving a significant problem for Croatia: Landmines. Although Mr. Majetić's initial motivation was humanitarian, he has built an innovative company that has also been a commercial success.

You'll probably recognize the gentleman in the middle as President Mesić, president of Croatia. We'll see him again. One thing I love about Mr. Majetić, SEAF's partner, and I work with him for several years, is his ability to promote himself and the company. I'm not quite sure if it's himself or the company that's more prevalent. As you can see in this picture, he's on very, very good job of doing that. From the company's earliest days in demining, it received significant assistance in the form of information, access, and testing ground from the Croatian Mine Action Center, as well as the United Nations and NATO, in developing its products and ensuring the highest technical standards and quality. I think there has been a lot of talk about this triple helix model at the conference. This isn't exactly triple helix, but I think you can absolutely say that this company developed this product in conjunction with the government.

As I mentioned earlier, they were given preferential treatment on receiving initial contracts. CROMAC also bought two versions of their early prototype models, which were good land mine removal devices, but there was also, they were trying to be helped out by CROMAC towards developing their company.

I love this quote: "Without a map, any road will take you there... (But where do you want to go?)". You've got an idea, or you've got an innovation, or you've got a small company, you need to have a plan to go with it. For an innovation to be successful commercially, an innovator must prepare a business plan. This plan is necessary whether a company, a new company is planned, or if the innovation is part of a new project within an existing company. The business plan is usually an internal document. So often people think: Oh, a business plan, that's what I need for the bank. You need a business plan for yourself. And the business plan is not just about the economics, but it's also about the production, the research and the development. And if the innovation is within a university or government setting, my opinion is they should look for a commercial partner to whom the innovation can be licensed or a joint-venture formed. So, if you have some very interesting technology, a patented product, something that is commercially viable, perhaps the best way to take it out of the lab, if it's truly coming from a university setting or a research setting, is to license it off to a commercial company. So, you're sharing the profits, but now you've allowed a commercial company to take it to market. There are different views on that, and different ways of making it work, but I think this is a very viable method.

Elements of a business plan (Table 2) includes, first of all, executive summary. That's just a summary of what's contained in a document. Then, description of the business. A discussion on the research and development that has taken place and will take place. You need to have a sales, marketing plan. You need also to discuss business development and the partners you're going to work with. You need to have a very detailed section on management, who is going to manage the company. Financial projections and explanations of those projections are key. And you can be anywhere from 2-50 pages long. Shorter is usually better, quite frankly. 10, I would say if somebody asks me what's a really nice size of a business plan, I would say 10, but it can vary. The biggest reason for failure that I see amongst innovators is that they also try to be business managers. Sometimes that works. With Dok-Ing it did work. With company like Microsoft it worked, if you consider them innovative. But often times these gentlemen are very good in a lab, but not such good business managers. They should just seek professional managers to assist them.

Table 2
Elements of business plan and financing the business

Elements of business plan	Sources of financing
• Executive Summary • Business description • Research and Development • Sales, marketing, business development and partners • Management • Financial projects and explanation • Can be anywhere from 2 – 50 pages long	• Out of pocket (self – financing) • Friends, family, and "Angel" investors • Government grants or credits • Bank loans • Venture capital • Cooperation with a corporate partner

How do you finance it? Out of pocket financing is key. Friends, family, "angel" investors. "Angles" are wealthy individuals who would often venture in initial projects to start up. Government grants or credits, bank loans, venture capital or cooperation with a corporate partner.

Going back to Dok-Ing. In January 1998, the SEAF Croatia venture capital fund became a minority partner in Dok-Ing. We also assisted Dok-Ing in developing their business plan, and provided the necessary initial financing to achieve the plan. I love the Dok-Ing corporate logo, by the way. It's very frightening.

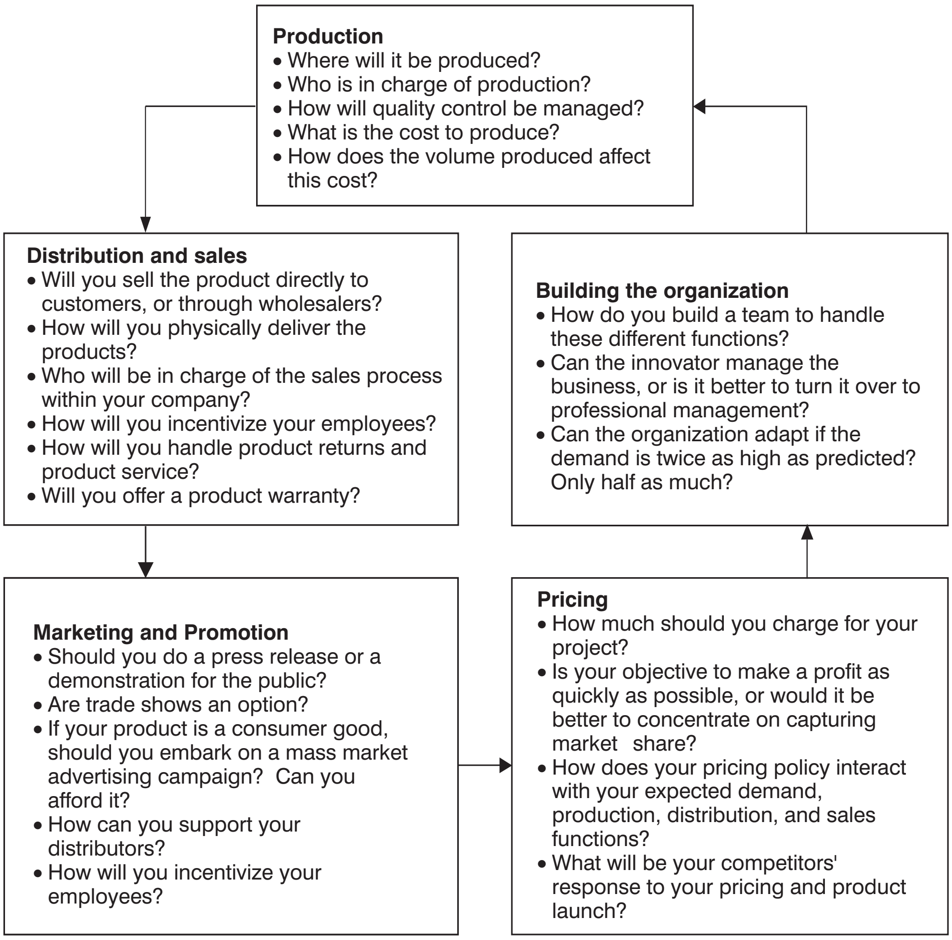
LAUNCHING THE PRODUCT

The main elements of launching the product (production, pricing, distribution and sales, marketing and promotion, building the organization) are presented in Table 3. A lot of questions here, actually, as opposed to specific steps to take. We need to think about production, where it will be produced? Who is in charge of production? How you are going to manage quality control? What's the cost of production? And how does the volume produced affect this cost of production?

Distribution of sales: Will you sell the product directly to customers, or through wholesalers? How will you physically deliver the products? Who will be in charge of the sales process? Incentivizing your employees. You need to pay these people to make the sales take place. How will you handle product returns and service? How about offering a warranty?

Marketing and promotion: Should you do a press release or a demonstration for the public? Are trade shows an option? If it's a consumer product, should you embark on a mass market advertising campaign? Can you afford that? It's very expensive. How can you support your distributors?

Table 3
Elements of launching the product



And again, how will you incentivize your employees? You'll see this on every side. People need to be incentivized to make a commercially viable project successful.

Pricing: How much should you charge for your product? Is your objective to make a profit as quickly as possible, or would it be better to concentrate on capturing market share? How does your pricing policy interact with your expected demand, production, distribution and sales functions? What will be your competitors' response to your pricing and product launch? This point is often neglected, especially from entrepreneurs.

Building and organization: How do you build a team to handle these different functions? Can the innovator manage the business, or is it better to turn it over to professional management? Can the organization adapt if the demand is twice as high as predicted? What if it is only half as much as predicted? How are you going to handle those different scenarios?

And again, looking back at Dok-Ing. Here, the company initially produced their equipment in the garage of the founder. They later moved to a small production facility in 1999. In 2002, so just last year, they moved to a 10,000 meter facility, and they can produced up to 25 of these machines a year. These machines, by the way, cost about a quarter of a million EUR a piece.

Yes, and here we go, following that example. Because of the highly specialized nature of their equipment, Dok-Ing sells most of their products directly to end users. To date, the company has sold machines to companies in Ireland, Sweden, Switzerland, South Africa, Israel and Croatia. These machines are on the fields now in Croatia and in Bosnia. They are in Iraq, they're in Africa, and they're in South East Asia. A very, very successful innovative Croatian company.

And finally, the company does have a small advertising budget, and thus tries to maximize all promotional opportunities, as well as attend trade fairs, conduct on-site product demonstrations, and direct mail campaigns. I mentioned that Mr. Majetić is a great promoter. And he's done a good job for him in this market world.

FOOTNOTE

[1] Director of the Business-innovation centre of Croatia (BICRO).

V.

EDUCATION, VALUES AND ETHICS FOR THE KNOWLEDGE-BASED SOCIETY

Dr Denisa KRBEC

Associate Professor of Sociology
Associate Dean for Academic Affairs
Head of Department for Economic Theories
University of Rijeka
Faculty of Economics and Tourism “Dr. Mijo Mirković” in Pula
Preradovićeva 1/1, 52100 Pula, Croatia
Phone: +385 52 377-023, Fax: +385 52 216-416
E-mail: dkrbec@efpu.hr

“EUROPEANIZATION” OF EDUCATION: CHALLENGES FOR ACCESSION COUNTRIES

"Knowledge has been at the heart of economic growth and the gradual rise in levels of social well-being since time immemorial"
(David & Foray, 2003)

INTRODUCTION

Considering the current calls for educational reform surrounding the ties between education and international recognition, a large portion of the current reform initiatives is oriented toward the needs of the economy. A central feature of the sociological approach is recognizing the most important basic goals of reforming the higher education system. Education as a public and a private good is both a subtle and a complex process of *production.* At *the international level*, the perception of the (higher) education *functionality* can result in improving their social role for a specific country on the global platform, indirectly giving the same benefits as at the national level (van Tilburg, 2001).

The higher education institutions have a critical role in supporting knowledge-driven economic growth and in constructing knowledge societies. The very recent World Bank study *Constructing Knowledge Societies: New Challenges for Tertiary Education*, published in 2002, analyses "how tertiary education contributes to building up a country's capacity for **participation** (emphases added by D. K.) in an increasingly knowledge-based economy" (World Bank, 2002: XVIII). Policy options investigated and presented in this study should also be elaborated during discussions of intensive policy implementation to avoid the risk of being further marginalized in a highly competitive world economy.

Starting with the Sorbonne Declaration (1998) and continued by the Bologna Process (1999) the central objectives of higher education became:

- Employability;
- Mobility; and
- International competitiveness.

These objectives are replacing the traditional ideals of the university as: searching for true recognition, studying to become a well developed personality and to cooperate as a community for the sake of scientific progress. The current official propositions, papers and policies regarding learning society, life-long learning and higher education must be seen in the European Union's current goal to become the most competitive and dynamic knowledge-based economy of the world (Kellermann, 2002).

The implication of the knowledge economy is that there is no alternative way to prosperity than to make learning and knowledge-creation of prime importance. According to New growth economics (based on work by Stanford economist Paul Romer and others who have attempted to deal with the causes of long-term growth), a country's capacity to take advantage of the knowledge economy depends on how quickly it can become a "learning economy" and after that an overall knowledge-based society. Romer has proposed a change to the neo-classical model by seeing technology – and the knowledge on which it is based – as an *intrinsic part of the economic system* (Romer, 1986, 1990). Sidelining capital and labour, knowledge is now becoming the *one* factor of production (Drucker, 1992), especially in developed economies[1].

It was recently discussed that *production of educational services* is often under pressure of society's expectations (Krbec, 2002a, 2002b, 2003). Educational institutions use resources and technology to produce services that benefit individuals and society. Traditionally, all educational institutions have been, and continue to be, learning centers with the objectives of accumulating and transmitting knowledge. Societies (transitional as well as "established" ones) are undergoing continuous review and change. As regards education and training in general, these circumstances imply a permanent adaptation by the education system to technological and social change.

Presently, higher education institutions (university and autonomous faculties belonging to them) are undergoing radical transformation from conservative (or traditional) to modern, innovative, which means socially more effective. According to Etzkowitz (2002) "the second academic revolution" is also a marketable commodity; it's a part of any further economic development.

Regulating the system of higher education, transitional countries have used a combination of bureaucratic regulation and market forces as the most recent key tools of governance. Following other reforms, higher education in Croatia also began a process of transformation, modernization and diversification. When completed, it would fundamentally alter the profile of a traditional university. In these circumstances many discussions about the future of Croatian higher education revolve around issues of finance and management. On the other hand, different pressures force the universities and other higher education institutions to build partnerships with both industry and government agencies. From transitional perspectives, these activities must be analyzed as a part of the privatization processes in the field of education in general.

"EUROPEAN EDUCATION SPACE"

Among the policies and/or initiatives that have been launched, *the new strategic goal* for Europe set at the Lisbon European Council in March 2000 should ensure a transformation to a society *capable of sustainable economic growth, with more and better jobs and increased social cohesion*. Such "an ambitious goal" (Zgaga, 2003:13) demands very concrete action. Therefore, the Council of Education has been asked "to undertake a general reflection on the concrete future objectives of education systems, focusing on common concerns and priorities while **respecting national diversity**" (Lisbon European Council, Presidency Conclusions No. 5 and No. 27).

Prior to this communication, the framework of a number of policies was meant to serve only as a basis for helping to define projects for implementation by EU as follows:

- The Commission Communication *Strategies for Jobs in Information Society* – COM (2000)48 – analyzed the impact of the information society and presented a set of proposals and recommendations in different areas (education/learning, working/organizing, public services, enterprise etc.).
- Based on the previous communication, *eEurope Initiative* was also launched in 2000. The initiative's goal was to encompass different objectives accompanied by several measures needed to ensure that future EU generations benefits fully from changes in the information society. Two "Action Plans": "eEurope 2002" and, from year 2003, "eEurope 2005" – COM (2002)263 final – identify the specific initiatives and modes of monitoring their results.
- According to the conclusions of the Lisbon European Council, the most important strategic goal for Europe for the decade is to become *"the most competitive and dynamic knowledge-based economy in the world"*.

- Following this, *the European Employment Strategy* (EES) enhances the development of human capital in terms of education, improvement of professional qualifications, shaping new roles within a changing work organization, equal gender participation in all economic activities, etc.

The European Commission will carry on these programs at all levels, in cooperation with networks either currently existing or specifically established for this purpose. Besides policy-makers, each network should actively include representatives of academic communities, researchers and experts from different (scientific) fields. Also, institutions specialized in curriculum related matters (such as national councils for higher education or scientific research or institutes/centers specialized in the analyses of curriculum evaluation) should also be associated with implementation of the EU standards.

After the *Copenhagen Declaration* (Nov 29-30, 2002), the Bologna Process enhanced new European co-operation in the area of higher education and enlarged its activities in the area on vocational education and training (VET). The Copenhagen Declaration stresses the following main priorities:

- Strengthening the European dimension in VET, accordingly helping to introduce the lifelong learning strategy as a new dimension of (inter)national cooperation;
- Increasing transparency through implementation and rationalization of IT tools and networks, supporting real time monitoring of connection between research and educational institutions in the least developed countries;
- Optimization and awareness of resources, and review of available technologies;
- Encouraging recognition of competences and/or qualifications by developing two different stages of higher education, principles for certification, a credit system (ECTS) for HE and VET;
- Validation of non-formal and informal learning (certified programs);
- Promoting cooperation in quality assurance.

These priorities/measures should be "voluntary and principally developed through **bottom-up co-operation** (emphasized by D. K.)" and also "based on the target of 2010, set by the European Council in accordance with the detailed work programme and the follow-up of the Objective Reports". *Detailed work programme on the follow-up of the objectives of educational and training systems in Europe* has been accepted by the Council of European Union on February 20, 2002. Consequently, the Berlin Communiqué (September 2003) explicitly set up the Follow-up Group obligations their summit in 2005:

- Quality assurance,
- Two-cycle system, and
- Recognition of degrees and periods of studies.

The Follow-up process is expanding to 37 European countries now. All participating countries should be prepared to allow access to the information necessary for research on higher education relating to the objectives of the Bologna Process. To this effect, access to data banks on ongoing research and research results shall be facilitated (Berlin Communiqué: Sept 19, 2003; Part: Stocktaking).

THE ROLE OF THE STATE

According to the European Commission's attitude (2001), education in general and higher education in particular are not subjects of a "common European policy": **the content and the organization of studies remain at the national level**. The state has a responsibility to shape a framework that encourages and/or supports HE institutions to be more flexible, attractive, and innovative in a "borderless" environment. Salmi and his research team (World Bank, 2002) go on to say that the rising competition for resources and customers in the context of a global education market is producing a much more complex interplay of forces that need proper consideration in order to understand how the transformation of (each) current education system(s) and institution(s) takes place and the range of levels that the state and society can rely on to promote change.

At the Prague Summit 2001 it was clearly confirmed that the importance of the Bologna Process and the need for a common *European Higher Education Area* (EHEA) increased in all member-states not only at the governmental level but also at the level of institutions. Some accession countries expressed their readiness to join the Process. The most recent report prepared for the Ministers of Education of the signatory countries, named "Bologna Process between Prague and Berlin" (Sept 18, 2003), highlights the importance of *the Bologna Club* in the intergovernmental process of exploring the most important issues and searching for consensus.

> "There are *national* educational systems and curricula but there is also a firm understanding that *European cultural diversity* gives us great advantages

and richness. Our advantages and richness can be mutually and fully enjoyed only if we create solid 'common roads' among us" (Zgaga, 2003:7).

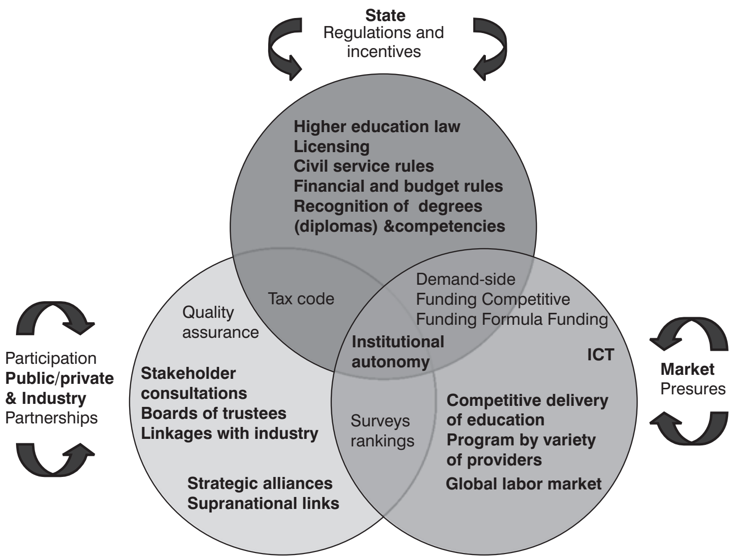
Under the light of EU enlargement, there is a growing convergence between the Bologna Process and educational policy making on the EU level. Forthcoming EU enlargement in 2004 will give additional dynamism to the Process.

The 1997 World Development Report observed that changing government rules and constraints was not sufficient to bring about reforms in an effective manner. A more recent World Bank study (2002) stresses the significance of three mechanisms bearing together on the behavior and results of (tertiary) education institutions:

- State regulations and financial incentives;
- Participation and partnerships, with industry, civil society and professional associations; and
- Competition among the various research and higher education providers (international/national, public/private, university/vocational, presentable/virtual provision, etc.).

Figure 1. illustrates how the overall social context and the diverse types of incentives used by the state interact with market forces and civil society at large to get better performance and responsiveness among HE institutions. This analysis could be used as a framework for considering the relationship between educational (nonprofit) trustees and their management. (In the balance of this paper, we do not distinguish between trustees and management.)

Figure 1.
Social Context of Change in the Education Systems



Source: World Bank, 2002:84

In this sense, education becomes a branch of economic policy rather than a mix of social policy's solutions. Under the pressure of neo-liberal regimes and societies' ability to solve their problems by themselves (e.g. self-help strategies of employment or life-long learning activities), traditional forms of government and policy-making strategies' began to be reformed.

The degrees of transformation or *transfiguration* (Rikowski, 2001/02) in the education system vary from one country to another (also see Krbec, 2003). In educational settings, discussions about decentralization of public services and/or privatization mean different modes of funding service. In the transitional countries, the process of decentralization is not only a strategy but also a political restructuring plan. Decentralization is often defined as an *intended effect of the site-based or school-based management, which redistributes decision-making authority* (Bauman, 1996).

Following Chubb and Moe's (1993) opinion that the educational "market system is built around decentralization, competition and choice", some approaches to organizational change in transitional circumstances might not be identified only as a political reform. **If decentralization is designed to make educational systems more responsive and accessible, we may talk about radical educational reform that introduces a new system of public education.**

EFFECTS OF "EUROPEANIZATION" OR HOW THE ACCESSION COUNTRIES SHOULD ACT

According to Lawn (2001), the idea of a "European education space", connected to a similar proposal for a "European research area", is fundamental to the contemporary structuring of the European Union. Recent studies by Eurydice on reforms in higher education in Europe during 1980 and 1990 show more diversity in interaction processes between educational decision-makers and the economic environments belonging to them (Eurydice, 2000). On the one hand, this resulted from the intensive participation of business members in the decision-making process. On the other hand, growing marketization in the field of higher education was forced, and it's going to force higher education institutions (and their management teams) to find ways of attracting more consumers in accordance with demands of the economy.

Furthermore, current relationship between *superordinate communities* and national communities (as a cultural entity) is becoming more heterogeneous. Every higher education institution may decide on the relative balance between the type and level of community with which it identifies (Neave, 2003:160). The choice is among international (which means: European), national, and even regional means of collaboration.

Generally speaking, the EU Member States adopted the basic (educational) political direction under the title "The European Dimension in Education" (1988) and "Toward Educated Europe" (1997) on which they reached consent of the Committee for education and science (now Department of Education and Employment). The documents include several groups of the basic goals in the field of education, such as (ISCED, 1997):

- Stimulating professions according to the diversity of historic, geographic and cultural development of European countries;
- Preparing youth to assume their share of responsibility in the economic and social development of Europe by offering a variety of opportunities to acquire education and skills sought and demanded by society;
- Stimulating professions and enhancing communication in several European languages, realization of political, economic and social tenets of development (past, current and future), including knowledge about the origin and appearance of the European Union, creation of a European (cultural) identity by building on the experiences from other (neighboring) countries;
- Stimulating innovations through pilot projects at the level of transnational cooperation with special emphasis on education, training and programs for youth (Erasmus, Lingua, Comett, Socrates, Leonardo Da Vinci), as well as;
- Promoting the sense of European unity and accepting the European Union as a distinguished economic and political association apart from the rest of Europe and the rest of the world.

The importance of creating the European system of higher education has further been emphasized in the Sorbonne Declaration or *Joint Declaration on Harmonization of the Architecture of the European Higher Education System* (signed in Paris – Sorbonne May 25, 1998). This document is a key for achieving the mobility and employment of citizens. It is also important in the overall development of the continent. The Sorbonne Declaration emphasized the roles of governments in "achieving these goals (op. goals of Declaration), by stimulating methods according to which the adopted knowledge is valorized and the appropriate levels are identified and recognized". The main goal of this declaration is the commencement of the *harmonization process* of European structure of higher education. This only directs the previous principles to the field of higher education by emphasizing that: "Europe must be the Europe of knowledge". It provided a *reference framework* aimed at promoting the external recognition and facilitating student mobility as well as enabling easier employment.

APPLYING STANDARDS IN HIGHER EDUCATION

According to the Sorbonne Declaration, the Bologna Declaration and other documents, there is a need to implement a *subsidiary principle of the responsibility*. Primarily, the responsibility rests on administrative bodies, such as the ministries of education and their subsidiary administrative bodies on regional, i.e. local levels. At the same time, the administrative bodies of educational institutions (school boards and various councils depending on the level of education) have the authority over implementation.

This requires *a holistic analytical approach* that links different dimensions of the EU accession process instead of merely describing the particular obligations, competences, and organizational behaviors conducive to improving the efficiency of education decision-makers, administrators and others subordinate to the various power processes.

Such a model enables introducing uniform criteria for the estimate/assessment of the social benefit "product" of educational processes; the model interpretation needs to be viewed at two levels:

a) strategic level, which implies setting the framework for regulation and the principles for application of the basic tenets of educational policy: *product*, *service*, *investment* or *identity*; and

***b) production* level,** which implies a well established network of mutual relations among institutions that offer education services. These include universities and institutions of higher education that comprise it, such as the schools of higher learning, higher schools and other institutions of higher education outside the university system as in Croatia, regardless of the ownership structure and program orientation.

Both levels are analytically present in different approaches to (higher) education as a public good. In the Preamble of the Berlin Communiqué is focusing on higher education as a public responsibility. The final goal is the development of *a coherent and cohesive European Higher Education Area* by 2010.

In Table 1, column A is central to the common policy process. This context represents the diverse production process of education. In this sense, knowledge should be understood as the potential for (individual, community) action that depends not only on stored information but also on the way in which individuals interact with it. Based on Hövels' opinion, knowledge occurs in interaction and is made valuable by the ability to act upon it. Interaction between higher education and economic life is of a particular relevance (Hövels, 2003:2).

As a consequence, HE institutions (individual university or faculty/school/academia) are forced to change their traditional, passive role in transmitting knowledge, and to use more competence-based methods of producing and applying knowledge in the (higher) education process. Different institutional mechanisms should serve to develop new forms of knowledge creation. The institutional perspective on educational innovations highlights the importance of a social entrepreneurship strategy both in higher education and in academic research. The complexity of collective decision-making may be simplified by considering an analytical strategy useful in making decisions on social issues in different countries. The benefits of implementing this strategy can be substantial if a concerted effort is made to deliver an optimal view of activities to the public, to key decision-makers, and to university administrators. Institutions that want to build and nurture successful as well as effective inter-organizational forms will have incentives to decentralize authority down to the production level.

Table 1
Diversity of analytical approaches to education as a public good

	The education is defined as:			
	A. Product	**B. Service**	**C. Investment**	**D. Identity**
1. Establishing the process	**Production**	Providing service	Opportunity	Shaping
2. Social benefit	**Possible accumulation of "stock"**	Momentary Use	Postponement of the adopted values	Morally acceptable
3. Benefit for an individual (interest)	**Knowledge**	Experiences in learning	Increasing lifetime opportunities	Quality of life
4. Possibility of measurement	**Degrees and test results in transitions between levels**	Involvement / participation	Employment and/or continuation of schooling	Culture / values

Source: Mitchell, 1998:222

More than before, development strategies of higher education aimed at satisfying the basic (desirable) **criteria of social effectiveness** imply the presence of:

a) Stratified structures of higher education institutions;
b) Appropriate and stable financing of the activity (educational, as much as research-development);
c) (International) Competitiveness in the market for providing higher education services;
d) Flexibility in preparing and implementing the education programs (higher education curriculum) with a system of implementing (international) standards; and
e) *Value - neutral* scientific orientation (in Weber's definition of the concept, *op. value-free scientific orientation*) in a program field as well as in research.

Systems of higher education developed in this manner may expect increased interest on the international market for knowledge and skills which will occur by reflecting upon the increase in quality of their educational contents.

THE LIMITED EFFECTS OF POLICY DESIGN – A CROATIAN PERSPECTIVE

Over the last decade, Croatia, like other transitional countries, has experienced fundamental changes in its economic, social, and cultural dynamics as well as changes in a number of significant demographic characteristics. These changes have important implications for the way education and training programs in schools, faculties, universities, and the workplace are designed and delivered.

Formal interpretations and implications (UNESCO, EURYDICE et al.) have generated several broad issues and questions about the positioning of education in the specific **social context**. Furthermore, educational systems are forced to respond to the challenge of globalization. The challenges of diverse forms of modernization are now inevitable. One of them is certainly the need to shape the criteria for standardization. From a perspective of new economic sociology, that need is defined as a type of social intervention (or social invention) within the circle of the EU's Member States. But, the main demand is very clear: *efficiency in providing (educational) services* which should provide *transferability* (a matter of special concern because national practice in areas such as student assessment, performance, and evaluation revealed immense variation), and *portability* of student financial support. This efficiency is crucial for re-shaping of complementary of qualifications.

Following current reform activities in Croatia, the introduction and acceptance of European standards in higher education became one of the objectives reinforcing the means to act:

1. On a **strategic level**: based on the new Scientific Research and Higher Education Law, introducing standards should be one of the basic goals of the upcoming reforms of higher education in Croatia at the university level. Among the many goals of the future transformation of higher education, *standardization* and implementation of the *instruments of integration* are the inevitable requirements for every national system of higher education. Over the ten years that the European Credit Transfer System (ECTS) has been running, it directly reinforced the integration of European universities. Accordingly, Europe's adjustment to globalization additionally contributes to the harmonization of national systems of higher education. Therefore, Croatia like all other countries approaching accession to the European Union, must – among others – adopt the standardization requirements. The requirements are adopted with the attempt to make *qualitative assessment of benefits that academic knowledge and skills yield*. Among the well-known goals of ECTS implementation, one is ***the principle of general social benefit*** resulting from the transformation of higher education. The principle should complement actions such as:

a) *Formulation of an effective and efficient system* that will promote the high quality of academic knowledge measured by educational standards;

b) *Promotion of equal opportunities in education* in the context of equality in the approach to educational institutions;

c) *Harmonization* of the ability to grant financial support to institutions of higher education with national, economic and political needs for development;

d) *Responsibility* of the institutions of public administration and their *managements* for achievement and maintenance of the high qualitative level of the educational processes, which occur on various levels of higher education and in various fields of science.

2. On a **"production"** (operational) level:

e) Creating scientific (expert), as well as administrative support in overcoming the existing misunderstanding of foreign educational systems (originally undergraduate and graduate);

f) Defining the length of individual curricula (per week/semester);

g) Overcoming the problem of low level of student preparation when transiting between academic years as well as the low number of graduates relative to the total number of students etc.

Considering that "Europe of knowledge" surely cannot postpone the use of acquired knowledge and skills, the changes of current condition should be approached decisively.

FOOTNOTE

[1] Along the same lines, the OECD has suggested that the society's benefit of knowledge, compared with natural resources, physical capital and low-skill labour, has taken on great importance. "Altrough the pace may differ, all OECD economies are moving towards a knowledge-based economy" (OECD, 1999:7).

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Dr Katarina PRPIĆ

Institute for Social Research – Zagreb
Amruševa 11/II, 10000 Zagreb, Croatia
Phone: +385 1 4810-264, Fax: +385 1 4810-263
E-mail: katarina@idi.hr

GENERATIONAL DIFFERENCES IN RESEARCHERS' PROFESSIONAL ETHICS: AN EMPIRICAL COMPARISON*

APPROACHES USED IN OTHER/EARLIER STUDIES

Empirical studies of research ethics, sociological or other, are rare and existing ones usually follow two different lines of interest. Some are interested in scientific misconduct, while others are preoccupied with scientists' cognitive standards and/or convictions. These two groups of studies differ both in conceptual and in methodological approach: the first start from pragmatic definitions of the research subject, the second from theoretical criteria.

Pragmatic approaches define scientific misconduct and questionable research practices on the basis of ethical codes or recommendations of scientific academies, scientific societies, universities and other research institutions. They investigate the spread and incidence of proscribed behaviour patterns on larger or smaller samples of the scientific (sub)population. The largest and best-known study of the American Acadia Institute was carried out on a sample of 4,000 faculty and doctoral students in chemistry, civil engineering, microbiology and sociology (Swazey et al., 1993).

Other studies were smaller, with fewer respondents, usually from one scientific field or discipline, and thematically they usually concentrated on particular ethical problems, often authorship assignment (Eastwood et al., 1996; Tarnow, 1999). These studies also analysed statistical data about scientific misconduct allegations and the findings of investigations carried out on their basis (Rhoades, 2000).

Theoretically most ambitious is research into scientists' cognitive standards or convictions. These start from at least some assumptions about the character, source and/or meaning of science ethos. Usually this is a norm-based framework, in the first place Merton's (1974) concept of science ethos, such as in the Hill (1974) research. In the nineties this concept was verified in another Acadia study, focusing on the normative orientation of faculty and doctoral students. What is more, it examined the enactment of mertonian norms and Mitroff's counternorms, i.e. the degree in which they represented typical faculty behaviour in the respondents' departments (Anderson, 2000). So far this is the only study that covered science ethics on both levels – normative and behavioural.

Unlike the above research that empirically verified an existing and very often criticised theory, modified normative approaches are now developing from the combination of various hypotheses about scientific values and norms, empirical results, pilot research, even teaching experiences. Some studies stopped on the level of adopting norms (Berk et al., 2000), others were performed on the behavioural level of research ethics (Kaiser, 2002). These empirical investigations also include, at least in part, some social dimensions of science ethics. Theoretically (most) interesting are studies that investigate scientists' cognitive convictions starting from classical sociological concepts and postmodern hypotheses (Andersen, 1999; 2001).

Scientists' cognitive standards can also be discerned from research quality studies, especially studies focused on quality evaluation criteria. Ranking standards of (good) research by respondent scientists enables recognising the criteria and/or cognitive norms that the scientific population finds important when evaluating research and publication quality (Chase, 1970; Hemlin and Montgomery, 1990; 1993; Hemlin, 1993; Hemlin 1996). Yet, such data are partial, too, since they show the cognitive side of science ethics but leave its social dimension completely out of research focus.

To sum up the results of this literature analysis, we will point out two major problems in the approaches used in empirical studies of research ethics. The first is that the value-normative level is separated from the behavioural level of science ethics, that is, what researchers consider their professional standards are separated from their actual everyday behaviour. The second problem is reducing research ethics to cognitive standards and neglecting social relations and considerations in scientific work and profession. None of these studies included both levels (normative and behavioural) and both dimensions (cognitive and social) of research ethics.

Unless we gain comprehensive empirical insight into both levels and both dimensions of research ethics, the contrasting descriptions of old academic and new research ethics are merely hypothetical models. In this case the discussions and controversies concerning that subject remain mainly speculative and thus not very promising.

The purpose of this contribution is not to participate in these discussions or to attempt answering these dilemmas. All the more so as the framework of Croatian society, economy, technological development and national innovation system do not allow empirical findings about Croatian researchers' ethics to be generalised to knowledge-based societies. Our picture may be interesting and indicative, although not necessarily representative, for the transitional social and economic context.

What can be generalised are trends in (generation-based) changes confirming that scientists' values and everyday behaviour are not static and uniform, as Merton's concept suggests. On the other hand, we tried to avoid the constructivist tendency of reducing science ethics to a mere set of moral prescriptions (Collins, 1982), of pronouncing epistemology to be ideology (Chubin and Restivo, 1983), and of equating professional ethics with professional ideology intended for presentation to the public, without any deeper importance in everyday scientific professional practice (Fuchs, 1992).

The starting point in both studies was the sociological concept of professional ethics understood as a constituent element of the scientific profession. Moreover, the concept of professional ethics is placed within the broadest socio-cognitive approach to science studies, emphasising the mutual linkage of the social and the intellectual organisation of science (Whitley, 1977; 1981; 1984). This approach recognises the pluralism of the cognitive and social features of contemporary science, but also presumes the existence of some common characteristics that distinguish science from other forms of intellectual and cultural production. Consequently, science ethics can be viewed as a complex structure: a) with a common (yet changeable) core of scientists' professional standards and patterns in everyday professional practice; b) with an pronounced inner differentiation of professional values and norms, and patterns of researchers' conduct according to their organisational and cognitive context.

Therefore, science ethics is defined here in two ways. As a *set of scientists' professional values and norms* it encompasses both cognitive and social standards, standards of scientific work and standards of behaviour in professional relations respectively. As scientists daily *professional practice*, research ethics may not strictly follow their cognitive and social ideals and thus includes their ethically questionable conduct as well.

The goal of this study, on the basis of two empirical research projects undertaken in Croatia on (large) samples of eminent and young researchers, is to show: a) a comparison between the professional values/norms of these groups, their cognitive standards, and also the behaviour standards in researchers' professional relations (normative level of research ethics); b) a comparison (of perceptions) about the frequency of ethically questionable and unacceptable behaviour of researchers in Croatian research institutions (behavioural level of ethos).

The basic concepts were defined in accordance with the above approach: cognitive and social norms, as well as ethically questionable and unacceptable behaviour of scientists.

Cognitive and social values and norms are constituent parts of scientific ethical code(s), written or not, formal or informal. Cognitive standards are seen as a basic element of the intellectual structure of science. They rest on consensus adopted by scientists about relevant scientific research criteria, research evaluation criteria and some rational procedures that science, as a collegiate profession, could not exist without. These norms are not of absolute nature, yet science analysts (philosophers) expect the epistemological orientation of most practising scientists to be realistic, even that researchers by and large accept mertonian norms (Elkana, 1978; Lelas, 1990; Cole, 1992; Sonnert, 1995; Fuchs, 1996).

In this study the choice of cognitive norms was based on some, theoretically and empirically, most frequently examined components of the scientific professional code: *objectivity* (represented by several procedures considered crucial for this cognitive ideal); *verifiability,* which is considered the *differentia specifica* of scientific knowledge (represented by relevant procedures too); *logical rigour*; *systematism,* which denotes incorporating research findings into a system of scientific cognition; *precision* (not only methodological, but also conceptual, as well as precision of writing), and *originality* or cognitive novelty, the most important (and the most fluid) feature of creative scientific thought and work.

The social component of science ethics consists of values and norms governing desired and prescribed behaviour in the professional relations that a scientist establishes in his/her work. These relations include: a) colleagues (cooperation, open communication, help, deserved authorship assignment), b) students (fair/correct teaching and support); c) patients and/or respondents (protecting their rights); d) clients or funders (universalistic principle and professional autonomy); e) work organisation (caring for the institution's research excellence); f) the wide(er) social community – scientists' social (ir)responsibility was observed through three orientations: ethical neutrality, social responsibility and cognitive uncompromisingness.

Since no clear consensus on unethical behaviour in science exists, in this paper deviations from the professional – cognitive and social – values and norms defined above are observed as ethically questionable and unacceptable types of scientists' conduct. The categories used here were constructed so as to ensure comparison with other studies whenever possible.

Deviations from the cognitive norms of *objectivity, verifiability and precision* refer to data manipulation, distortions in using the findings of other scientists (Swazey et al., 1993), secrecy (Hagstrom, 1965; 1974), noncognitive particularism (Mitroff, 1974; S. Cole, 1992) and theoretical dogmatism (Mitroff, 1979; Mahoney, 1979). Also included is adjusting scientific findings to the dominant theoretical orientations and to the mainstream ideology, politics, religion and world-view in society. Expedient reasoning, i.e. adjusting arguments to the thesis (Mahoney, 1979), and empiricism or theoretically insufficient empirical research are included as the most adequate indicators of possible deviations from *logical rigour* and *systematism*.

Whereas the deviations from cognitive standards mentioned may cause damage to scientific knowledge, deviations from social norms harm or even endanger the participants in and users of scientists' professional work. Instead of an unfeasible examination of all the distortions of *collegial relations* in science, only those that maximally erode the norm of communality – plagiarism, inappropriate authorship assignment and discrimination in scientific collaboration – are covered here. Exploitation of subordinated associates has also been taken into account (Hagstrom, 1965; Heffner, 1979; Swazey et al., 1993).

The ethically questionable conduct of scientists towards *students* primarily includes "hidden" exploitation and discrimination (Berelson, in Hagstrom 1965; Swazey et al., 1993), and regarding *respondents and/or patients,* this includes jeopardising their well-being, as well as their voluntary and anonymous participation in scientific research. In the relations of researchers with their *funders/clientele* and with their *organisation,* we have focused on neglect of scientific standards in (applied and/or contract) research. Concerning the *social responsibility* of scientists, the existence of two extreme types of conduct was presumed. One shows scientists' denial of any social responsibility or their complete ethical neutrality. The other includes the impact of social benefit on cognitive options, namely, on the un/acceptance of scientific theories and methodological criteria, and on the non/publication of scientific results.

DATA COLLECTING AND PROCESSING

Data for this study were derived from responses to two mail surveys carried out in the nineties. The first survey was mailed in 1995 to the population of the most distinguished scientists listed in the biographical directory called *Who is Who in Croatia* (Maletić, 1993). A relatively restricted definition of eminent population was used, comprising only professionally active scientists living in the country, excluding professors at academies of art and at theological faculties and institutes. This population included 769 eminent scientists to whom the questionnaire was sent.

After three reminders, 385 respondents or 50.1% sent back the questionnaire. Chi-square tests showed that the obtained sample did not significantly deviate from the known relevant characteristics of the population: gender, age and scientific field. In the analysis only 320 questionnaires were used, in which items related to scientists' professional ethics were completely answered, response rate thus falling to 41.6%. The social and professional profile of these 320 respondents was practically identical to the entire sample of eminent scientists. The application of chi-square tests discovered no significant differences in the most relevant features (respondents' scientific field and type of research) among them.

In 1998, the same questionnaire was mailed to all researches and scientists aged under 35 evidenced by the Ministry of Science and Technology of Croatia (1,696 persons). After three reminders, 840 respondents answered the questionnaire, which was 49.6% of the total population of young scientists.

The most relevant characteristics of the sample – gender, age, scientific degree and type of organisation – were compared with the corresponding data for the young researchers' population. Chi-square tests were used to establish the significance of differences among them. The sample is socio-demographically representative because it does not significantly deviate from the population in gender and age structure. However, it is socio-professionally selective, because respondents with a master's or doctor's degree, and those employed in public institutes, are over represented.

The same questionnaire (batteries of items) was used in both surveys. The most relevant social and professional characteristics of the respondents were examined in a specially designed part of questionnaire. Operationalised professional norms and forms of ethically problematic and unacceptable types of conduct made separate sets of questions. The items were derived from the listed cognitive and social values and norms, and from the list of deviations from these norms. The questionnaire included three batteries of items concerning science ethics.

The first battery was related to the importance of each norm in respondents' scientific fields/disciplines. Respondents ranked each of the 34 items on a four-degree scale from *mostly unimportant* to *very important*. The second battery included the same norms, but this time the respondents were asked to indicate the extent to which they see these norms enacted in their fields (first survey) or institutions (second survey). A scale of four degrees was used for rating each item from the *lowest* to the *highest* degree of norm enactment. The third battery consisted of 26 items about misconduct and questionable research practices. The respondents marked the frequency with which, according to their personal observations, each type of (mis)conduct had occurred in their scientific institutions in the last five years. Four-degree scales, ranging from *never* to *very often,* were again used.

Data were analysed using the SPSS programme (for MS Windows). After obtaining descriptive statistics (frequency distributions, means and standard deviations), t-tests for equality of means were used to determine whether there were significant differences between eminent and young scientists in their subscription to the norms, and between their perceptions of incidence of ethically questionable conduct.

EMINENT AND YOUNG RESEARCHERS' ETHICAL CODE

Table 1 shows the rank-ordered means of the respondents' ratings on every scale (M), as well as t-tests for the equality of these means, showing subscription to the cognitive and social values and norms of eminent and young researchers, as well as in/significant subscription differences between these groups.

Even the first inspection of the table shows that both groups of respondents ranked the possible norms of scientific work and profession very highly, attributing each of them an above-average importance (the average result on a 1-to-4 scale is 2.5). On all scales, the overall mean subscription to the norms is 3.25 for eminent scientists, and practically the same, 3.23, for young researchers. This general

Table 1

Subscription to professional values/norms of eminent and young researchers (rank-ordered means) and the results of t-tests

Professional values/norms	Eminent scientists		Young researchers		t-test for equality of means		
	Mean	Rank	Mean	Rank	t	df	Sig.
Conceptual accuracy	3.74	1	3.61	1	4.060	638.466	0.000
Commitment to searching for the truth	3.65	2	3.23	21	9.260	777.803	0.000
Responsibility for the effects of one's research results	3.55*	3	3.49	4-5	1.268	575.637	0.205
Strict scientific standards of applied and developmental research	3.55*	4	3.31	17	5.138	770.850	0.000
Avoiding quick generalisations	3.55*	5	3.47	6	1.622	574.589	0.105
Support for the institution's excellence	3.54	6	3.51	2-3	0.905	604.097	0.366
Encouraging talented students	3.51	7	3.33	14-16	3.885	652.969	0.000
Collegial support	3.45	8	3.43	7	0.456	593.734	0.649
Developing knowledge for the benefit of man and society	3.44	9	3.51	2-3	1.415	590.411	0.157
Receptivity to all relevant data	3.41	10	3.49	4-5	1.781	513.659	0.075
Incorporating new results into knowledge	3.40	11	3.36	12	0.712	577.750	0.477
Careful use of one's colleagues' results	3.38	12	3.27	18-19	2.221	575.130	0.027
Full autonomy in relation to funders/clients	3.34	13	3.20	22-23	2.561	665.477	0.011
Deserved authorship assignment	3.32	14-15	3.20	22-23	2.349	536.991	0.019
Scientific training and fair evaluation of students	3.32	14-15	3.37	11	1.020	593.992	0.308
Non-subjectivity in reporting one's results	3.32*	16	3.33	14-16	0.281	547.868	0.779
General logical rigour	3.29*	17	3.09	28	4.218	616.213	0.000
Precision of scientific measuring	3.29*	18	3.26	20	0.593	576.459	0.554
Accuracy and clarity of writing style	3.26	19-20	3.16	27	2.180	608.424	0.030
Non-subjective evaluation of scientific ideas and contributions	3.26	19-20	3.35	13	1.643	549.354	0.101
Constant scrutiny of statements and data	3.20	21	3.17	25-26	0.597	553.054	0.551
Independence of cognitive options from their social and political implications	3.18	22	3.04	29	2.541	675.864	0.011
Replicability of research	3.17	23	3.42	8-9	4.356	484.641	0.000
Open collegial data exchange	3.15*	24	3.38	10	4.772	568.753	0.000
Maximal professional service to funders and/or clients	3.15*	25	3.33	14-16	3.062	562.836	0.002
Theoretical originality	3.12	26	3.27	18-19	2.768	496.116	0.006
Methodological originality	3.06	27	3.17	25-26	2.116	562.975	0.035
Non-exploiting the (work of) students	3.04*	28	2.97	31	1.157	522.936	0.248
Originality of empirical evidence (data)	3.04*	29	3.42	8-9	7.648	591.858	0.000
Protection of psycho-physical integrity of respondents and/or patients	2.90	30	2.78	32	1.416	591.874	0.157
Accessibility of research and data to scientific public scrutiny	2.82	31	2.60	35	3.358	569.038	0.001
Anonymity of respondents/patients	2.80	32	2.76	33	0.473	588.557	0.636
Voluntary participation of respondents and/or patients in research	2.79	33	2.62	34	2.269	604.918	0.024
Ethical neutrality – avoiding to evaluate social desirability of scientific results	2.67	34	3.01	35	5.561	634.785	0.000

* Different ranks have been retained when the values of the means rounded to three decimals (here for the sake of comparison rounded to two) were originally different.

result implies that the ethical code of the eminent and the young consists of traditional cognitive standards connected with objectivity, verifiability, precision, logic and originality of scientific thought and work. Such cognitive standards are typical for the realistic epistemological orientation and are roughly compatible with the findings of other researchers (Chase, 1970; Hill, 1974; Hemlin and Montgomery, 1990; Hemlin, 1993; Anderson, 2000).

Yet, the professional ethics of both groups also includes values and norms that were not taken into account in studies of the traditional academic code, or they are considered to be typical of Mode 2 research (Gibbbons et al., 1997). Such non-traditional orientation can be identified in respondents' subscription to maximal professionalism regarding commissioned research and/or applied investigations and experimental development. The same conclusion applies to the highly ranked social responsibility of scientists, roughly comparable with the strong accent on the social role of scientists found in a study of the Venezuelan scientific community (Roche and Freites, 1992).

Therefore, researchers' professional ethics may be perceived as a combination of their classical cognitive convictions and standards, and their pronounced social sensitivity reflected in all social relations connected with the scientific profession. Social sensitivity is especially reflected in perceiving the importance of scientists' responsibility to the broader social community. This is true both of the older and young(est) generation of scientists: of eminent researchers and of beginners, which indicates a similar, or even identical value frame for scientists' professional socialisation.

However, we found considerable and significant differences in the importance respondents within each group give to particular cognitive and social norms, and also differences between eminent and young researchers. In other words, despite standards, about whose importance there is a relatively high level of consensus, professional ethics is nevertheless a hierarchical set of values or norms that do not have the same importance for all groups of researchers, especially in different fields of science (Prpić, 1998).

It is interesting to consider potential generation-induced differences, to which the results strongly point. At the time of the first survey (1995) eminent scientists were 59 years old on an average, while young researchers, respondents in the second survey (1998), were an average of 32 (Prpić, 1996; 2000). Therefore, there was a thirty-year age difference, and the different importance the two groups accord to particular cognitive and social norms may be attributed to their different professional position and role, but also to the generation effect of long-term changes in the social organisation of science and professional socialisation.

Let us see to which norms young and eminent scientists attribute a significantly different importance? In the case of cognitive standards of scientific research, differences are greatest in evaluating the importance of unconditional commitment to the search for truth. Young researchers do not find this as important as their eminent colleagues, who place this value at the top of their most important cognitive convictions. On the other hand, young researchers find the originality of empirical evidence/data much more important, and also value other kinds of originality (theoretic and methodological) significantly (but not considerably) higher than their older colleagues.

Young researchers care significantly less than their distinguished colleagues about strict scientific standards of applied research and experimental development, general logical rigour and conceptual accuracy, but they find research replicability more important. They attribute significantly less importance to accuracy and precision of writing style, and also to the accessibility of research and data to scientific public scrutiny.

Although these two groups of researchers differ greatly in scientific distinction and achievements, which may lead to different criteria, it is difficult to avoid concluding that the young generation nevertheless attributes less importance to cognitive norms linked with basic research (search for truth, conceptual precision, logical rigour, clarity and precision of style, public scrutiny). On the other hand, young researchers place more emphasis on cognitive standards that may be more closely connected with applied research, such as original empirical material and research replicability. These differences in cognitive convictions could be qualified as changes typical for the manner of Mode 2 knowledge production, where the participation of basic research is considered decreasing.

However, contrary to this conclusion are the results showing that there is no significant difference in the structure of research in which eminent and young scientists are predominantly engaged. Both groups are engaged on more or less the same level in basic research (about 1/3 of the respondents) and applied and mixed types of research (also 1/3 respondents). Furthermore, some empirical studies indicate that the concept of basic research is itself flexible, so scientists tailor their research to make it appear more applicable (Calvert, 2000). It therefore seems that the reasons for generation-induced differences in cognitive convictions should be sought in the social organisation of science, especially in priorities of scientific policy that favourises applied research.

The greatest differences in assessing the importance of social norms appear in attitudes to scientists' ethical neutrality. The young, in a significantly greater degree, consider it important to consistently avoid any evaluation of the human and social desirability of research results. At the same time they find independence of cognitive options (accepting theories, methodological criteria and non/publication of papers) from their social and political implications less important. This contradiction, and the misbalance between the highly ranked values of social responsibility and ethical neutrality of scientists, was found among eminent respondents too, but this need not necessarily be confusing. Most of them accept social responsibility in principle, but at the same time guard the traditional views about the importance of ethical neutrality. This mixture of different, sometimes even contrary values, emerges out of real-life conditions. In the case of young scientists the inconsistency is greater, which is both socially and psychologically convincing.

The other social norms to which eminent and young researchers attribute a significantly different importance may indicate the different professional position and obligations of the two groups. The young will therefore probably rank incentives for gifted students lower. At the same time, they also rank lower some standards of collegial relations, such as careful use of colleagues' work or assigning authorship corresponding to scientific contribution. They also consider less important autonomy from those who commissioned research. These are, in fact, relations on which they have less influence because of their low/lower professional status. The above social norms correspond with traditional academic values of collegiality, communality and autonomy, and may in truth be less important for new generations of scientists.

The young accord greater importance to open exchange of information about research and maximum professional services to clients. The latter corresponds with the growing importance of contract research. The greater inclination of the young to open collegial communication, and thus their smaller inclination to secrecy, seemingly fits into traditional academic values better than into new research ethics. It may emerge from young researchers' subordinate professional position and their need to enter the collegial network, which is extremely important in current knowledge production.

To conclude. Although the ethical code of distinguished and young researchers has the common core of the same professional values, the differences we found suggest that a significant change has taken place in cognitive and social standards between older and younger generations of scientists. The results do not allow us to speak about the emergence of new research ethics contrary to the previous academic ethics, but nevertheless we notice a decreased importance of the cognitive norms of classical fundamental research with an increased importance of the norms of applied and developmental research. In the case of social norms the importance attributed to traditional academic values is also decreasing, with the concurrent growth in the importance of professionalism and establishing research networks. Younger research generations also find social sensitivity indisputable, but they are still under the (even greater) influence of the traditional value of ethical neutrality.

RESEARCH PRACTICE PERCEPTIONS AND GENERATIONAL DIFFERENCES

The question about the practical enactment of norms differed in the two surveys because the eminent scientists estimated it for their entire scientific field, while the young scientists estimated it for their research institution only, so comparison between the groups is not possible. Thus we will analyse only basic results about young respondents' perceptions (see Table A in the supplement). The overall mean for norm enactment is 2.57, much smaller than the respondents' evaluations of norm importance and only slightly greater than the mean on the 1-to-4 scale.

The first conclusion to which these results point is that enactment of professional norms is above average in Croatian scientific institutions, that researchers, according to the perceptions of young scientists, follow them in quite a high degree. Most respondents estimate that most cognitive and social standards of the scientific profession are realised mostly or in a high degree in everyday life. At the same time great differences appear in respect to practising particular norms. With the exception of norms concerning respondents and/or patients, with which most scientists do not work in any case, there is below average adherence to some traditional cognitive and social standards. This refers to constant scrutiny of statements and data, unconditional scientific commitment to searching for the truth, and the public nature of scientific research. The same is true of some communality norms – open collegial exchange of research information and helping colleagues, especially younger – and of some aspects of the relations with students, such as the prohibition of exploiting (the work) of students and encouraging gifted students.

Therefore, despite the importance (both eminent and young) scientists give to professional norms, the latter do not idealise everyday professional practice in research and development. Although only a minority of respondents perceives that researchers do not follow these standards, a much larger number reports that in their organisations professional standards are followed only to a degree. Some norms connected with mertonian "communism" and organised scepticism are realised least in scientists' professional practice. Consensus about the common normative core of scientific professional ethics is much higher than about the harmony between values/norms and researchers' professional practice. The Acadia study (Anderson, 2000) reached a similar finding and conclusion.

Two methodological remarks concerning the following analysis of professional (mal)practice in science are important. On the one hand, the required respondents' personal observation of ethically problematic and unacceptable conduct in their scientific institutions excluded all cases based on second-hand information. On the other hand, a serious methodological limitation is data overlapping, i.e. reports on the same cases of professional misbehaviour (respondents from the same scientific institution). Therefore, it is not possible to estimate either the number of ethical incidents or the number of wrongdoers during the examined period. Bearing in mind these remarks, let us examine the incidence of different types of ethically questionable and unacceptable conduct according to the perceptions of eminent and young scientists'.

A glance at Table 2, which contains rank-ordered means of the respondents' ratings on every scale and t-tests results, shows that both eminent and young scientists ranked relatively low, under the average of the 1-to-4 scale, the incidence of all ethically unacceptable and questionable conduct of colleagues in their institutions. The ratings of eminent and young researchers give almost identical overall means: 1.84 and 1.82 respectively. This implies that, on the average, respondents met deviant conduct among their colleagues relatively rarely.

It can in general be said that both groups of respondents perceived (somewhat) more frequently (M>2) conduct about whose harm or irregularity the scientific community does not always agree. Deviations from cognitive norms are considered questionable research practices which may harm scientific knowledge, but there is usually neither agreement about the seriousness of such conduct nor consensus about standards in these matters (Swazey et al., 1993). Both the eminent and the young most frequently encountered adjustments of result interpretation to the dominant theoretical model or school of thought in their scientific field. This is not a question of the well-known impact of theoretical expectations on selective attention and perceptual distortion (Mahoney, 1979), but of a certain intellectual conformism. The decisive importance of result publication can encourage researchers' conformity with the theoretical orientation of editorial boards or of reviewers of (leading) scientific journals.

Other questionable research practices rated as relatively (more) frequent in both surveys are:

- Rigidity or persistent commitment to one's own theoretical, hypothetical model, even when it is not empirically confirmed. The result is congruent with the findings of other researchers, showing that theoretical dogmatism is not rare among scientists (Mittrof, 1974; Mahoney, 1979).
- Expedient reasoning – adjusting or selecting arguments logically congruent with a thesis or a theory, a not unknown aspect of research practice (Mahoney, 1979).
- Secrecy – denying access to information on the course and the results of research before publication. This is compatible with Hagstrom's (1974) classical findings and with more recent studies (Eastwood et al., 1996).
- Uncritical use of other scientists' data and/or interpretation – this finding is somewhat comparable with Acadia study which shows overlooking sloppy use of data or interpretations by others (Swazey et al., 1993).
- Empiricism or insufficient theoretical foundation of empirical research.

Significant differences in the incidence of these problematic practices appear in the case of secrecy, which eminent scientists report more often than young. They also more frequently observe uncritical use of the findings of others. Similar differences appear in the perception of other problematic research practices, which is probably connected with the different personal insight and level of informedness of those at the top and those at the bottom of the professional pyramid. Thus eminent scientists significantly more often notice adapting the interpretation of research results to dominant political,

Table 2

Eminent and young scientists' perceptions of incidence of ethically questionable or unacceptable conduct in Croatian scientific institutions (rank-ordered means and t-tests results)

Types of questionable research practice and research misconduct	Eminent scientists		Young researchers		t-test for equality of means		
	Mean	Rank	Mean	Rank	t	df	Sig.
Adjusting interpretation of the findings to dominant theoretical model or school	2.38	1	2.30	1	1.622	1.158.000	0.105
Secrecy – denying access to information on research (results) before publication	2.28	2	2.09	7	3.341	651.545	0.001
Rigidity – commitment to one's theoretical model, even when it is not confirmed	2.26	3	2.25	3	0.129	1.158.000	0.897
Expedient reasoning – selecting arguments logically congruent with a thesis or theory	2.23	4	2.18	5	1.078	1.158.000	0.281
Consistent ethical neutrality – full distancing from every social responsibility	2.21	5	1.85	13	6.717	1.158.000	0.000
Uncritical use of other scientists' data	2.18	6-7	2.06	9	2.453	1.158.000	0.014
Insufficient theoretical foundation of empirical research	2.18	6-7	2.08	8	1.950	1.158.000	0.051
Undeserved assignment of authorship	2.16	8	2.26	2	1.840	645.067	0.066
Adjusting the interpretation of results to mainstream politics, ideology, religion, world-view	1.99	9	1.73	17	4.304	1.158.000	0.000
Exploitation of the work of subordinate associates	1.93	10	2.21	4	5.293	731.545	0.000
Failing to present findings contradictory to the author's research	1.91	11-12	1.86	12	1.199	664.481	0.231
The impact of social benefit criteria on cognitive options	1.91	11-12	1.60	21	6.614	619.109	0.000
Failing to publish procedures essential for replicating and verifying the research	1.91*	13	1.92	11	0.294	641.196	0.769
Evaluating scientific findings under the influence of their authors´ nonscientific characteristics	1.84	14	1.61	20	4.294	1.158.000	0.000
Plagiarism	1.83	15-16	1.81	15	0.352	636.334	0.725
Neglecting scientific criteria in applied research and experimental development	1.83	15-16	1.77	16	1.248	644.460	0.213
Adjusting research criteria and results to the expectations of funders/clients	1.76	17	1.72	18	0.840	1.158.000	0.401
Subordinating educational needs of students to one's personal scientific interests	1.75	18	2.02	10	5.049	1.158.000	0.000
Collaboration with colleagues dependent on their nonscientific characteristics	1.73	19	2.12	6	6.924	719.262	0.000
Forging or polishing of data and/or results	1.62	20	1.83	14	4.444	1.158.000	0.000
Insufficient care for the protection of environment, for (experimental) animals	1.60	21	1.52	22	1.650	1.158.000	0.099
Fabricating data and/or results	1.49	22	1.61	19	2.619	1.158.000	0.009
Discriminating students on the basis of their gender, nationality, political affiliation, world-view or religion	1.34	23	1.36	23	0.531	1.158.000	0.595
Executing research without voluntary consent of respondents/patients	1.29	24	1.26	24	1.007	1.158.000	0.314
Violating anonymity of respondents/patients and misusing data for nonscientific purposes	1.21	25	1.15	25	2.041	562.729	0.042
Jeopardising the psychophysical integrity of respondents/patients	1.14	26	1.12	26	0.559	1.158.000	0.576

* Different ranks have been retained when the values of the means rounded to three decimals (here for the sake of comparison rounded to two) were originally different.

ideological, religious or world-view currents. They more often register the influence of social benefit criteria on cognitive options (on accepting theories, methodological criteria and non/publication of papers), and evaluating scientific contributions under the influence of their authors' gender, ethnicity, political affiliation, religion or world-view.

Except for consistent ethical neutrality, which the eminent notice more often in the behaviour of their colleagues, young scientists report more often on conduct differing from the social norms of the scientific profession. They report on conduct that those at the bottom of the professional hierarchy might sooner experience, in the first place cooperation with colleagues depending on their ascriptive features (gender, ethnicity, political affiliation, religion or world-view), exploiting (the work of) subordinated associates, and subjecting students' educational needs to one's own scientific interests.

According to both studies, there is least unethical conduct in researchers' relations with respondents and/or patients. A great majority of respondents have never noticed jeopardising the integrity and the rights of these participants in scientific research in their institutions. What is more, data generally show fewer incidents of jeopardising or damaging the rights of non-scientists participating in scientific and teaching processes. Most respondents report that student discrimination on the basis of gender, ethnicity, world-view, political affiliation and religion never occurred in their scientific institutions.

Finally, let us look at behaviour usually classified as misconduct, i.e. the ethically unacceptable behaviour of scientists. This is plagiarism, fabrication and forgery. Whereas only 8% of American university faculty knew colleagues who plagiarised (Swazey et al., 1993), as many as 15.7% of our eminent respondents and 18.3% of the young rank plagiarism as (very) frequent. The differences are very great but can mostly be ascribed to more frequent data overlapping in the smaller research community and to a much broader definition of plagiarism in our research, which includes stealing (individual) ideas, methods and techniques, data, texts, reports.

There are also considerable comparative differences between the Acadia and our studies in regard to forgery. In the former, the authors reported that 6% of faculty knew colleagues who forged or "cooked" research data (Swazey et al., 1993), but in another American investigation postdoctoral research fellows reported greater proportions of forgery (Eastwood et al., 1996). Our results show that 8.4% of the eminent and almost twice as many of the young (15.8%) stated that forgery was (very) frequent in Croatian scientific institutions.

Finally, fabrication or invention of data/results is the rarest of these three types of scientific misconduct, since 5.0% of the eminent and 8.4% of the young report that it is (very) frequent. Although fabrication does not appear in alarming proportions in R&D, even the smallest proportion is always very serious and intolerable.

In conclusion, the findings about implementing cognitive and social norms in the scientific profession are as expected. Everyday scientific practice does not adhere to professional standards impeccably, but researchers nevertheless follow them to a considerable degree. Data about the incidence of ethically questionable and unacceptable behaviour in the experience of eminent and young researchers supplements this picture. In everyday scientific professional life questionable research practices, even marring collegial relations, are met more often than infringing social norms that jeopardise or threaten participants in and users of scientists' professional work. Eminent and young respondents differ in perceiving the incidence of certain kinds of questionable behaviour, which may be attributed to their different professional position and experience, and their insight into the professional practice of scientific institutions.

CONCLUSIONS

Our findings indicate that it is empirically corroborated and theoretically meaningful to observe scientists' professional ethics on both levels – normative and behavioural, and in both dimensions – cognitive and social.

As a set of professional values and norms, science ethics includes a core of cognitive and social standards about which there is relatively high consensus in the research population. Cognitive standards correspond to epistemological realism with an accent on objective, reliable, measurable and precise new knowledge. This finding is not only consistent with the assumptions of science philosophers, but also with the findings of other empirical studies of normative orientations or the criteria for judging scientific quality. The fundamental social values of the scientific profession include the broadest social responsibility, responsibility towards colleagues and students, and professionalism in relation with funders and/or clients. In social dimension, most rarely investigated and least well known, researchers' professional values are more similar to what is called new research ethics than to the traditional academic, socially isolated, value matrix.

Thus it is difficult to avoid the generalisation that research ethos rests on a set of common, cognitive and social standards that distinguish the scientific profession from other forms of intellectual production. It is a combination of traditional cognitive norms and new socially-engaged values.

However, research ethics is not a static or homogeneous set of professional values and norms about which researchers are in absolute consensus. Generational differences also play a part. Young scientists value cognitive norms relating to basic research lower, but rank some cognitive standards more closely linked with applied empirical research higher. Considering the social dimensions of research ethics, young researchers rate traditional academic values of collegiality, communality and autonomy less important than do eminent scientists, but they hold professionalism and establishing research networks more important.

As expected, cognitive and social values and norms are not strictly followed on the behavioural level, on the level of professional practice. Young researchers perceive that the practical application of these professional standards in Croatian research institutions is not ideal, but nor is it dissatisfactory because both norms are relatively highly respected.

In their everyday professional life eminent and young researchers experience particular questionable research practices that could harm research work and results, and impair collegial relations in science, more often than they encounter breaking social norms that harm or even threaten participants in and users of scientific professional work. Graver forms of scientific misconduct are not very widespread but are not insignificant, as claimed in classical sociological studies of scientific ethos.

In short, researchers' cognitive and social values and norms are important professional benchmarks in the scientific profession, not only a façade turned to the public, but they are by no means omnipotent regulators of everyday behaviour and professional practice in research and development.

FOOTNOTE

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APPENDIX

Table A

Young researchers' perceptions of the enactment of norms in their institutions (rank-ordered means and the structure of answers in %)

Professional values/norms	Mean	SD	Enactment of professional norms			
			Mostly not enacted	Enacted to some extent	Mostly enacted	Enacted to a great extent
Originality of empirical evidence (data)	2.83	0.86	7.5	24.8	45.5	22.3
Maximal professional service to funders and/or clients	2.81	0.93	11.2	20.5	44.2	24.2
Conceptual accuracy	2.78	0.85	6.3	30.0	42.6	21.1
Developing knowledge for the benefit of man and society	2.78	0.89	8.6	27.5	41.8	22.1
Replicability of research	2.73	0.88	9.5	27.7	43.2	19.5
Responsibility for the effects of one's research results	2.72	0.89	9.6	28.0	42.9	19.5
Support for the institution's excellence	2.71	0.91	9.8	30.6	38.2	21.4
Receptivity to all relevant data	2.69	0.81	6.9	32.4	45.7	15.0
Strict scientific standards of applied and developmental research	2.69	0.88	11.0	26.3	45.8	16.9
Full autonomy in relation to funders/clients	2.67	0.89	11.7	26.4	45.4	16.5
Precision of scientific measuring	2.67	0.90	11.3	28.2	42.6	17.9
Methodological originality	2.62	0.85	10.1	32.4	43.1	14.4
Avoiding quick generalisations	2.62	0.88	10.4	33.6	39.6	16.4
spnumAccuracy and clarity of writing style	2.61	0.84	8.9	35.6	40.8	14.6
Scientific training and fair evaluation of students	2.61	0.87	11.0	32.5	41.2	15.4
Careful use of one's colleagues' results	2.61	0.89	11.9	31.2	41.0	16.0
Theoretical originality	2.59	0.86	9.9	36.2	38.8	15.1
Non-subjectivity in reporting one's results	2.57	0.85	10.4	35.5	41.0	13.2
Non-subjective evaluation of scientific ideas and contributions	2.56	0.85	11.4	33.6	42.6	12.4
Incorporating new results into knowledge	2.56	0.89	12.5	33.9	38.8	14.8
Ethical neutrality – avoiding to evaluate social desirability of scientific results	2.55	0.89	14.3	29.5	43.5	12.7
General logical rigour	2.54	0.84	11.4	35.0	42.0	11.5
Anonymity of respondents/patients	2.53	1.16	29.6	12.4	33.3	24.6
Deserved authorship assignment	2.51	0.86	13.1	34.0	41.5	11.3
Independence of cognitive options from their social and political implications	2.51	0.89	14.9	32.0	40.7	12.4
Protection of psycho-physical integrity of respondents and/or patients	2.50	1.15	30.5	12.7	33.6	23.2
Constant scrutiny of statements and data	2.46	0.87	14.0	37.4	37.5	11.1
Commitment to searching for the truth	2.46	0.89	15.1	36.2	36.4	12.3
Non-exploiting the (work of) students	2.43	0.91	17.3	34.2	36.4	12.1
Voluntary participation of respondents and/or patients in research	2.36	1.09	30.8	19.3	32.9	17.0
Collegial support	2.35	0.90	17.7	40.6	30.5	11.2
Encouraging talented students	2.35	0.92	19.3	37.4	32.0	11.3
Open collegial data exchange	2.31	0.94	21.8	37.4	29.0	11.8
Accessibility of research and data to scientific public scrutiny	2.23	0.92	24.4	37.3	29.3	9.0

Matko MEŠTROVIĆ

Senior Research Fellow
Institute of Economics, Trg J. F. Kennedy 7, 10000 Zagreb, Croatia
Phone: +385 1 2335-700, Fax: +385 1 2335-165
E-mail: mmestrovic@eizg.hr

INTANGIBLES' VALUE – A CHALLENGE TO POLITICAL ECONOMY OF INFORMATION

INTRODUCTORY REMARKS

How should we conceive the new role of universities in the knowledge-based economy? Or what are the new types of technological transfer from the university to the economy? – these are relevant questions, there is no doubt! But, has it ever been possible to speak of such a straight exchange – between university and economy? And what was exchanged – money for knowledge?

I am aware that the intentions of the Conference organisers are contrary to any such kind of simplification, but a blunt simplification is already being imposed by this notorious appelation of a supposedly new society and its economy that would be based on certain knowledge. Freeman and Louçã (2001) remind us of the fact that every human economy has been a "knowledge economy" and not only the contemporary one. What have been changing are the ways of learning and accumulating knowledge and passing it on, interacting with changing ways of organising production, and of regulating economic activities and social behaviour.

Still more profound is a warning that comes from Jacques Derrida (2001): "Something serious is happening or is about to happen to what we call 'work', 'tele-work', virtual work and to what we call 'world' – and therefore to the being-in-the-world of what is still called man". And more precisely: "... this capitalistic situation (there where capital plays an essential role between the actual and virtual) is more tragic in absolute figures that it has ever been in the history of humanity".

THE UNDERSTANDING OF HISTORICAL DYNAMICS

The link between the facts and the induced theory has never been established in a systematic and rigorous way for a time span from the first industrial revolution to the so-called "new economy". It seems that Freeman and Louçã's book *As Time Goes By: From the Industrial Revolu-*

tion to the Information Revolution fills that gap. There is an evident ambition of the authors to discuss the nature of the dynamics of the economic system, the different modes of capital accumulation and technology, culture, and the modes of social control prevailing in each epoch. Following Richard Nelson's insight that the theoretical quest is for an understanding of the dynamic process behind the observed change, and that evolutionary theory is based on the concepts of selection and creation of variety, they believe that evolutionary economics is consequently about choice and social responsibility.

The concept of time as an arrow is a recent one in the history of civilisations, associated with the idea of destiny. Contrary to that, evolution is understood as an open process, evolution evolves but accepts no destiny. Nevertheless, the authors argue that the evolution of societies and economics has recognisable patterns. These patterns are discernible as the relation between technological innovation, social structure, economic development, institutional framework, and cultural standards. Economics was originally, and must continue to be, an historical science. A inquiry into economic fluctuations and structural change must be immersed in time.

The social subsystems (science, technology, economy, politics, culture) generate a large number of irregular fluctuations, caused either by specific subsystem cycles (political and business cycles, technological trajectories, cultural movements, etc) or by lags and feedback in the inter-system connections. Given that each subsystem is defined as the heuristics for some social relation, their interrelations cannot be deterministically discriminated by an exhaustive account of a simple model. The variable most relevant to the understanding of historical dynamics is the co-ordination process itself, articulated by its power under all its forms, from the production of legitimacy to strict coercion.

INFORMAL CONSTRAINTS

Insights from technology studies and studies of history of technology highlights the contingent nature of many technological innovations, and the important role played by the "social" and institutions (Soete and Dolfsma, 2003). Integrating institutions into economic theory and economic history is an essential step in improving that theory and history. But there as yet has been no analytical framework to integrate institutional analysis into economics and economic history (North, 1990:3). Together with the technology employed, institutions determine the transaction and transformation, but technology, at least in the neo-classical framework, was always an exogenous factor and thus never really fit into the theory. The problem of human co-operation, North considers, is the theoretical foundation of the underlying role of institutions.

Institutions exist to reduce uncertainties that arise from incomplete information with respect to the behaviour of other individuals in the process of human interaction. The consequent institutional framework, by structuring human interaction, limits the choice set of the actors. We should take explicit account also of the way institutions alter the price paid for one's convictions and hence play a critical role in the extent to which non-wealth-maximising motivations influence choices, North suggests.

Without institutional constraints, self-interested behaviour will foreclose complex exchange, because of the uncertainty that the other party will find it in his or her interest to live up to the agreement. The third-party enforcement has been the critical underpinning of successful modern economies involved in the complex contracting. A coercive third party is essential. One cannot have the productivity of a modern high income society with political anarchy.

The formal rules, in even the most developed economy, make up a small part of the sum of constraints that shape choices. In our daily interaction with others, the governing structure is overwhelmingly defined by informal constraints: by codes of conduct, norms of behaviour, and conventions. They come from socially transmitted information and are part of the heritage that we call culture. The informal constraints that are culturally derived will not change immediately in reaction to changes in formal rules.

Neo-classical theory is concerned with the allocation of resources at a moment of time, a devastatingly limiting feature to historians whose central question is to account for change over time, North underlines.

COMMODIFICATION

Informational capitalism (Castells, 1996) had very different manifestations in areas and different societies around the world. It proceeded on the basis of the political defeat of organised labour and the acceptance of a common economic discipline inscribed in the integration of global financial market, equalising basic economic parameters. The new information technology is being used to homogenise conditions of global capital accumulation around the world. A theory of the informational society, as distinct from a global/informational economy, will always have to be attentive to historical/cultural specificity as much as to structural similarities related to a shared techno-economic paradigm, Castells warns.

As against the postindustrialists' assertion that the value of information derives from its inherent attributes as a resource, Dan Schiller (1988) counters that its value stems uniquely from its transformation into a commodity. As a resource information has been socially re-valued and redefined through progressive historical application of wage labour and the market to its production and exchange.

Coming to a deeper understanding of that perspective requires that one approach the political economy of communication with the self-consciousness and self-reflexiveness necessary to take stock of its fundamental epistemological and conceptual foundations, as Vincent Mosco (1996) has done. His reading of epistemology broadens the knowledge process from simple determination to multiple, dynamic interactions among elements that are themselves in the process of formation and definition. Guided by the insight that structures and institutions are in the process of constant change, Mosco developed a substantive map of political economy with three entry processes: from the process of transforming use to exchange value (*commodification*), to the process of transformation of space with time, or the process of institutional extension (*spatialization*), and finally to the process of constituting structures with social agency (*structuration*).

As a term, commodification is implicit in discussions of the process of capitalist expansion, ranging widely to include the global extension of the market, privatisation of public space, and the growth of exchange value in interpersonal life.

The expansion of capitalist power over the last five hundred years has been associated not just with inter-state competition for mobile capital but also with the formation of political structures endowed with ever more extensive and complex organisational capabilities to control the social and political environment of capital accumulation on a world scale (Arrighi, 1994:14).

A COLLECTIVE INTELLECT

Investigating the history of the Internet, Castells (2001) found out that it did not originate in the business world.

The Internet was too daring a project, too expensive and risky to be assumed by profit-oriented organisations. The Internet developed in a secure environment, provided by public resources and mission oriented research. The meritocratic gentry met the utopian counterculture in this invention. Only a network of thousands of brains working co-operatively, with a spontaneous division of labour, and loose, but effective co-ordination, could accomplish the extraordinary task of creating an operating system able to handle the complexity of increasingly powerful computers interacting via the Internet.

The Internet transformed business as much as business transformed the Internet.

The realisation of the potential of transforming mind power into money-making became the cornerstone of the entrepreneurial culture. Ideas were sold to venture capitalists, and these ideas embodied as companies were sold to investors via public offerings on the stock market. The only way for entrepreneurs to be freed from capital is to be able to attract capital by themselves and to control a large enough share of the future wealth that would come from investors. This is why stock options are the fundamental mechanism connecting individual freedom to entrepreneurship.

The fate of the company is dependent on its ability to attract investors in the financial market. Their valuation is a function of technological innovation, business innovation, and image-making in the financial world. The ability of capital to flow in and out of securities and currencies across markets is technologically powered by a network of computer networks that ensures the capacity to trade and decide globally in real time.

The electronic trading reduces transaction costs at least by 50 percent, thus attracting more investors, and generating more transactions. The investment is led by the growth of stocks values, not by earnings and profits. Empirical evidence shows that the stock market valuation of firms has increasingly diverged from their measured book value. Intangibles count: once the market decided that the Internet was the technology of the future, any stock related to the Internet had an instant premium. Financial markets have become a sort of automaton, with sudden movements that do not follow a strict economic logic, but a logic of chaotic complexity: the interaction of millions of decisions reacting in real time, in a global span, to information turbulences from various origins.

If labour is the source of productivity, the creative power of labour and the efficiency of business organisation ultimately depend on innovation. Innovation is a function of highly skilled labour, and of the existence of knowledge-creation organisations. Castells emphasises the essential role of co-operation and open access to information in the process of innovation, facilitated by on-line interaction.

A product of superior quality is generated by the collective effort of a network, an effort in which each participant finds a reward from the freely contributed efforts of others. So, innovation is still the product of intelligent labour, but of a collective intellect. Co-operation in innovation, and competition in applications and services, seem to be the division of labour in the new economy.

CORPORATE POWER

The dramatic rise in the banking business around the world was an essential economic foundation of the cyber-financial order (McMahon, 2002). At its centre was the transformation of money into electronic signals. Not only did the new technology enable the big financial institutions to operate more flexibly, it changed the very character of money. "Telematic reorganisation" of business corporations revolved around the restructuring of the corporation as a cyber-financial control structure which increasingly processed information instead of materials. The technological development which enabled efficient electronic data communication within and between corporations – electronic data interchange (EDI) – acted to remove human elements and to integrate outside entities into the internal hierarchical structure of the dominant partner.

The rise of the cyber-financial order had basic implications not only for the development of the world economy, but also in relation to the fundamental issues of systemic governance of a global society. One could see, McMahon suggests, the clear structural tensions between the tendencially globally systematised finance markets and the state-managed productivist policies of developed states, and the overall growth of deflationary monetary policies. Finance markets were so much greater than national financial resources, traditional national economic policy options were being closed down by finance market power, and nation states were increasingly dependent on financial markets for their own funding needs.

The free and open Internet is running out of time. We are reaping the worst of both worlds, networked chaos and monopolistic consolidation. In other words, we are screwed. To Rosenberg's pessimistic conclusion, Lovink (2002) responds: The presumption of the "we" as consumers is itself a setback and points at the fading awareness that only user empowerment, not consumer behaviour, can make a difference. Internet advocacy groups are still mainly focused on issues related to government regulation, with the blind spot for corporate power.

A polarisation is becoming visible between those sticking to the outworn New Economy tales of "good capitalism" and others, questioning the free market a priori. The critique of globalisation is not a backlash movement, as conservatives suggest. The movements active under the "Seattle" umbrella all offer a clear blueprint for global justice and economic democracy. Opposite to the branch model there are active translocal exchanges between a "multitude" of nodes.

The new economy is a mix of neo-liberal state policies and entrepreneurial myths. Its rhetoric of how to achieve a high-productivity and low-inflation economy never mentioned the notion of "the public". At the end of the story, the new economy can be characterised as a process of transforming and adapting the old economy to information technology in all layers of capitalist production, distribution and services, including the communication patterns on the user-turned-consumer. Fights over patents and intellectual property have destroyed the innovative culture of the early 1990s. But the conflict between utopia and negativism cannot and should not be solved, Lovink suggests invoking Hannah Arendt's reading of Plato's *Republic*. The (self) containment of cyberspace should be rooted as a call for responsibility, not in a passive delegation of power to the state or the market.

We are challenging the internationalisation of a single economic model: neo-liberalism, Naomi Klein (2002) declares. What we are calling "globalisation" must be recast not just as an inevitable stage in human evolution but as a profoundly political process: a set of deliberate, debatable and reversible choices about how to globalise.

It is time to stop conflating the basic principles of internationalisation and interconnectedness with this particular economic model that has a tendency to treat trade not as one part of internationalism but the overarching infrastructure of it. It gradually swallows everything else – culture, human rights, the environment, democracy itself – inside the perimeters of trade. We are discussing the effects of this profound corporatization around the world; the ways in which "the commons" is being transformed and rearranged – cut back, privatised, deregulated – all in the name of participating and competing in the global trading system.

CHANGING EPISTEMOLOGY

The realm of the postmodern denotes rampant commodification, unchecked by oppositional forces that find themselves subverted or even co-opted by the very power and allure of the market (Cullenberg et al., 2001). And this world structured according to the object-life of the commodity has been thought to have received an enormous recent boost by the emergence of new information technologies.

According to this view, computers have made commodity time and space ultimately traversable in ways unthinkable for the past generations of producers and consumers. This obliteration of previous constraints of time and geographical location in buying and selling reconstruct all notions and experiences pertaining to community and nation.

If the postmodern age is one in which culture is merely an accompaniment to capitalist economic expansion, then it is a legitimate question whether it is at all possible under the circumstances to think about such issues as value and exchange in any register "outside" the regime of the commodity as "the general equivalent" Cullenberg and co-authors point out.

Self-reflexivity, they argue may be something other than subjective self-awareness; it is more concerned with the argument that all things, from politics to philosophy, are intimately bound up with the situatedness of those engaged in these activities. Identifying the locations from which people speak, write, and act matters for the kinds of meanings and values that can be produced. "All knowledge, a fortiori economic knowledge, is local and contingent and connected to a community in which that knowledge was produced or interpreted or otherwise made significant", E. Roy Weintraub (1992) is quoted. Postmodernists often claim that knowledge in classical epistemology is built upon a misspecification of the nature of the subject and ignores the impossibility of ever pulling apart the knower from the known. Subjects are active in the construction of truth, and their very observations and perceptions structure those truths irresistibly.

The imbrication of power and knowledge was the focus of much of Foucault's work, Cullenberg and colleagues remark. Postmodern critics have taken from him the view that there is nothing much to be ashamed of in the recognition that there are "wills" and "desires" to knowledge that have as much to do with power as they do with anything else. The power can be contended over; it can be an object of struggle over who gets to speak and produce authoritative knowledge and who does not.

Scientific knowledge, as Wade Hands (2002) clarifies, is not one thing, and human interests something else. Knowledge and interests are deeply intertwined; "interests" are not separated from "knowledge-producing interests". The relationship between political economy and epistemology is a much more complex relationship than once thought. Throughout economic activity, John Dunning (2002) observes, *created intangible assets* are replacing natural or created tangible assets as the main source of wealth augmentation in industrial society. The trend towards *the cross-border augmentation of assets* is an important instrument for increasing economic well-being. In evaluating the economic prosperity of societies, scholars need to give more attention to the dynamics of asset-seeking FDI and to the contemporary spatial distribution of economic activity.

"INTELLECTUAL CAPITALISM"?

Tom Karp (2003) uses this strange appellation reminding us that the capitalism of today needs to mature as a system before intellectual capital will be more measurable and more manageable. The most important challenge for intellectual capitalism is to develop the necessary organisational platform of social capital, on which intellectual capital can grow. But, is it just the question of an organisational culture, as Karp seems to believe?

The last decade has seen an explosion of a literature on the nature and significance of knowledge capital and its competitive enhancing qualities for both firms and countries. And also, of the appropriate organisational modalities for its creation, sustenance, exploitation and diffusion. But, as Dunning (2003) remarks, only scant attention has been paid to what he terms relational assets (R-assets) as they affect the success or failure of infra- or extra-firm association. They are different from other assets in a number of ways, but their essential uniqueness lies in the fact they can be productively employed if they are used jointly with the R-assets of another economic actor. They cannot be owned; only accessed and then controlled or influenced in the way in which they are deployed. Therefor, their content and effectiveness is likely to vary according to culture, values and ideologies.

The term "social capital" has a variety of meanings. According to Dunning, a definition more directly related to R-assets is "the accumulated societal fund of economic relationships, which are embodied or reposited in both individuals, organisations, and networks of organisations, engaging in economic activities". The extent and content of a community's social relational capital affects the capacity of particular firms to generate and deploy their own R-assets. It can be a major influence on the kind and purpose of relationships, their form and their location – both between and across national borders.

In the context of their exploration of the role of social capital in the creation of intellectual capital Nahapiet and Ghoshal (1998) suggest that it is useful to consider three clusters: the structural, the relational, and the cognitive dimensions of resources rooted in relationships. Unlike other forms of capital, social capital is owned jointly by the parties in a relationship making possible the achievement of ends that would be impossible without it.

The term intellectual capital as Nahapiet and Ghoshal understand it refers to the knowledge and knowing capability of a social collectivity. It comprises both socially explicit knowledge and socially tacit knowledge. They argue that all new resources, including knowledge, are created through two generic processes: combination and exchange. The combination and exchange of knowledge are complex social processes and much valuable knowledge is fundamentally socially embedded – in particular situations, in coactivity, and in relationships. Social capital facilitates the development of intellectual capital by affecting the conditions necessary for exchange and combination to occur. It is the coevolution of social and intellectual capital that underpins organisational advantage.

The concept of embedding fundamentally means the binding of social relations in the context of time and space. Social activities are recursive, and for Giddens, quoted by Nahapiet and Ghoshal, this implies a concept of human knowledge ability that underpins all social practice. The reciprocal quality of the relationship between social and intellectual capital seems to be confirmed in the common social embeddedness of their forms. Institutions facilitate some forms of exchange and combination but limit their scope. The creation and maintenance of social capital, particularly its relational and cognitive dimensions, are costly; like all such investments – conscious or unconscious – they require an understanding of the relative costs and benefits likely to be derived there from.

The uncertainty associated with knowledge-related investment, and the need for effective networks which enable knowledge to flow easily, point to the importance of high levels of trust both at organizational levels and in macro-level systems (Trewin, 2002).

Using the notion of social capital indicates a tendency to focus on the connection between economic performance and invisible social "glue" which facilitates coherence and coordination of economic behaviour. The term *systemic competitiveness* (Nielsen, 2003) is used to describe the broader context and the interaction between various elements influencing competitiveness, including social cohesion. The fact that the vast majority of developing countries have failed to find a path of dynamic economic growth needs specific consideration. The reforms are not translated into beneficial societal effects because of missing links in the overall functioning of the economic and social system. The importance of *participatory forms of governance* and efforts to strengthen social integration is now evident.

The lack of organisational and governance capabilities (*meta-level deficiencies*) is the reason for the failure to develop appropriately *interlinked decision-making* at the meso level, which is of special importance in the contemporary context of new production paradigms and globalisation.

Neo-classical economics assumes autonomous, atomistic agents interacting in anonymous market relations. Contrary to this under-socialized view of the individual, the concept of social capital presupposes a culturally and socially embedded individual.

Along that fundamental insight some essential questions remain to be duly considered and researched.

It is necessary to examine which kinds of value system deficiencies at the meta-level hinder the development of interconnected decision-making at the meso-level and how that corresponds to the socio-cultural values of individuals and their own social networking?

By means of which research methods can we identify the patterns of spatial and virtual linking/networking within and between structures that form different national systems of knowledge/innovation and the levels upon which the system of competitiveness depends?

Not less difficult would be a possible effort to monitor the flows and types of exchange (commodified and non-commodified), their degree of intensity and the kinds of imperatives (economic, political, technological, ideational/ideological, moral) upon which they are based.

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ANNEXES

ANNEX 1

Emira BEČIĆ*

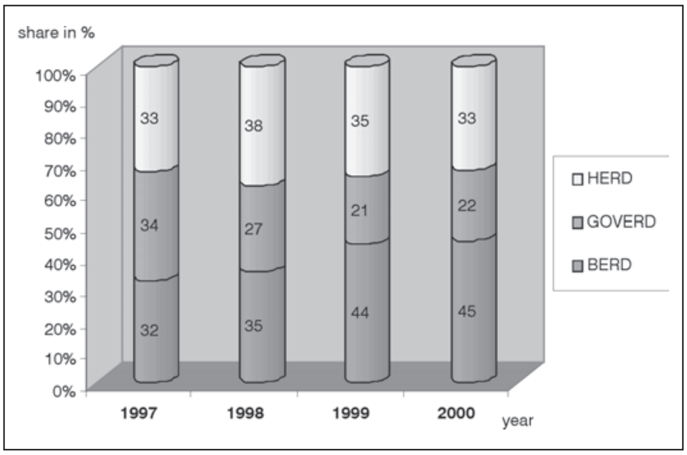
CROATIAN S&T POTENTIALS: SOME COMPARATIVE FACTS AND FIGURES

Table 1
Total expenditure on R&D in Croatia

Expenditure on R&D in Croatia	1997	1998	1999	2000
BERD Expenditure on R&D in the Business Enterprise Sector				
% of GDP	0,25%	0,25%	0,43%	0,54%
GOVERD Government Intramural Expenditure on R&D				
% of GDP	0,26%	0,19%	0,21%	0,26%
HERD Expenditure on R&D in the Higher Education Sector				
% of GDP	0,26%	0,27%	0,34%	0,40%
GERD Gross Domestic Expenditure on R&D				
% of GDP	0,77%	0,71%	0,98%	1,19%
GDP at market prices (current)				
USD mln	20.108,6	21.628,0	20.031,1	19.030,0

Source: Central Bureau of Statistics

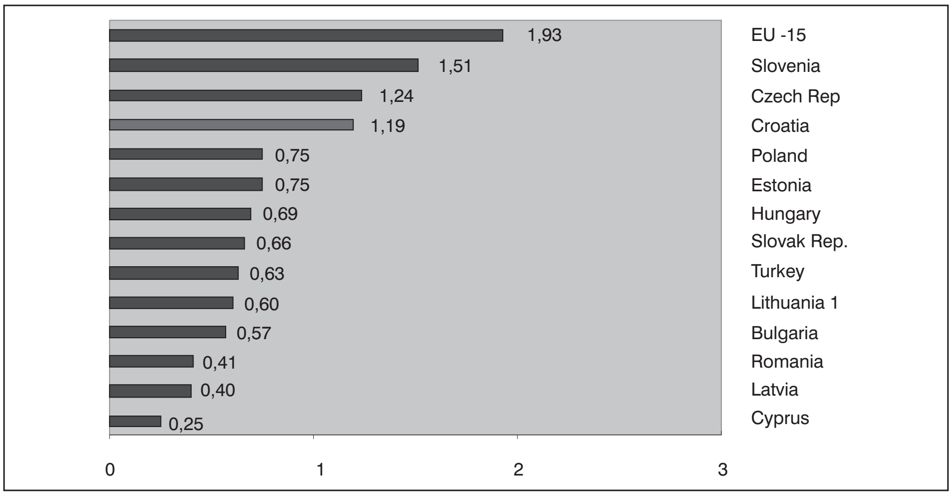
Figure 1
Sectors performing R&D as % of GERD in Croatia



Source: CBS of Croatia

Figure 2

R&D intensity (GERD as % GDP) in Candidate countries – comparing Croatia (1)



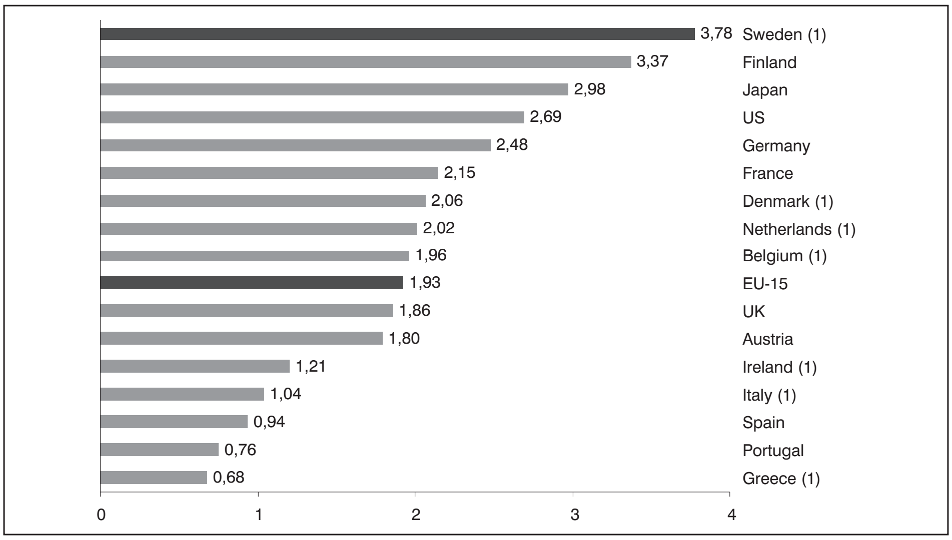
Source: Eurostat

Notes: (1) EU-15: estimate, LT and CRO: 2000

All other countries 1999

Figure 3

R&D intensity (GERD as % GDP) 1999 (1)



Source: Eurostat, OECD

Notes: (1) EL, IRL, I, B, NL, DK, S: 1999

All other countries and EU: 2000

Table 2
Financing R&D in Croatia, by sources and sectors performing R&D

Sources of funds for R&D	Sectors performing R&D			All sectors total GERD
	Business BERD	Government GOVERD	Higher education HERD	
1997 total, HRK 000	**311.182**	**326.218**	**320.951**	**958.351**
Own resources	89,6%	14,6%	20,7%	41,0%
Central and local government	1,6%	71,0%	65,7%	46,7%
Private and public enterprises	6,9%	2,2%	9,6%	6,2%
Other domestic resources	0,8%	1,3%	1,9%	1,3%
Foreign investors	1,1%	10,9%	2,2%	4,8%
1998 total, HRK 000	**343.540**	**260.683**	**376.992**	**981.215**
Own resources	88,1%	13,1%	20,5%	42,2%
Central and local government	0,4%	79,2%	65,0%	46,2%
Private and public enterprises	10,7%	5,2%	13,2%	10,2%
Other domestic resources	0,3%	1,7%	0,3%	0,7%
Foreign investors	0,6%	0,9%	1,1%	0,8%
1999 total, HRK 000	**609.337**	**298.602**	**489.822**	**1.397.761**
Own resources	83,1%	14,6%	20,0%	46,4%
Central and local government	2,4%	80,4%	69,6%	42,6%
Private and public enterprises	11,4%	2,7%	7,7%	8,2%
Other domestic resources	2,5%	1,0%	2,0%	2,0%
Foreign investors	0,6%	1,3%	0,8%	0,8%
2000 total, HRK 000	**847.874**	**405.382**	**628.583**	**1.881.839**
Own resources	72,6%	15,8%	15,2%	41,2%
Central and local government	2,0%	80,0%	77,5%	44,0%
Private and public enterprises	10,7%	2,9%	6,2%	7,5%
Other domestic resources	3,9%	0,9%	0,1%	2,0%
Foreign investors	10,8%	0,4%	1,0%	5,3%

Source: Central Bureau of Statistics

- The business sector financed cca 90% for its R&D activity through its own resources in 1997, and 73% in 2000. The amount of BERD doubled in the same period, with internal business sector financial sources being replaced by financing from other private and public enterprises and by foreign investors.
- The government sector is 80% financed by central and local government funds with a constant source of financing derived from its desire to provide R&D as a social and economic service.
- Higher education R&D is also financed mostly by government (70%)

Table 3

R&D Investment in human resources in S&T in Candidate countries-comparing Croatia, 1999

	R&D personnel FTE per thousand labour force	Total R&D personnel FTE[1]	Researchers by sector			
			Total FTE[1]	Government sector %	**Business sector %**	Higher education sector %
Bulgaria	:	16.087	10.580	66,7	11,8	20,9
Cyprus	:	681	278	29,7	23,1	42,7
Czech Rep.	4,7[3]	24.106	13.535	31,6	42,9	25,0
Estonia	:	4.545	3.002	20,7	12,6	66,3
Hungary	5,7	21.329	12.579	36,2	25,9	37,9
Latvia	:	4.301	2.626	28,6	7,3	64,1
Lithuania	:	11.791	7.777	32,9	3,7	63,4
Poland	3,3[3]	82.368	56.433	19,2	18,3	62,5
Romania	2,9[3]	44.091	23.473	24,3	65,8	9,9
Slovak Rep.	5,8[3]	14.849	9.204	26,4	27,4	46,2
Slovenia	8,9[3]	8.495	4.427	34,1	34,8	29,5
Turkey	1,0	24.267	20.065	10,9	16,2	72,9
EU-15[2]	**9,9**	**1.689.490**	**919.796**	**14,2**	**50,0**	**34,3**
Croatia[3]	**3,2**	**8.827**	**5.523**	**30,3**	**17,3**	**52,4**

Source: Eurostat, OECD MSTI (5) CBS of Croatia

Note: 1) All values for Lithuania from year 2000

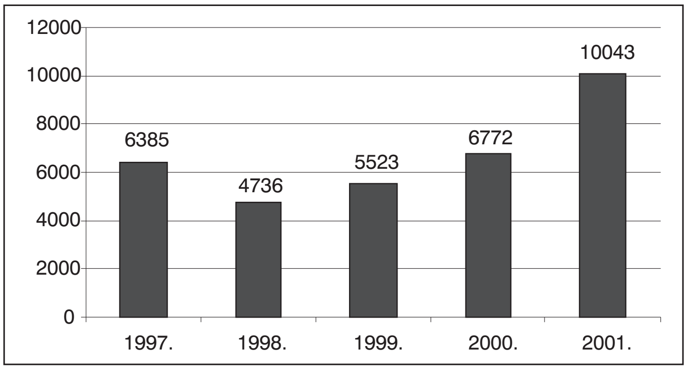
2) FTE = full- time equivalent

3) values for year 1998

4) Czech Rep. 2000

Figure 4

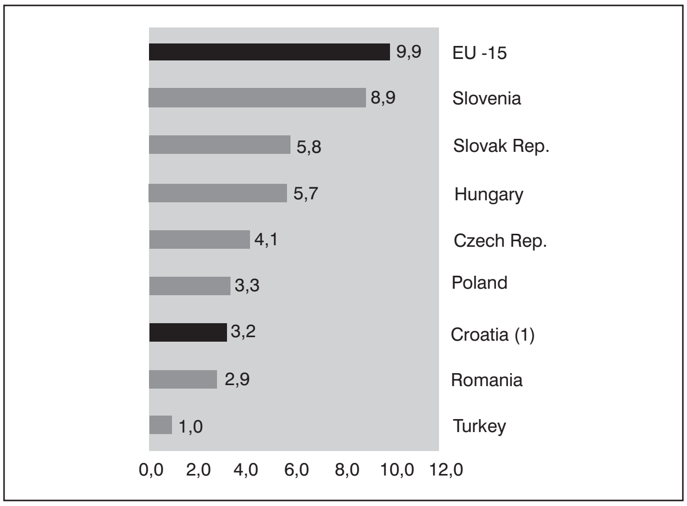
Total number of researchers (FTE) in Croatia



Source: CBS of Croatia

Figure 5

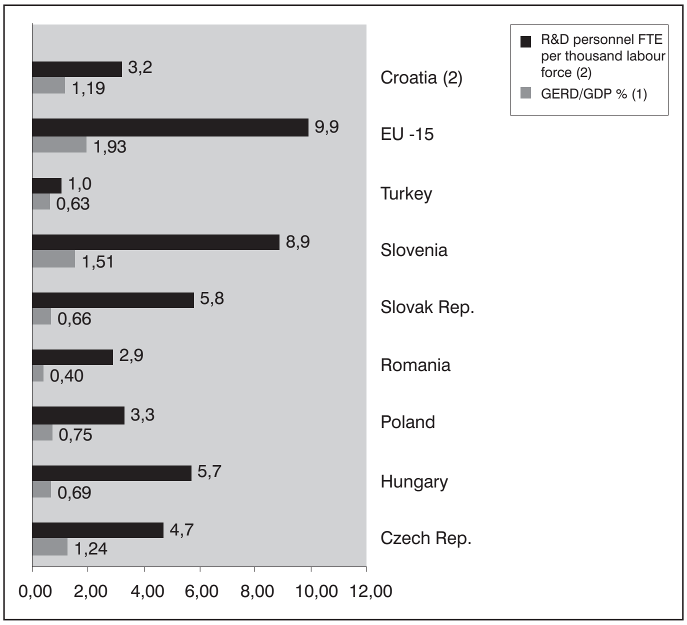
Total researches (FTE) per 000 labour force – comparing Croatia, 2000



Source: Eurostat, (1) CBS of Croatia

Figure 6

Total researchers

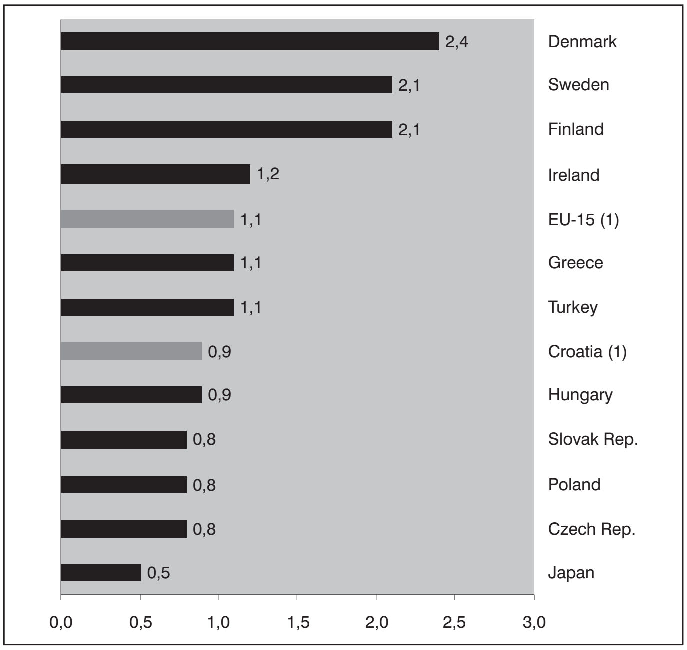


Source: Eurostat; CBS of Croatia

Notes: FTE = full-time equivalent; (1) 1999; (2) 2000

Figure 7

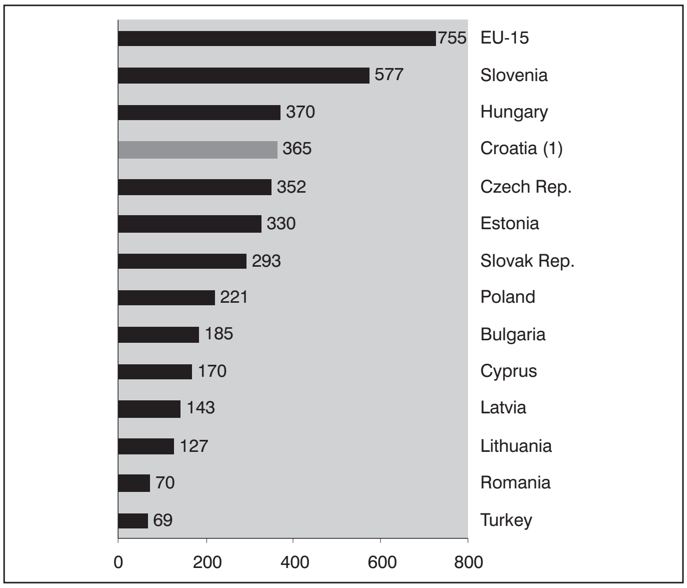
Public expenditure on tertiary education: % of GDP 1999



Source: (1) OECD, CBS of Croatia

Figure 8

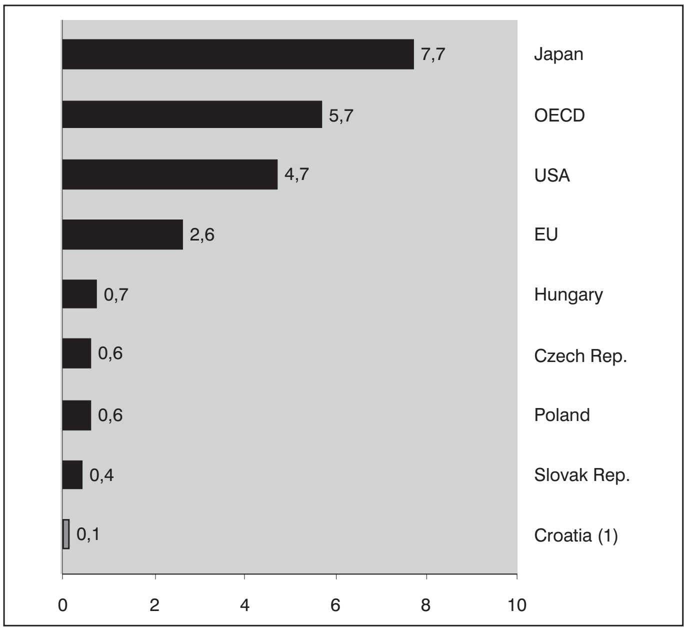
Number of Publications (2) per million population – comparing Croatia, 1999



Source: Eurostat; (1) CBS of Croatia

Notes: (2) Publications from 11 fields

Figure 9
Number of patents per 10000 population, average 1996-1998



Source: OECD MSTI, (1) Croatian Patent office

Table 3
R&D investment and human resources in S&T in candidate countries – comparing Croatia, 1999

	GERD/ GDP %	BERD/ GDP %	GERD: Financed by Gover-nment %	GERD: Financed by Business %	R&D personnel FTE per thousand labour force	Total R&D personnel FTE[1]	Researchers by sector: Total FTE[1]	Researchers by sector: Gover-nment sector %	Researchers by sector: Business sector %	Researchers by sector: Higher educa-tion sector %
Bulgaria	0,57	1,16	69,7	22,8	:	16.087	10.580	66,7	11,8	20,9
Cyprus	0,25	0,50	68,5	17,4	:	681	278	29,7	23,1	42,7
Czech Rep.	1,24	7,81	42,6	52,6	4,7[3]	24.106	13.535	31,6	42,9	25,0
Estonia	0,75	1,79	64,8	24,2	:	4.545	3.002	20,7	12,6	66,3
Hungary	0,69	2,76	53,2	38,5	5,7	21.329	12.579	36,2	25,9	37,9
Latvia	0,41	0,70	55,6	15,7	:	4.301	2.626	28,6	7,3	64,1
Lithuania	0,60	1,29	:	:	:	11.791	7.777	32,9	3,7	63,4
Poland	0,75	3,08	58,5	38,1	3,3[3]	82.368	56.433	19,2	18,3	62,5
Romania	0,40	2,99	46,7	50,2	2,9[3]	44.091	23.473	24,3	65,8	9,9
Slovak Rep.	0,66	4,16	47,9	49,9	5,8[3]	14.849	9.204	26,4	27,4	46,2
Slovenia	1,51	8,32	36,8	56,9	8,9[3]	8.495	4.427	34,1	34,8	29,5
Turkey	0,63	2,40	47,7	43,3	1,0	24.267	20.065	10,9	16,2	72,9
EU-15[2]	1,93	12,63	34,2	56,3	9,9	1.689.490	919.796	14,2	50,0	34,3
Croatia[3]	1,19	0,54	21,5	45,1	3,2	8.827	5.523	30,3	17,3	52,4

Source: Eurostat, CBS of Croatia
Notes: 1) FTE = Full time equivalent
2) 2000 and estimate
3) 2000 and estimate

FOOTNOTE

* The data are presented within a paper "S&T Indicators: an overwiev of Croatia" prepared by Emira Bečić, senior consultnat at the Ministry of Science, Education and Sport of Croatia, at the international workshop "S&T Indicators and Statistics for S&T Policy Making in South-East European Countries (SEECs)", 15-18 November, 2003, Sofia.

ANNEX 2

LEGAL FRAMEWORK* FOR INNOVATION POLICY OF THE MINISTRY OF SCIENCE AND TECHNOLOGY OF THE REPUBLIC OF CROATIA: SELECTED DOCUMENTS

CROATIAN PROGRAM FOR INNOVATIVE TECHNOLOGICAL DEVELOPMENT

Innovations, research and development of new technologies, products, processes, services and markets have no alternative!
August 2000

INTRODUCTION

At present the market economy challenges Croatia to join a successful economic environment – European Union – and strengthen its place in the world. In order to meet this challenge it is necessary to identify, choose and implement scientific and technological policy appropriate for the beginning of the third millenium.

In this introduction we want to emphasize the position that scientific and technological policy, side by side, present a basic orientation of this administration, a pledge for future progress. Besides the orientation towards new knowledge, this Program deliberately directs scientific research towards its applicability, and materialization of ideas into products, processes, services and markets. At the same time the Program does not neglect original scientific ideas, not even if their aim is purely theoretical. However, important work and creative effort are stimulated and focused to feasible results of scientific research that can have a direct and immediate benefit to human welfare. This approach is emphasized for a specific reason. In this hard and difficult world that knows only its selfish appetites, Croatian administration deliberately focuses results of its implementation policy towards the welfare of all Croatian citizens. This Program and daily operational policy for its implementation, contribute to this more than ever before.

The starting point of this Program is a true orientation to create environment for both general and individual welfare. In the context of this Program for strategic orientation, a general welfare implies spiritual satisfaction of the community followed by all comforts of the contemporary civilization. However, some restrictions, moral and ethical principles should be embedded, in the course of creating new values, into the conscience and awareness of all scholars, researchers, workers, and ordinary people who use achievements of the civilization.

Finally, this Program deals with the approach to development and operation of technology policy, and it is based on the postulate that innovation, research and development of new technologies, products, processes, services and markets have no alternative in the Croatian economy. It is a slogan for the development of the Croatian innovative technological policy.

CURRENT SITUATION

A planned approach to technological development of Croatia dates back to 1993, and coincides with the beginning of the cooperation of the Croatian Ministry of Science and Technology with the German Federal Ministry for Education, Science, Research and Technology (BMBF). The cooperation was implemented with the Fraunhofer – Institut für Systemtechnik und Innovationsforschung (ISI) and VDI/VDE TZ. The results of that cooperation culminated in the workshop with a working title "Conceptual Approaches for an Industry – Related Promotion of Research and Development in Croatia", held on June 28-29, 1994 in Zagreb. In the same year the Ministry of Science and Technology organized a scientific-business conference "Technology Parks: European Experience for Croatian Development" held on November 3-4 in Brtonigla, Istria.

After the elections held on January 3, 2000 and a subsequent change in government, the Ministry of Science and Technology continued its approach to technological development. The Ministry first accepted and latter organized a conference with a working title "Technology Transfer: Experiences for the Countries in Transition" that was held on June 20-21, 2000 in Zagreb.

Following the international cooperation between the Ministry of Science and Technology and Germany in the area of research organization and development of new technologies, and particularly the creation of infrastructure for such an activity, the cooperation extended to Italian and US partners. In the framework of the Italian Government technical assistance to Croatia, the cooperation on the BICRO Project was implemented through the Italian partner SEED – Services for Eastern Economic Development from Trieste. Cooperation with the United States of America was implemented through the

William Davidson Institute Business School, University of Michigan. WDI elaborated a study entitled *BICRO – Global Project*, as a basis for a subsequent development of BICRO as an institution, and a plan for the Business-Innovation Center in Vukovar.

The entire international cooperation and efforts of a small number of enthusiasts at the Ministry and at Croatian universities have resulted in the organization and effective operation of the following institutions – technology centers: Center for Technology Center (CTT) attached to the Faculty of Mechanical Engineering and Shipbuilding in Zagreb (1996); Technology Center Split (TCS) in 1997, Center for Innovative Technology Rijeka (TIC) in 1997. The idea behind the foundation of these technology centers at the centers of Croatian universities was to encourage research in terms of transfer and creation of new technologies, products, processes, and services. The foundation of technology centers in terms of securing premises and necessary infrastructural equipment, was aimed to the start-up and incubation of knowledge-based small and medium enterprises, and to the application of results of technology research and developmental projects. BICRO (Business and Innovation Center of Croatia) was established in 1998, as a state agency to assume a role of an umbrella institution in the creation of the overall technology infrastructure. In addition to the network of technology centers, the technology infrastructure also implies a financial institution that has a task to finance and invest into the establishment and initial operation of new knowledge-based small and medium enterprises.

At this point we do not want to do an elaborated analysis, but only to state that despite the fact that relevant state actors and academic community (particularly proved by an impressive number of scholars and officials in Brtonigla – 172), have been informed on technological development, not much has been done systematically in this area. The only notion more serious than this one is that even among professionals all efforts (insufficient, as stated earlier) have been belittled and considered inappropriate for conditions in Croatia.

For the purpose of stating facts, we want to add that activities of technology centers, with some exceptions, have been reduced to typical incubation activities. BICRO has never commenced with planned activities, since foreseen seed – funding has not been allocated. The Ministry supports activities of technology centers and of BICRO through monthly payments of overheads, i.e. the Ministry finances activities that do not involve development.

At the end of this short overview about measures taken in relation to technology, we need to emphasize that, following the elections of January 3, 2000, and a subsequent change in Government, a new organization of the Ministry involved a thorough reorganization and creation of a separate Directorate for Technology with a Deputy Minister for Technology. This position of the Minister and the Government is a sign of the completely new quality in the approach to technology development that will be, according to all forecasts, at the very core of all research and economic events in the third millennium.

INTERNATIONAL ENVIRONMENT AND TENDENCIES

The above mentioned postulate "Innovations, research and development have no alternative!" the motto of this Program, has its stronghold and incentive in the global approach to the issue that presents a topic of this material. The agricultural era at the end of the 18^{th} century and at the beginning of the 19^{th} century was replaced by the industrial era characterized by technological achievements such as steam engine, automobile, and telephone... International centers of progress were located in Europe. After the First World War and especially after the Second World War the United States of America literally gathered scholars from all over the world, and became a leading global center of industrial, technological development. That was the first real brain drain.

Realizing that only innovation and research guarantee development, both regional and national, between the 40s and 50s, the USA slowly accepted a concept of innovation centers. Two concepts were established: scientific parks such as the Stanford Research Park in Northern California, and technology centers around Boston; and finally in the early 70s a completely new approach of constructing a complete city in the service of science and development – the Silicon Valley.

Europe followed the American way in its own manner. A current network of technology centers in Europe started in the 60s. We must mention four important parks established before 1969: Heriot – Watt in Scotland, Louvain-la-Neuve in Belgium, Grenoble and Sofia Antipolis in France. Asia accepted a concept of parks in the 70s, Korea (Teodok) and Australia (Adelaide) in the 80s. In 1983 a concept of parks was accepted as a development strategy of the Japanese Government.

This short overview of international trends deliberately ends with examples that particularly emphasize the motto of this material – innovations, research as a basis for development. These are renowned Asian global miracles of the present: Korea, Malaysia, Taiwan and Hong Kong.

CROATIAN PROGRAM FOR INNOVATION AND TECHNOLOGY

The serious consequence of unfortunate periods of war and its aftermath is, among other things, that Croatian technology lags behind developed countries. It seems that this fact of Croatian lagging behind developed countries has not been given any significance or importance (that it deserves) neither in the political arena, nor in the broad public. A direct consequence of lagging behind in terms of technology is inefficient economy with all its negative material, spiritual and social consequences.

In shaping a strategy of its development each country always asks: What are comparative advantages or dominant resources on which the strategy should be based? It is beyond question that Croatia has appropriate natural resources for development of agriculture, tourism and tertiary, service activities, thanks to its geopolitical position in terms of transportation.

However, many times in different situations it has been confirmed that the greatest potential of Croatia, a small country with less than five million inhabitants, are its human resources. Beyond doubt an average Croatian citizen has a solid and broad education, and in many areas Croatians are top experts on the global level. The data of the Ministry show that the organized scientific research activity engages 4,700 scholars. The same number is registered outside the system of the Ministry. In addition, according to the most recent available data, 70% of the population aged 14-18 are attending high schools (mainly vocational high schools); and 28% of the population aged 19-22 are attending college to acquire either an associate or a bachelor's degree.

Future can be built only on knowledge and expertise. Only capable people and professionals may stop a downhill economic loop, and start a wheel of a speedy progress. Therefore, we agree that human resources are a basis for designing all concepts of economic strategy. This Program creates an environment for active layers of society with the best education and greatest prosperity to find its place in a broad spectrum of creating knowledge-based small and medium enterprises.

Basic Principles of the Program

This Program is based on the experience of successful economic systems, but in some segments it has been adjusted considerably to conditions of Croatian economy and tradition:

- Research and development of new technologies, products, processes, services and markets have no alternative in the Croatian economy;
- Opening perspectives to human potentials, particularly those with higher education degrees, capable of their own personal involvement in the creation of relevant technological future;
- Integration of all research potentials ranging from higher education institutions, public institutes, economic institutes to individuals, including existing infrastructure and premises, as well as establishing new institutions, into a planned research activity that will result in feasible technological solutions and patents;
- Experience of developed countries shows that founding technology centers, technology parks for research and development, is by all means appropriate for Croatian conditions. It is the only correct way to decrease a gap among countries with developed and underdeveloped technology;
- Creating environment and infrastructure to support establishing of knowledge-based small and medium enterprises;
- Establishing an efficient system to support the creation of new technologies, products, processes, services and markets;
- Change in a manner, philosophy of thinking, towards attitudes that would enable Croatian integration into designing, creation and production of new products, technologies, processes, such as biotechnology, microtechnology, communication-information technology;
- Gathering and acting towards a mutual goal, necessity – technological development of Croatia – by all the actors that must and can contribute to this.

A Short Analysis of the Present Program Approach

A project for future technology was launched during the war in Croatia when ideals of the people, including former structures in power, were great. On one hand the state was being built, and on the other, economic blossoming of a new state was expected. It is clear that many commenced projects were not considered in detail, neither in all their segments, or as a whole. From a present perspective it is easy to conclude that such mistakes, judging from commenced projects that have never been finished, are almost unforgivable. The same thing happened to the project for the national technological development that remained in the stage prior to the establishment of infrastructural institutions. We have to state that only a portion of the infrastructural technology network has been created, and that it is not a shaped and operational unity.

An important requirement has not been fulfilled: everybody needed in this chain should contribute to the integration with the world of more developed technology.

A project for technological development should have had, and it still requires, a firm support by the government, creator of the economic policy, beginning with the initial idea, its promotion to a powerful financial support. Following the creation of a portion of the technology network, Croatian authorities obviously deserted the project and left it to sink or swim. Although they had competence to complete the project, a few diligent employees of the Ministry and staff of the centers could not complete the project, since they had no active support and no support from policy makers. The task of the state administration and the Ministry was to create conditions, pass regulations and design day-to-day operational technological policy. It results that the biggest responsibility for a partial implementation of the project lies on the administration that failed to reach relevant decisions.

The project was also harmed by the absence of active involvement of the entire academic community in the overall project of creating, shaping and operating the technology project. Hereby the Ministry addressees everybody that, in a crucial moment, has not accomplished completely its "oath" that everybody should contribute for the benefit of all according to the best of his/her own capabilities. With all due respect to the most skilled and educated social stratum of every community, we must state that it has been a moral act and a big commitment. Public and organized scientific research and education have a special role in the creation of technological future, but we will deal with this issue latter in the Program.

At this point it is important to mention that an active creation of necessary technological institutions is not after all a task for the state administration, in this case the Ministry of Science and Technology. This role should have been assumed by a separate state agency, founded particularly for this purpose. Project documentation shows that this role should have been assumed by BICRO. Did this fail to happen due to the fact that the role designed to BICRO was not modified to Croatian conditions, or due to the fact that its establishment has not been completed as planned? At present this is irrelevant, but the fact remains that such a state institution does not exist.

In this partial implementation of the technology project it is essential to grasp a right reason for inadequate functioning of the existing technology infrastructure, disregarding who is responsible for it. The experience of efficiently organized networks shows that the existing network is just a component of a real technology network. In fact this is an important oversight, i.e. a wrong approach that did not take into consideration a purpose of creating technology network, i.e. infrastructure. To make this easy to understand let us say that technology development is based on research conducted by the public, economic or private scientific-research institutions. In the course of designing future technology with a significant participation of the knowledge-based small and medium enterprises there was not foreseen the institutional link among scientific-research institutions (potentials), and possible users of their research (small and medium enterprises in development). Technology centers were not able to complete this task due to inertia related to changing way of thinking of Croatian scientific research institutions i.e. researchers. They have not accepted the reality that a true purpose of majority, particularly applied and developmental research, is a final applicability of research results. In addition, potential entrepreneurs did not know how to use an outstanding scientific-research potential that Croatia certainly possesses. Therefore, it was necessary to found an institution to link researchers with enterprises established within or outside technology centers.

This short analysis of shortages in the former program approach has been deliberately confined to the technical aspect of program approach to technology development, without political and daily "economic" connotations, since such an analysis falls outside the framework and purpose of this material.

CROATIAN POLICY FOR INNOVATION AND TECHNOLOGY

Technology policy as a framework and a manner of operation, it encourages progress, development of a country in a specific segment of economy and life as a whole through creating new technologies, products, processes, services, and markets. This technology policy is focused to the future that brings many changes, some unpredictable.

The following principles have been identified:

- Usefulness and ethics that technologies should be applicable, and increase the quality of life of individuals and community as a whole;
- Incentives for development applying national, regional and local priorities and resources;
- Encouraging only the development of environmentally-friendly technologies;
- Scientific research and entrepreneurial projects related to the development and commercial use of new technologies, should be coordinated with the generally accepted moral criteria, therefore falling under the control of the public, experts and moral authorities.

Basic principles of this Program for Technological Development of Croatia especially emphasize:

- Organized and efficient research with secured funding is the only safe path for future development;
- Continued communication and professional cooperation among all research resources, from innovators – individuals, technology centers – parks, public institutes, economic institutes, faculties to universities, is necessary for the creation of technology system and a prerequisite for technology development;
- A need to change educational curricula and curricula of higher education institutions to adapt to research and entrepreneurship, i.e. training Croatian citizens with a college degree for a tough market race that requires only efficiency and profit;
- Continuing education, learning and training. New technologies and processes necessarily require new knowledge and skills. In reference to continuing education a new infrastructure should be established to include focal points and regional points for specific regional priorities (various production processes).
- Small and medium enterprises, especially knowledge-based SME, are necessary in the promotion of transfer and creation of new technologies;
- Planned and efficient support to knowledge-based small and medium enterprises is the fastest way of integration with countries with developed technologies, and the creation of new jobs, especially jobs that require highly qualified staff;
- Inventive ideas and work enjoy special care and support;
- Innovations, research and development of new technologies, products, processes, services and markets have no alternative.

A crucial task of this innovative technological policy is to translate the essence of this approach into an efficient high-quality system. Therefore we need to repeat that at present Croatia, in terms of technology, largely lags behind successful economies that could be entitled "economies of knowledge". This technological gap may be bridged by: (1) application, introduction, transfer of foreign or existing technologies, or (2) creation of Croatian technologies, products, processes, and services. In simple and relative terms, the transfer of existing technologies may be implemented by: (1) traditional entrepreneurship, or (2) using a globally accepted model of the so-called transfer institutions as technology centers, parks, and knowledge-based small and medium enterprises. It is important to stress here that when it comes to technology the destiny of small countries, such as Croatia, is to transfer, import, and copy the existing, foreign technological products, processes, and solutions.

The rest of this Program will not deal with traditional entrepreneurship, small and medium or large entrepreneurs and companies, since in their essence they are in purely economic, profit-oriented systems, under the jurisdiction of other ministries.

Bridging the technological gap, technology transfer, organized entrepreneurship of knowledge-based small and medium enterprises, technology centers or other organizations of similar origins, differs considerably from traditional entrepreneurship. Such entrepreneurship largely includes inventiveness and innovative capabilities of entrepreneurs, and has its specific characteristics. Therefore, even in the successful economies this type of entrepreneurship is implemented under the state administration responsible for science.

Croatia must be integrated into a circle of creators of new technologies, naturally according to its capability, capacity, and resources that should be, by all means, allocated separately for this purpose. Croatia should not be merely a site for import and use of technologies resulting from foreign knowledge. Such technology policy should create conditions in which all innovative solutions or ideas (ranging from ideas of individuals to the *Rudjer Boskovic* Institute, the most sophisticated public scientific research institute) form one entity in the creation of a Croatian product. Since a lack of resources makes it impossible to create a spatial entity that will have all the characteristics of a global, and spatially organized technology park, why should we not form such an efficient and functional entity? Croatia is a small country, so why should it not, in terms of technology, operate as a technology park? Since this is merely an organizational problem, why do not we make this a specific quality of Croatia? Achievements in telecommunications annul spatial separation. Integration of all human resources/potentials from innovators to researchers and scholars of worldwide reputation on one hand; and existing laboratories, research premises and equipment on the other hand (especially inventive entrepreneurs with higher education degrees), is a *condition qua non* of this technology policy. Knowledge-based small and medium enterprises within or outside technology centers are merely common productive and organizational segments of such an entity.

Efficiency of technology policy depends on the establishment of active technology system as a whole, and each component of that system, but also of the state as an important and necessary element of support to this policy. Therefore, having adopted former experience, we have identified the following components and levers of policy for innovation and technology:

- infrastructural institutions;
- instruments of policy for innovation and technology;
- control mechanisms of policy for innovation and technology.

Infrastructural Institutions

The functioning of the overall technology system will result in new technologies in the Croatian economic system with a maximal integration of domestic scientific research potentials, establishment of knowledge-based small and medium enterprises, creation of new jobs for highly-qualified people, and finally in the Croatian technological innovations, products, processes, services and markets. The technology system is comprised of the following infrastructural institutions:

- Research and Development Technology Institute
- Research and Development Centers
- Technology Innovation Centers
- Business and Innovation Center of Croatia (BICRO).

Developing the infrastructural system implies enhancing the existing institutions, and establishment of new institutions such as technology centers, technology parks, research and development centers, and in the future science parks. Nowadays the technological development is based on research and development, therefore these technology – related institutions are under the jurisdiction of the Ministry of Science and Technology.

Research and Development Technology Institute is a core infrastructural institution of the entire technology network. At present it does not exist in any organizational form, and it will be established as a public institute of the Republic of Croatia. Its activities will be financed by the Ministry of Science and Technology. In terms of organization, the Institute will employ scholars from various professional orientations, researchers with an entrepreneurial instinct and predisposition. Activities of the Institute will include monitoring and forecast of global technological trends, focusing Croatian research related to development and technology, consulting in the realm of technology transfer, and practical promotion of Croatian technological production.

Researchers of the Institute will be the first filter for targeted public research related to development and technology at Croatian higher education institutions, as well as public, economic and private institutes. Naturally, that research will enjoy a special incentive and financing by the Ministry. A prerequisite for funding such public research projects and tasks will be foreseeable and secured final results in terms of new technologies, patents, products, processes and services offered by the market. In order to implement research related to development and technology, the Ministry will announce public calls for proposals, in cooperation with the Institute, of similar type as calls for proposals for basic and applied scientific research projects. It is implied that economic and private institutes or research units, outside the research financed by the Ministry, will have their own rules and filters.

Research and Development Centers are research units attached to centers of universities and polytechnics, and their task is to carry out research and solve specific regional and local technology issues. The founders of a center for research and development are usually regional and local entities (universities, polytechnics, counties, cities, municipalities, interested economic entities), or the Ministry, but that requires a special decision. The Ministry of Science and Technology normally supports activities of a center for research and development through covering operating costs (overheads). Users of the research activity carried out by a center for research and development are its founders and the entire community, especially in terms of technology projects with a public funding from the Ministry. Centers will compete for those projects on an equal footing. Following the logic of the economy and the existing needs, future developments foresee *Technology Innovation Centers* attached to the Research and Development Centers.

Technology Innovation Centers are centers of excellence founded by a university or a faculty (higher education institution within a university), supported by the local government and economic entities. These are basic infrastructural institutions used for materializing ideas, innovations, new knowledge, and results of scientific research projects and research with public or private funding. In terms of organization, Technology Innovation Centers are basically incubators for knowledge-based small and medium enterprises. Their specific quality is that they are incubators for knowledge-based small and medium enterprises, and not traditional entrepreneurial small and medium enterprises. Business activities of knowledge-based small and medium enterprises within the framework of Technology Innovation Centers, are closely connected to their own innovative and research undertakings, and/or result from the abovementioned scientific research projects and research. Experience of countries with developed technologies often show that owners/co-owners, i.e. founders/co-founders of the knowledge-based small and medium enterprises are scholars, researchers that participated in research projects or research. The purpose of founding a center for innovative technology, and operation of the incubation knowledge-based small and medium enterprises in their premises, is a convenient use of the infrastructure, laboratories, phone lines, accounting services, secretarial service, contacts with domestic and foreign partners. In a principle, the foundation of knowledge-based small and medium enterprises, production start-up and a complete functioning including marketing and product sale, judging from global experience depends on the type of production and lasts from three to five years, often seven even ten years. Following this period, incubated knowledge-based small and medium enterprises, at that point accomplished and successful enterprises, leave a center for innovative technology and join a market race. In the period between the foundation/ start-up, and the final product i.e. full operation of the knowledge-based small and medium enterprises, the Ministry provides financial support through specially allocated resources that fall under the activities of the Business and Innovation Center of Croatia, and therefore we will deal with this issue latter.

This technology policy encourages the youth with associate and bachelor degrees to become inventive, participate in research and develop business and entrepreneurial spirit already during their education. Particularly these circles are expected to found knowledge-based small and medium enterprises, and use services of Technology Innovation Centers. Therefore, the Ministry supports operation of Technology Innovation Centers through co-financing operational costs (overheads), but not development. The experience shows that each country has to use its specific qualities. This technology policy aims to have results exactly in this segment, and use Croatian resources for the individual and common benefit, the youth with broad education and college degrees.

Business and Innovation Center of Croatia (BICRO) is a government institution, established by the Government of the Republic of Croatia, under a direct jurisdiction and within the system of financial support of the Ministry, through co-financing operational costs (overheads), but not development.

This technology policy assigns BICRO a very important role in the implementation of the program for creation and development of knowledge-based small and medium enterprises. BICRO is actually a coordinator of the Program for knowledge-based small and medium enterprises. To be specific, its tasks are related to professional and financial monitoring of the creation, development and final formation of knowledge-based small and medium enterprises. In a full sense it implies overall assistance in the creation of the knowledge-based small and medium enterprises, including consulting; analysis of the entrepreneurial plan, investment project, business strategy and organizational development; providing financial resources; identifying domestic and foreign partners during the foundation and final formation and marketing of its products or a whole company in Croatia and abroad. BICRO offers services that are similar to those offered to knowledge-based small and medium enterprises, to existing companies engaged in the transfer and improvement of technology, and to innovators. The Government of the Republic of Croatia continually provides financial resources for this purpose. Co-financing is expected from regional and local communities and interested economic entities. In the implementation of this function BICRO relies considerably on Technology Innovation Centers, as well as on other public or private institutions, and they present a framework for the creation of a flexible and open network of transfer institutions focused towards the development of knowledge-based small and medium enterprises.

Technology System is an integrated system in terms of organizational infrastructure and operation. It consists of the Research and Development Technology Institute, BICRO, Technology Innovation Centers, and other relevant institutions, Therefore among active members of the Research and Development Technology Institute there will be at least one member of each infrastructural unit, i.e. institution, although they will not be at the same location. They will be considered as employees of public institutes in the full sense of the word, including obligations and a right to a salary. This will ensure both vertical and horizontal links, a real organizational and active technology park. This organizational and functional unity, uniqueness, will be established by decrees on the foundation of the Research and Development Technology Institute, and Research and Development Centers, or by amending acts on founding technology centers and BICRO.

Establishing technology infrastructure, infrastructural institutions in a described manner, apart from the most important goal of a uniform activity on the creation of future technology, has another important characteristic or reason. Independent operation within the framework identified by the Government is an important prerequisite for success. In this manner research in the area of science and development will enjoy creative freedom, from an idea to a finished product, developing inventiveness in the service of individual and general welfare. Through the Ministry, the Government will act as a mechanism for control of spending taxpayer money, and for the creation of environment for a successful technology system. Up to now the Ministry sponsored and directly implemented the entire activity related to both the ideas and implementation in this area. A firm position of the Ministry and global experience definitely show that this is not and cannot be a task of the state administration. This technology policy corrects that wrong approach. State administration, the Ministry of Science and Technology, sees its place and tasks in the framework of the instruments of technology policy.

Instruments of Policy for Innovation and Technology

This technology policy provides for a planned state support to the orientation towards development of the knowledge-based small and medium enterprises. Its final products are economic and entrepreneurial advancement and results of planned scientific research. Instruments of technology policy are measures that will and may be modified or expanded, depending on the economic development and needs of the country:

- Regulations related to the knowledge-based small and medium enterprises;
- Technology Field Council at the Ministry;

- Financing scientific and developmental technology projects and research;
- Financing technology infrastructural institutions;
- Financial support for founding, development and operation of knowledge-based small and medium enterprises;
- Promotion of knowledge-based entrepreneurship;
- Education, training for the needs of the knowledge-based entrepreneurship;
- Support for the associations of knowledge-based small and medium enterprises;
- Support to "traditional" inventive and innovative activities.

Regulations related to the overall issue of small and medium enterprises are still partial. They do not even mention knowledge-based small and medium enterprises. Previously mentioned special characteristic of knowledge-based small and medium enterprises is emphasized again here due to its solid foundation in research and inventive work. Within the framework of passing national regulations, the issue of knowledge-based small and medium enterprises will be regulated by joint and special regulations. This falls under the jurisdiction of the state administration, i.e. the Ministry of Science and Technology.

Technology Field Council, i.e. its creation and operation is a prerequisite for implementation of technology projects and research. Its creation is a matter of organization under the jurisdiction of the Ministry. A close link between activities of the Research and Development Technology Institute, and Technology Field Council has been emphasized. The Research and Development Technology Institute, within the framework of its research activities, estimates the overall Croatian national and regional possibilities for integration into national and global technology trends, in terms of technology transfer and its own production possibilities. Such research activities, and they are among the reasons for the foundation of the Institute, dictate an obligation to focus scientific and developmental projects and research in Croatian scientific-research institutions. Having accepted merely this limitation, that in reality levels with agreed and argumented decision-making, the activity of the Technology Field Council is completely independent within the framework of its authority, similarly to other field councils for scientific-research activity, so it falls under the same regulations.

Financing scientific and developmental technology projects and research is in a full sense financing the creation of Croatian product with a high proportion of intellectual work. Abundant financial resources would enable Croatian researchers a possibility to participate in the improvement of existing technologies, introduction and creation of new technologies, products, processes, services and markets. Financing is channeled through the Ministry, as a control mechanism of technological orientation and progress, recognizing full autonomy and freedom of research. The Ministry cooperates closely and accepts recommendations of the Research and Development Technology Institute in relation to allocation of funding for research at registered scientific-research organizations.

Financing technology infrastructural institutions is a direct assistance to development and functioning of those institutions through co-financing of necessary costs related to research. This assistance is obligatory, especially in the environment of a fragile economy. In addition, this logical co-financing is a control mechanism of the Ministry over those institutions in terms of limiting planned activities to research and technology and the creation, developing and operating knowledge-based small and medium enterprises. The Research and Development Technology Institute, and employees of institutes located in infrastructural institutions have a special way of financing. As it was stated earlier, their activities are completely financed by the Ministry. Such financing requires special authority of the Ministry, as regulated by a decree on founding the Research and Development Technology Institute.

Financial support for founding, development and operation of knowledge-based small and medium enterprises is a new category, although the Government of the Republic of Croatia by approved this idea its conclusion dated March 18, 1998. It is an instrument, a technology policy measure that Croatia uses to join the economies of knowledge in the most direct way.

This measure provides a real support to entrepreneurial projects based on new technologies and products. Results of scientific and developmental research are implemented through the production activity of knowledge-based small and medium enterprises. Those financial resources support their founding, development and final formation. However, the logic of the economy lies not only in the introduction and creation of new technologies, products, processes, services, and markets, but also in the improvement of the existing ones. A portion of foreseen and secured financial resources is used for this purpose, i.e. for activities of existing companies outside technology centers. In addition, innovative ideas of individuals, innovators, are also financed from these resources up to the level of a prototype, in case that the innovator, apart from his/her innovation, does not possess entrepreneurial spirit to establish a company. Two last types of financing, innovative improvements and prototype solutions, become prominent for another reason and that is the fact that regional and local communities have to deal with the problems of existing local companies, and they in addition to the state and the Government in reality finance technology development. That is to say that resources for described support are provided in the state budget, budgets of regional and local administration and self-government, and interested economic entities.

Young researchers (recent graduates) enjoy a special attention within the financial support system in order to set up their own business or use their knowledge being employed by companies established in such a manner.

Direct financial support from the state is used for example for direct loans, non-repayable funds for projects, guaranteed loans or other types of direct support. In order to secure instruments of public support to the introduction and creation of new products and technologies, specific financial instruments for their financing are created e.g. various investment funds, such as a seed-fund or risk-capital fund. Procedure and manner of use of resources and creation of funds, if necessary including other institutions from the region, will be regulated by separate legal acts. BICRO drafts such acts and submits them to the state administration. BICRO has jurisdiction for the actual implementation of the technology policy instrument.

Promotion of knowledge-based entrepreneurship is an important link in their creation. Promotional activities are implemented at all levels, from national to local, including various media. A special importance is given to a planned, educational promotion, even through special educational topics or instruction units. Promotion and acquiring knowledge during education directly encourage founding of knowledge-based small and medium enterprises, since, as it has been previously emphasized, Croatian citizens with a college degree are expected to found such companies.

Education, training for the needs of the knowledge-based entrepreneurship is a prerequisite for a successful economy. In the course of the entrepreneurship era the force of new knowledge multiplies itself. However, diversity of necessary entrepreneurial knowledge and skills is not always correlated to inventive capabilities of entrepreneurs at knowledge-based small and medium enterprises.

Entrepreneurs learn just a portion of needed entrepreneurial skills and activities through a service, or have them made by BICRO or Technology Innovation Centers. Therefore this technology policy emphasizes the need for a foundation and operation of a center for continuing education, and the allocation of separate funds for this purpose in the state budget.

Support for the associations of knowledge-based small and medium enterprises is an instrument of technology policy that gives a special importance to knowledge-based entrepreneurship. Communication of freely associated entrepreneurs from knowledge-based small and medium enterprises, is a safe path to the overall concept of the present technology in Croatia, and mutual cooperation in the creation of the future. The Ministry separately covers costs for attending organizing conferences and study visits by members of those associations characterized by science and development.

Support to "traditional" inventive and innovative activities complements the Croatian Program for Innovative Technological Development in its full context. Therefore it is treated as a separate instrument of technology policy. Everything begins with a "big idea" born in a head of a "big small man", with more or less education – an ordinary person. A final implementation of the idea is for the benefit of ordinary people. This technology policy uses resources of the Ministry to co-finance all the needs of the "traditional" entrepreneurship of ideas through the above mentioned modality, naturally according to capabilities and depending on the state of the Croatian economy.

Due to the complexity of the innovative entrepreneurship, innovators and stimulation of innovative activities will be implemented through projects in coordination with the Ministry of Crafts, Small and Medium Entrepreneurship, from the initial stage of an idea to the entrepreneurial implementation in manufacturing.

Control Mechanisms of the Policy for Innovation and Technology

Control mechanisms have been established for the overall operation of the technology infrastructural network, distribution and spending of allocated resources, and ethical control mechanism in research, or the commercial use of results of scientific and developmental projects and research. Some control mechanisms, Interdisciplinary Control Group and the Ethical Committee, are organized according to valid national regulations.

The Ministry of Science and Technology is organized to control all segments of scientific and developmental research in all fields, including technology, and spending of allocated resources. In the same manner, as a responsible state administration it controls functioning and activities of infrastructural technology institutions according to separate authorities pursuant to the acts on founding institutions.

Interdisciplinary Control Group is a separate control mechanism under development. It controls the use of resources supporting improvement, introduction and creation of new technologies, products, processes, services, markets, as well as innovative activities. Authority of the control arises from resources for support allocated from the state budget for funds under the jurisdiction of BICRO. Activities of the Interdisciplinary Control Group are coordinated by the Ministry, and the members are representatives of the following ministries: Ministry of Science and Technology, Ministry of Economy, Ministry of Crafts and Small and Medium Enterprises, Ministry of Tourism, Ministry of Agriculture and Forestry, Ministry of Finance, Ministry of Environmental Protection and Urban Planning, and the Ministry of Culture and Sport.

The Ethical Committee will be established and attached to the Ministry to control compliance with the principles of this innovative technology policy: "Scientific research and entrepreneurial undertakings related to development and commercial use of new technologies should be in accordance with generally accepted moral criteria and therefore under the control of the public, experts and moral authorities." The Committee will be established despite frequent criticism that ethical committees restrict freedom of scientific research, since this Program implies the materialization of results of scientific research. The purpose of creating new technologies is their usefulness for individual and general benefit. Nobody has the right to materialize results of scientific research or import such results if they annul this purpose. Therefore the firm position of the Ministry is that all scientific and developmental projects, research, and the creation of new technologies, as well as the overall activities of the Ministry, will be transparent to the public and under the ethical control of experts and moral authorities.

INSTEAD OF THE CONCLUSION

The Ministry of Science and Technology has a special role in the overall experience of modern, successful and market-oriented economic system. This program approach meets the requirements that, following the logic of things and commitments, face the Ministry in the area of technological development. Such a commitment is emphasized in research that confirm the generally accepted notion and position that new technologies will be at the top of all economic events of the third millenium.

Accepting the motto "Innovations, research and development of new technologies, products, processes, services and markets have no alternative," the Ministry is taking Croatia closer to the systems of economies of knowledge that are considered to be technologically developed. However, the speed of this approach depends on the general awareness that technology development, integration with technologically developed countries, is the only safe way of increasing the quality of living.

An exceptional human potential in the organized scientific research and outside that environment, people with a college degree, especially youth and inventive people with various educational background, now have a chance to use available scientific research premises and premises that will be constructed, to use the existing equipment, and the equipment that will be purchased, to focus their creative effort in a stimulating manner towards achieving results of scientific and other research directly and immediately contributing to the welfare. This general approach of mobilization followed by personal satisfaction of creating individual and general welfare, requires an active and operational technology system.

This Program identifies framework for the overall technological infrastructure of a technology system, with a basic emphasis on research and development of new technologies, and the creation of knowledge-based small and medium enterprises, carriers of production programs resulting from research. In a nutshell, the system stimulates the relation among the idea, research, and prototype – improvement of an existing or a new product.

Devised technology system may function only if it enjoys a continual support by stimulative and necessary financial resources. Financial resources will be allocated in the state budget, Science and Technology Foundation, budgets of regional and local governments, or self-governments, and interested economic entities. Taking into consideration the state of the Croatian economy, the implementation of the Program requires initial funding in the amount of 100 million Croatian kuna, and plans for the increase according to the economic development of Croatia. In case that less resources are allocated, it will multiply a slow down of expected results.

Finally, it needs to be emphasized that the Ministry of Science and Technology, as the state administration, in relation to the operation of the proposed technology system retains only tasks or a role of creating necessary regulations, control over spending, distribution of financial resources, and pursuant to authority arising from the foundation acts, monitoring the activities of infrastructural technology institutions. In this manner, full freedom is achieved in terms of creative work of scholars, researchers and operation of economic entities that arise from the implementation of this program approach.

The program orientation towards the Croatian innovative technological development is in its essence constant, while the operational innovative technology policy is subject to overall, especially economic conditions in Croatia.

GLOSSARY

BICRO – Business and Innovation Center of Croatia
RIC – Research and Development Centers
RITI – Research and Development Technology Institute
TIC – Technology Innovation Centers

DIRECTIVES
FOR THE IMPLEMENTATION OF THE HITRA PROGRAM INVOLVING THE POTENTIAL FOR NATIONAL SCIENTIFIC RESEARCH

Contents:

PURPOSE AND GOALS FOR INITIATING THE CROATIAN PROGRAM OF INNOVATIVE TECHNOLOGICAL DEVELOPMENT

Technological modernization of companies and introduction of advanced technologies or new production and business programs initiate economic development. A model that proved to be indispensable for those processes in successful economies is direct cooperation, i.e. participation of scientists and experts from public and private scientific research institutes and higher education institutions with scientific research focal points in the industry and other economic entities.

A purpose of the Program is to mobilize scientific research potentials and human resources in Croatia in order to create and introduce advanced technologies into the economic sector thus resulting by business success i.e. economic development and growth.

In the Croatian Program of Innovative Technological Development (hereinafter: Program) advanced technology has been defined as knowledge that materialized through production and business processes, products and services, taking a form of skills related to production/procedures, marketing and management in the industry and other economic entities. This knowledge stems from available and activated R&D potentials both in public and private sector of research and development, thus creating basic national resources for achieving permanent progress of technology. Economic growth and development of Croatia in the conditions of technological and economic globalization can no longer be based exclusively on natural resources, common entrepreneurship models, and repetitive production and business processes that do not imply managing the change of technology, i.e. advanced and new technologies in the function of development.

Advanced technology, as knowledge materialized through the use of R&D resources in private and public scientific research sector, is a point of support in the creation of added value to products and services with a market value determined by infrequency and usefulness for a user i.e. consumer.

In this sense advanced or new technology, respectively, as well as technological modernization of a company, implies development and commercial use of the process/procedure/product/service with considerably enhanced added value achieved by the use of knowledge i.e. R&D.

In addition, the efficiency of the Program implementation is measured by the development of strategic and technological skills at the company, i.e. its ability to offer products and services with a high added value to the market by combining knowledge-based resources.

Unfortunately, the reality of companies in Croatia is restricted to the mere existence, while the importance of R&D is secondary. This has resulted in systematic weakening of economic entities and research in the economic sector, and very poor cooperation between academic community and the economic sector.

According to the estimates of the Ministry of Science and Technology almost 80% of funds of higher education institutions and institutes are provided by the state budget. Due to the decrease of budget funding majority of scientific and particularly technology research has been brought to the edge of feasibility. On one hand the solution is in a considerable and necessary increase of the budget for the development of science and technology, and on the other hand in the establishing of cooperation with the economic sector as a complimentary financial resource, i.e. in the development of strategic partnerships between public and private sector.

Due to systematic weakening of the industrial research sector, implying research in the overall economic production sector, a participation of the industry in financing the overall scientific research in Croatia equals 0.3% of GDP. According to the evaluation by OECD experts this fact indicates an alarming situation in the industrial research, and a need for an urgent revitalization of this sector by a joint effort of both the government and industry. For the sake of comparison, a business sector investment in the Chech Republic in 1995 equaled 0.75%, in Denmark 1.10%, Finland 1.59%, Ireland 0.99%, Belgium 1.09%, while in the US, Japan, Sweden and Korea it exceeded 2% of GDP.

This is why the industrial i.e. commercial institutes employ merely 6-8% of the overall number of researchers in Croatia. To compare, the economic sector of developed western countries employs between 40-70% of researchers. E.g. the average of EU is 50:50, and OECD countries 65:35 in favor of the industry.

This situation bears double negative consequences for the overall development: on one hand for the industry because its development and technology level remain stagnant, and on the other hand for the scientific research sector that has lost a possibility for interaction with experts from the industry, including a possibility of employment in the industry, as well as additional R&D projects for the need of the industry. The result is a brain-drain of a large number of renowned researchers and experts, often for good. This weakens the scientific and economic basis even further.

These reasons have prompted the Technology Directorate of the Ministry of Science and Technology to propose to the Government of the Republic of Croatia **the Croatian Program of Innovative Technological Development** that emphasizes the use of resources of universities and public institutes for the development of technology in Croatia. Technology development often implies the creation of the economic sector with its growth, international competitiveness and efficiency based on the use of knowledge i.e. R&D materialized in new and advanced technologies. Therefore the primary goal of the Program is to encourage the transfer of knowledge, i.e. technologies from the sphere of science and technology into the economic sector, as well as creative transfer and use of foreign knowledge and technologies ("bridging a gap"), creating cooperation among managers and scholars in solving technology problems in the function of the economic development.

The Program includes two subprograms:
- technology-related R&D projects,
- development of knowledge-based companies.

These subprograms are complementary. The first program includes pre-commercial technology-related R&D projects carried out in scientific research institutions and units. They refer to R&D of advanced and new technologies, as well as strategic and generic research relevant for the development of particular industry sectors and branches of industry. The second subprogram includes development, introduction and commercial use of advanced technologies (processes/procedures, products, services) relevant for the industry i.e. economic entities.

Technology-related R&D projects include pre-commercial development of products and technologies up to the stage of original solutions (prototype etc.), or a pilot stage (background and solution), as well as strategic research linking fundamental science and its application in technology. In this manner, strategic technological skills are created in the industry and economic entities. Technology-related R&D projects are implemented on the principle of cooperation among scientists and experts from both the economic sector and science (public and commercial scientific research institutes and higher education institutions), with emphasized priorities, i.e. preferences for close cooperation with experts from collaborating economic entities.

The second subprogram includes development and introduction of advanced technologies (processes/procedures, products, services) including the development of original solutions (prototype/pilot stage) with the aim of commercial use i.e. the introduction of wider market exploitation and continued production. The Program is aimed at encouraging knowledge-based companies, as well as at technological and business reconstruction of a company, developing strategic partnerships with foreign companies, as well as developing existing and conquering new markets. In principle development-related activities are implemented in small and medium-sized companies and their networks, and if necessary at scientific and research institutions disposing of required equipment and experts. In this manner the results of technology projects or R&D from private and public scientific research sector are applied. A basic instrument for the implementation of this Program in terms of institutions is a network of technology centers composed of the Business Innovative Center of Croatia – BICRO and technology centers within the system of support by the Ministry of Science and Technology.

In this Program technology centers are intermediary institutions intervening in the transfer and commercial use of technologies from science and technology into the industry i.e. into the economic sphere. In addition, by developing not only company's technology-related but also its business skills required for a change in technology, technology centers transfer needs and projects from the economic sector into the academic and technological community, as well as into administrative units, in order to implement joint activities. This is why technology centers can be considered as an essential factor to the regional development, and also as a factor of the national development in certain sectors of the industry or economy, in relation to the intensity of its functional specialization. In this sense the Business Innovation Center of Croatia (BICRO) is the point of integration and joint development of the technology centers network.

Technology Department has decided to start the implementation of *the Croatian Program for Innovative and Technological Development* with the second subprogram due to the following reasons:

- Technology Department has a modest budget that may be sufficient for the start-up of the Program but not for the implementation of technology projects. Their implementation depends on the resources allocated in the future by the Government of the Republic of Croatia.

- The subprogram for development of advanced technologies (products, processes/procedures, services) presents an innovation in the Croatian technology and innovative policy so there is a need for a pilot stage to test criteria and conditions for incentives for the creation of knowledge-based companies.
- This subprogram is also an introduction into the creation of new modes of financing technology development by using seed and other forms of risk capital. This presents a new technology in the area of financing, market development, and technology policy management.
- The second subprogram for development of new products, services, and technologies also includes a development of critical marketing knowledge and technology of access and analysis of existing markets and development of new markets, which is a prerequisite for a real growth i.e. development of knowledge-based companies.
- Finally, the subprogram for development of new products, services, and technologies also includes development of management technology and knowledge applied in up-to-date solutions of organizational issues.

TECHNOLOGY-RELATED RESEARCH AND DEVELOPMENT (R&D) PROJECTS

Purpose and goals of the Program

The purpose of the Program is to decrease a technological gap between Croatia and developed countries through cooperation of the academic community with the industry and other economic entities. This cooperation should be focused to research and development of technologies with a significant economic potential, and to the follow-up and transfer of the recent technology-related achievements and knowledge relevant to the development of Croatia. In addition, the Program includes research and development of advanced technologies (processes/procedures, products, and services), as well as the improvement of existing technologies with a potential for market exploitation.

The goal is to promote cooperation between the academic community (scholars and researchers) and the economy, related to the solution of specific difficulties in terms of technology, production or business operation. The aim is marketing of products, follow-up, and possible transfer of the recent technology-related knowledge, methodology and techniques ("bridging the gap" with developed countries). It is expected that the final outcome will be a revival of research in the economic sector, i.e. enhancing the existing and the creation of new R&D focal points in the industry using the potential for national scientific research.

The Program includes technology projects focused at research and development of advanced technologies (processes/procedures, products, and services), and technology projects in the field of strategic research.

Expected results

a. Short-term

- quick and efficient support to existing and underfinanced applied and developmental research relevant to direct use in the industry and economy
- stimulating scientists to initiate new R&D technology-related projects that may encourage additional investments by the industry and other economic entities
- new approach to the development of generic and strategic research in science and industry
- revival of research in the industry.

b. Long-term

- permanent cooperation between the public scientific research sector and economic sector;
- systematic development of research in the industry;
- decreasing the technology gap between Croatia and developed countries;
- increasing a general technological level of the economy i.e. improving the present state of techniques and technology;
- creation of new production/business programs, as well as new branches and sectors in the industry and the economy;
- application of knowledge and research in technology and economic development through the creation of products and services with an added value.

Users of the Program

The users of the Program are coordinators of the Program and candidates submitting project proposals.

A project may be coordinated by:

(a) any legal entity entered into the Register of Scientific Research Legal Entities maintained by the Ministry of Science and Technology;

(b) any legal entity entered into the Register of Higher Education Institutions maintained by the Ministry of Science and Technology;
(c) scholars and researchers through an institution or a unit registered for science and research or science and higher education.

A project proposal may be submitted by:
(a) any project coordinator from the previous paragraph;
(b) any economic entity and any other legal entity if a coordinator is one of the above mentioned legal entities.

Project financing

The Ministry of Science and Technology will use specially allocated resources to finance the implementation of this subprogram. The subject of financing in this Program will be as follows:
- technology projects focused at research, development, and the adoption of advanced technologies (processes/procedures, products, services);
- technology projects in the area of strategic research.

Technology projects are focused to pre-commercial development of products and technologies up to the stage of the original solution (prototype/pilot stage). They provide background and solutions for the development of processes/procedures/products/services necessary for the start-up of continued production and marketing.

They include only research and development projects that have been assessed to be of interest for the companies and contain real marketing possibilities.

Strategic technology research is research in the background of the so-called engineering or transfer science and generic technology directly creating new products and processes i.e. new or advanced technology. Strategic research is focused to the understanding of basic processes of technology impact, and it uses knowledge from fundamental sciences on one hand, and practical knowledge from engineering disciplines on the other hand, in order to advance or create new products and processes.

Strategic research includes:
1. research and development of generic technologies;
2. research in scientific fields related to transfer.

Generic technologies create technological innovations that can be used in a range of other industries, thus contributing significantly to the productivity of the entire economy. The importance of generic technologies such as information technology and communication technology, biotechnology (biochemistry, molecular biology etc.), microtechnology, new materials etc. is in the creation of intermediary products to be build into final products in various branches of industry. In this manner they connect traditional and new production sectors/industries, by generating new sectors/industries.

Transfer (or engineering) sciences such as chemical engineering, pharmacology, agriculture, medical sciences, civil engineering, metallurgy etc. operate as bridges between fundamental sciences and technology, thus shortening the period before the application of fundamental knowledge and technologies. Research in the area of engineering has significant economic potential since it contributes directly to the development of industry i.e. its technological progress, while linked to the contemporary marketing and management technology it considerably shortens the period before the commercial use of the research.

Criteria for project financing

Criteria for project financing are defined by the Technology Field Council. Criteria should reflect the complementarity of the projects with development needs of the economy, and give preference to the following principles:

- scientific research projects;
- economic (market) usefulness;
- the introduction of new or improvement of existing technologies;
- creation and improvement of R & D focal points in the industry;
- development of generic technologies;
- development of scientific fields related to transfer.

Project application

Financing of R&D technology-related projects will be implemented based on a public call for proposals announced by the Ministry of Science and Technology.

R&D technology-related projects are submitted on the application forms for proposing a technology project. The forms are available exclusively on the web site of the Ministry of Science and Technology (http://www.mzt.hr/).

Project evaluation

The Ministry of Science and Technology will establish the Technology Field Council to evaluate research and development (R&D) technology-related projects.

The Technology Field Council will be composed of renowned scholars and acknowledged experts from the industry and companies.

Projects must be evaluated not only by scholars but also by experts from the economic sector.

The evaluation of a technology project will be carried out according to the elements of a project proposal defined by the application forms for proposal of a technology-related R&D project.

Application and evaluation of technology-related R&D projects will be carried out following the same procedure and technique as the application and evaluation of scientific research projects.

DEVELOPMENT OF KNOWLEDGE-BASED COMPANIES

Purpose of the Program

The purpose of the Program is to stimulate development of knowledge-based companies and technological modernization of companies by developing existing and/or introducing new production and service programs, primarily by involving national scientific research resources from universities and public institutes. The efficiency of the Program is measured through the level of company's success at the market, so the emphasis of the Program is to stimulate and enhance company's strategic capabilities to achieve competitive advantage and make strategic and investment partnerships leading to continuous growth of production, export and employment.

In addition to the transfer and use of new knowledge, technology, methodology and know-how arising from the national academic community, technology sector and the industry, the Program also implies the transfer of foreign knowledge and technology with the assistance of Croatian scholars and researchers.

Program implementation stimulates and promotes cooperation among scholars and academic institutions with small and medium knowledge-based companies. In addition the Program endorses cooperation with specialized agencies, companies and other supporting institutions in Croatia and abroad with small and medium knowledge-based companies.

A knowledge-based company is a company that has achieved its competitive advantage, technological capability i.e. its development and growth using knowledge i.e. research and development converted into advanced technologies (processes/procedures, services, and products).

Technological modernization of companies implies development of knowledge and skills related to production and service activities, i.e. the introduction of advanced technologies (processes/procedures, services, products) into the production and business programs or significant improvement of existing technologies. In this manner the company accumulates technological capability i.e. research and development, based on the application of knowledge i.e. R&D. In addition, technological modernization of a company implies development of management and marketing skills necessary for the achievement of competitive advantage.

Goals of the Program

The Program is expected to achieve the following short-term and medium-term goals:

a. Short-term goals:

- start-up and development of new companies based on new or considerably improved technologies (processes/procedures, services, products), and development of the so-called academic entrepreneurship;
- technological modernization of a company, and improvement of its capabilities related to the production, marketing and management;
- creating new jobs, especially for professionals with the associate and bachelor degree;
- improvement and standardization of quality of products and services, and introduction of new or advanced technologies related to products or services;
- identifying potential business partners, development of existing markets and access to new markets;
- development of competitive advantage in international scale with the emphasis on internal growth/development;
- transfer of foreign knowledge and technology and their further development for its own needs;
- stimulating joint cooperation of experts from the entrepreneurial and research sphere;
- start-up of new technology centers, parks and similar institutions in the function of development of technological infrastructure;
- preparation of domestic companies for participation in international programs for development of new technologies such as COST, EUREKA; BRITE-EURAM etc.

b. Medium-term goals

- increasing general technological level of the economy i.e. improving the present state of technics and technology, as well as stimulating the creation of new production programs/branches of industry;

- gradual creation of export-oriented sectors of knowledge-based small and medium-sized companies;
- development of competitive advantage on international scale, relying on internal growth and development or external growth and development (networking of companies), respectively;
- preparation of Croatian companies for the participation in international programs for the development of new technologies;
- support to the development of new private branch of financial industry: seed and interest capital;
- attracting foreign funds involving risk capital (seed and interest capital) and direct foreign investments;
- gradual creation of the national system of innovations and strategic partnership between the private and public sector;
- gaining experience in the use of the so-called technological change for economic development i.e. increasing the profit rate (profitability) based on the use of knowledge, development and research.

Users of the Program

Users of the Program may be:

a) potential entrepreneurs i.e. citizens of the Republic of Croatia who wish to set up a new company in Croatia, based on development or introduction of a new product or technology;

b) companies:

- with a seat in the Republic of Croatia;
- with prevailing private ownership;
- independent of management by other companies.

Activities to be financed

Activities to be financed are as follows:

1. development and commercial use of advanced technologies (processes/procedures, products, services);
2. development aimed at technological modernization of a company.

In this Program development implies activities that include development of original solutions (prototypes/pilot stage) in a direct function of the commercial use of a product/service. It also implies the introduction of a product/service into the market and creating the conditions for continued production.

Technological modernization of a company implies the introduction of advanced or new technologies (processes/procedures, products, services) into production programs or their improvement/modification that differs in important functions from the existing program and therefore presents a new production/business process/procedure, product, service.

Advanced or new technology and technological modernization of a company implies development and commercial use of a process/procedure/product/service with a considerably increased added value that is achieved by the use of knowledge i.e. research and development.

Technology fields

The Program will give incentive to products and services with the increased added value from all fields of production and service activities, particularly if they:

a) contribute to the overall quality of living:
- environmental protection and clean production technologies;
- technologies for saving the energy, materials and natural resources.

b) belong to generic technologies, e.g.:
- information and communication technologies;
- biotechnology (biochemistry, molecular biology etc.);
- micro- and nano-technologies;
- new materials;
- intelligent production systems.

Principles of financing

Funds will be granted for entrepreneurial projects that fulfill the following criteria:

1. technical-technological innovations in terms of creating a product, process or service with a high added value;
2. academic entrepreneurship and/or setting up a company as a continuation of research in an institution engaged in scientific research or science and education;
3. planing or improving cooperation with the university or any other scientific research institution (institute, department etc);
4. developing generic technologies primarily: (1) information and communication technology, (2) biotechnology (biochemistry, molecular biology etc), (3) micro- and nano-technology, (4) new materials etc;
5. developing competitive advantage, especially oriented to the export and strategic partnership;
6. increasing diversification of the structure and scope of financing.

Principles of financing are implemented using the respective criteria, while priority in financing is expressed by weight, thus forming the base for the evaluation process.

The evaluation procedure has been defined by the Regulation on the Procedure for the Implementation of the Program for Development of Knowledge-Based Companies, and on Conditions and Financing of the Program, or Criteria and Activities in the Program Implementation, respectively.

Modes of financing

Funds will be granted based on a public call for proposals announced by the Ministry of Science and Technology, according to the documentation and procedure determined by the Directive for the Implementation of the Program for Development of Knowledge-Based Companies, Criteria and Activities in the Program Implementation, and the Program Budget for a Financial Year.

The Program foresees financing entrepreneurial projects in the form of:

a. non-repayable funds for research & development activities and expert consultations
b. financing with favorable repayment conditions
c. financing with the provision that repayment is required only in case that the project is successful
d. investment into a share capital of a company
e. supporting projects through the guarantee funds.

Modes of financing and a repayment guarantee are defined by the Regulation on the Procedure for the Implementation of the Program for Development of Knowledge-Based Companies.

Financing will be implemented through the authorized financial institutions that follow the requirements defined by the contract with the Ministry of Science and Technology.

A public call for proposals will include the preparation of a preliminary application (a short project proposal and documentation), and an application (business plan/investment study) according to the elements determined by the Regulation on the Procedure for the Implementation of the Program for Development of Knowledge-Based Companies, and Criteria and Activities in the Program Implementation.

Authorities responsible for the Program

The authority responsible for the *Program* is the Ministry of Science and Technology.

The Ministry of Science and Technology will entrust the network of technology centers with the Program implementation, project evaluation and monitoring the development of projects. The network is composed of the Business Innovation Center of Croatia (BICRO), and technology centers within the system of support of the Ministry of Science and Technology. Independent consultants and other competent institutions will be involved as circumstances require. BICRO will decide on project financing.

Project evaluation

The evaluation of applications will include the following assessments and procedures:

(1) (technical review of all elements of a preliminary application and application;

(2) (expert evaluation of a project according to the elements set by a preliminary application, and business plan/investment study in case of the application;

(3) (evaluation of entrepreneurial and management skills of the entrepreneur in a final stage of the project evaluation, including an interview with the applicant;

(4) (rank ordering of submitted projects according to the criteria and priorities for project selection determined by the Regulation on the Procedure for the Implementation of the Program for Development of Knowledge-Based Companies, and Criteria and Activities in the Program Implementation.

Organization and implementation of the Program

The Program will be implemented as follows:

1. preparation of documentation for a public call for preliminary applications and applications, as well as legal and other required documentation;
2. announcement of a public call for preliminary applications and collecting proposals;
3. evaluation of preliminary applications by technology centers;
4. selection of projects that can start the elaboration of the application (business plan/investment study);
5. evaluation of applications;
6. contracting entrepreneurial projects;
7. financing entrepreneurial projects;
8. providing systematic support to the companies within the Program;
9. systematic monitoring of the implementation of entrepreneurial projects within the support system;

10. achieving the so-called output (applying exit mechanisms) for the companies within the system of financing their ownership capital.

The Ministry of Science and Technology reserves the right to propose modifications of the Directives and related documents on its own initiative or on the initiative of any participant in the Program. The modifications will be approved by the Interdisciplinary Control Committee.

FOOTNOTE

* The Government of the Republic of Croatia has accepted on April 5, 2001, the following documents that make a legal framework for the current technology and innovation policy under the responsibility of the Ministry of Science and Technology:

1. Croatian Program for Innovative Technological Development (HITRA), adopted by the Government of the Republic of Croatia on April 5, 2001;
2. Guidelines for the Implementation of the HITRA Program Involving the Potential for National Scientific Research, adopted by the Government of the Republic of Croatia on April 5, 2001;
3. Regulation on the Procedure for the Implementation of the Program for Development of Knowledge-Based Companies, Official Gazette of the RH, No. 33/2001.

ABSTRACTS

Henry Etzkowitz

LEARNING FROM TRANSITION: THE TRIPLE HELIX AS AN INNOVATION SYSTEM

A triple helix of overlapping spheres of university-industry-government is increasingly the core, rather than the periphery, of national, regional and multi-national innovation systems. This paper discusses the methodology of achieving a triple helix transition through initiatives in knowledge, consensus and innovation spaces. Policy recommendations are offered to create an innovation system based on university-industry-government interactions.

Key Words: triple helix, endless transition, entrepreneurial university, knowledge, innovation and consensus spaces.

Franc Mali

THE NEED TO ACCOMMODATE THE NATIONAL INNOVATION SYSTEMS OF SMALL TRANSITIONAL COUNTRIES TO THE MAIN PRINCIPLES OF NEW EUROPEAN RESEARCH AREA

The main goal of the contribution is to answer how the small countries in Eastern and Central Europe are meeting with the challenge of the increased processes of globalization. The recent processes of globalization are leading to unprecedented integration of nations and localities in the new global order. Even nations with very large human resources are forced to join their R&D efforts to supra-national entities. But, we cannot even think about globalization without referring to specific locations and places. It is global-local dialectics which different analytics have in mind when they talk about "globalization". That is true for the situation in Europe as well. There is no doubt that after a more than two decades of action, common intervention had created a new R&D scene in Europe. The new European Research Area (ERA), as this idea is experienced among EU Member States, Acceding and Candidate

Countries, is in many respects not only new, but also revolutionary. For small transitional countries in Eastern and Central Europe, the "philosophy" of ERA is very important, because it encourages national and international R&D synergies. To implement the "philosophy" of ERA, The European Commission has embarked upon a serious of actions to tie the researchers in the common European R&D programs. The instruments and actions in the context of ERA further research partnerships among the R&D groups of all European countries, focus their efforts to interdisciplinary, practically relevant and applicable issues and give attention to – what is especially important for the small transitional countries in Eastern and Central Europe – the cooperation between the academic research sector and industry. The contribution emphasizes the above indicated issues. Primarily, it will analyze the situation in small transitional countries in regard to the processes of commercialization of the academic science. In many respect, the commercialization of academic science is becoming a fundamental value not only in USA, but in Europe as well. ERA effectively promotes cross-sector cooperation. The main thesis of the paper will be that for small transitional countries in Eastern and Central Europe it is very important to follow the strategic goal of ERA: to create strong university-industry-government relations. Namely, these relations are not important only because the diffusing basic research findings to practice. They are important because of re-definition of old-fashioned scientific values in this part of the world as well.

Key words: European Research Area (ERA), CEEC, transition countries, R&D systems.

Slavo Radošević

(MIS)MATCH BETWEEN DEMAND AND SUPPLY FOR TECHNOLOGY: INNOVATION, R&D AND GROWTH ISSUES IN COUNTRIES OF CENTRAL AND EASTERN EUROPE

Paper analyses the relationship between R&D and innovation in countries of Central and Eastern Europe. It points to a gap between local demand and supply for R&D and innovation as one of the key issues for long-term growth of the region. Analysis is based on innovation survey, R&D, patent and business survey data. Based on analysis paper develops policy implications.

Key words: CEEC, long-term growth, innovation gap, R&D system, innovation system.

Devrim Göktepe

A NETWORK PERSPECTIVE ON EU ENLARGEMENT: THE ANALYSIS OF SIX-EUROPEAN NATIONAL INNOVATION PROGRAMS AND IMPLICATIONS FOR TRANSITION ECONOMIES

The concept of innovation networks has become popular among academics of various disciplines and policy-makers. Though innovation network concept has been used in national, sub-national or sectoral innovation analyses and policy development, it *has not been utilized* enough at the international levels such as political institution building both in the transition countries and in the European Union enlargement. It is the belief of the author that although all nations have experienced unique trajectories in transition to knowledge-based economy, they are all advised to utilize networking between the users and producers of knowledge as a prevalent policy-tool to utilize the benefits of knowledge-based economy. This similar modus operandi of the national innovation programs would less complicate the enlargement of EU especially concerning the establishment of a common research area and cooperation in innovation.

Key words: transition economies, policy appropriation, institutional set-up, international innovation networks, EU enlargement.

Željka Šporer

KNOWLEDGE-BASED ECONOMY AND SOCIAL CAPITAL IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

The comparative analyses between the EU and the CEEC using 17 economic indicators reveals a complex picture of similarities and differences. In some respects, the difference between the European south and north is bigger than the difference between EU and CEECs. The capabilities of the human capital in CEECs are not far behind the EU, and are above those of south Europe. Orientation toward an open economy (globalisation) is present more in some CEECs than in most of the EU countries.

CEECs in general, invest less in research. Governments are still heavily involved in research funding in countries with a tradition in strong central planing systems and a large number of researchers. In other CEECs business enterprises are starting to be more involved in research funding but on average are still far below the EU. CEECs are substantial lagging behind EU countries in implementing new communication and information technol-

ogy. These countries are not taking advantage of the new cycle of innovation. As a consequence, the technological gap widens even further.

The ability to implement and adapt to change depends on social capital. Some dimensions of the value system indicate the prevalence of a modernistic orientation in CEECs. But because the communist system was dysfunctional, especially in relation to the market and democracy, social capital was rapidly replacing the imperfection of the formal system and social networks. Trust became more important than the law and regulatory institutional systems.

Key words: Knowledge-based economy and society, economic indicators, social capital, Central and Eastern Europe Countries, European Union, comparative analysis.

Jadranka Švarc
Jasminka Lažnjak

WHY HAVEN'T THE EU ACCESSION COUNTRIES YET ACCESSED KNOWLEDGE-BASED SOCIETY: WHAT CAN SOCIAL SCIENCES DO ABOUT IT? THE CASE OF CROATIA

The main thesis of the paper is that moving towards knowledge-based society is deeply socially and politically rooted. To support the thesis the authors analyze the social context of R&D and innovation activities in Croatia - an East European country in transition. The state of social and political "semi-modernism" in Croatia prevents the recognition of innovation and technological change as the main driving forces of the new economy. It also prevents the establishment of the national innovation system (NIS) which is the environment necessary for structural changes towards the new economy. The main components of the Croatian NIS are described to illustrate the influence of semi- modernism and the failures of the de-industrializing intellectual and political elites.

The authors compare the two models, the national innovation system and the triple helix (TH). They find out the striking similarity between NIS used to describe the transformation of economy towards innovation based competition and the concept of the Triple helix used in social sciences as an useful theoretical and analytical framework for studying the social process of that same "endless transition" towards the knowledge-based society. The authors conclude that the role of TH in social science closely corresponds to the role of NIS in economic sciences. The TH model of evolutionary convergence of the

three helices towards economic growth resembles the idea of managing innovation and designing growth by building NIS.

Finally, the paper argues that the concept of TH is suitable even for the less developed countries because today the transfer and imitation of innovation are knowledge intensive as well as network activities. If nothing else, the Triple-helix model of communication between helices is a democratic way of setting up national development priorities that Croatia, a semi-modern society, lacks.

Key words: EU accession countries, knowledge-based economy, triple helix, socioeconomic aspects, national innovation system, social sciences.

Vesna Andrijević-Matovac

CROATIAN NATIONAL INNOVATION SYSTEM: HOW TO CREATE AND TRANSFER KNOWLEDGE AND TECHNOLOGY

Innovation is increasingly important to business success. However, business efforts toward innovative activity are much more effective if the government plays its role through the National Innovation System.

The goal of this paper is to explore the possibility of improving the Croatian National Innovation System. First, the characteristics of the Croatian National Innovation System are presented. A survey on the innovation activity of Croatian firms is conducted and the results are briefly described in the paper: (1) transfer of new technology, (2) innovative and patent activity, (3) goals of innovative activity, (4) sources of ideas and information for innovative activity, (5) factors that influence innovative activity, (6) strategy of firms, and (7) investments in knowledge and research and development. The paper examines the experiences of successful countries that base their economy on innovations, and describes the experiences of Croatia's most successful firms. The disadvantages of the Croatian system for encouraging innovations are examined and the Croatian system is compared with the ideal national innovation system.

The following measures for increasing the effectiveness of the Croatian National Innovation System are presented: (1) measures for increasing input quality, (2) measures to provide a suitable environment, and (3) measures for improving communication. Measures for increasing input quality include intensifying the quality and availability of education, especially in computer science, increasing financial support for education, research and in-

novative activity, and decreasing the tax burden for innovative firms. Measures to provide a suitable environment include simplifying and lowering the cost of intellectual property protection, reducing bureaucratic procedures that block entrepreneurs, fostering consulting services for innovators, and encouraging firms that are oriented towards the development of new products and towards increasing their quality. Measures for improving communication are the triangular distribution of knowledge among universities, research institutes and industry, and promoting the innovative culture among Croatian citizens.

Key words: innovation, technology, national innovation system, economic growth.

Maja Bučar

SLOVENIA'S POTENTIAL FOR KNOWLEDGE-BASED ECONOMY WITH FOCUS ON R&D AND INNOVATION POLICY

The paper addresses the R&D and innovation policy of Slovenia as a country with the ambition to actively promote transition to knowledge-based economy and society. It starts with the presentation of the key factors which according to the World Bank KAM project determine the readiness of a particular country for knowledge based economy and looks into the position of Slovenia. In particular, attention is given to the current R&D and innovation policy. The implementation of basic elements of knowledge based economy and society is closely linked to the transition to a more innovative economy. This on the other hand is only achievable with a much more focused R&D and innovation policy, which needs to become a central element of development policy. While several documents reflect Slovenia's government's awareness of the topic, the day-to-day policies fail to implement the set goals.

Insufficient attention given to the so called "soft" indicators and horizontal measures (including a development of a coherent national innovation system) may in the long run be one of the key factors for slower growth and development of Slovenia and restrict its possibilities for catching-up with developed countries. On the other hand, forward-looking R&D and innovation policy could contribute significantly to the transition to knowledge-based economy and society. Lessons learned from Slovenia can be highly relevant also for other transition countries.

Key words: innovation policy, Slovenia, Slovenian system of innovation.

Mira KRNETA
Anči LEBURIĆ

THE APPLICATION OF THE TRIPLE-HELIX MODEL IN AGRICULTURAL SECTOR OF CROATIA

Since the nineties the technological development and various innovative activities have been considered to be the most important sources of productivity rise and of the material wealth of every country. The improvement of the competitive position has been broadly based upon knowledge, i.e. the ability to develop new products and methods and apply them when answering to the development challenges of a company, economic sectors and the economy in general.

Knowledge is regarded as the common welfare that can be shared by all human beings without loosing its value. The companies are directed to R&D activity and their cooperation with the researching institutions becomes more intensive. However, prevailing are the indirect ties between companies and the researching institutions. The lack of some linking mechanism between the companies and the researching institutions has been noticeable. Building and spreading of knowledge has been markedly interactive and in communication terms an intensive process, therefore, it is necessary to develop mechanisms that would stimulate the company ability to build knowledge, to create links with other companies and with own R&D environment. Consequently, the usual role of an university has been more frequently redefined to the role of creating the source of knowledge which is having an indirect influence upon the development of industrial innovations and entrepreneurship.

Nowadays, in numerous countries, the regional economic development has been encouraged by the government policy through relying on universities, R&D institutes and small and medium sized companies. Creating the system of relations among the universities, industry and state for the purpose of providing for the conditions necessary for transition into the knowledge-based society can be operationalized by Triple-Helix model. The model is based on commercialization of researching where universities, industries and governments take part, and, therefore is regarded to be the relevant methodological approach for faster development of socio-economic system in Europe and Nordic countries, as well as the development of innovative centres that would serve as supports to the small and medium-sized entrepreneurship in Italy, modern Russia and similar. In such model environment, the government, by taking different measures, including securing of financial sources for R&D and creating of nets of small and medium-sized companies, determines the main directions of the sector and region development of the country. Projects having particular interests and common social importance are being formulated. The companies are focused on creating new products or technologies, and in an feedback operation, suggest the fields of research to the universities and R&D organizations.

The authors, in the mentioned context, analyse projects in the agricultural sector of Croatia, which projects are based on the application of in-vitro technology in production of seed potatoes and pyrethrum flowers (*Chrysanthemum cinerariefolium*). The former project is undergoing the accomplishment stage, i.e. the first tone of the seed material, free of viruses, cultivated in green-house conditions, has been produced and planted on plough-fields for further multiplication. The latter project is in the phase of goals determination, scope planning and defining of the relations that would create the Triple-Helix model matrix as the prerequisite for the successful project launching.

Both projects have been assessed important in terms of the country economic development since they relate to one of the strategic agricultural products – seed potatoes are still imported and the importing dependence of the country is beyond dispute. In the other example, pyrethrum is considered to be the basic product in the development of ecological agriculture.

The accomplishment of the projects illustrated above presume linking of the sources of knowledge, the applicable ones in particular (universities, green-house production), with the industrial production (a large farming production capable to ensure the production base for commercialization of knowledge and a group of sub-contraction relations), as well as the economic policy incentives in the accomplishment of R&D of the projects' development part, financing, employment policy etc.

The authors conclude on the usage of the research findings with respect to (1) planning of the agricultural sector development strategy, particularly the development of certain farming products and regions (areas of special government concern, islands and similar); (2) creating of the development stimulation system corresponding to the goals defined by the development strategy; (3) concretization of the role of universities, of certain faculties, i.e. certain R&D institutions in the process of building and spreading of knowledge.

Key words: triple helix, agricultural sector.

Sonja Radas

INDUSTRY-SCIENCE COLLABORATION IN CROATIA: FIRM'S PERSPECTIVE

It has been recognized that industry-science relationship is at the core of national innovation systems, however in most European countries there is a gap between the public research and industry. An important barrier for industry-science collaboration that was identified in prior research is that these two worlds have different priorities, goals and culture. Understanding these differences can help improve the science-industry relationship, and consequently improve the functioning of the innovation system.

This paper reports on a study that was performed in spring of 2002. The study examines impediments to science-industry collaborations in Croatia. Hundred and ninety firms were surveyed, as well as ninety-five scientists from sixty institutions. In addition, fifty directors of research institutions were surveyed. This paper examines how each of the surveyed groups perceive the existing collaboration and investigates their motives for collaboration. This analysis offers insights into the functioning of the industry science relationship in Croatia.

Key words: industry-science cooperation, Croatia, survey.

Sanja Tišma
Krešimir Jurlin
Anamarija Pisarović

THE ROLE OF RESEARCH AND DEVELOPMENT IN ENHANCING CROATIAN COMPETITIVENESS

The ability to participate in the scientific and technological progress, through increasing productivity of factors and enhancing the quality of products and services, is the key element of the economic growth. Moreover, competitiveness of national economies is no longer relying on low labor costs, but on knowledge and investment in R&D aiming at upgrading the processes and products. Therefore, the innovation policy in research, production, management and all accompanying business activities shall be stimulated.

This paper is based on the results of the Annual Report on Croatian Competitiveness, which has been prepared following the Global Competitiveness Report 2002/2003 of the World Economic Forum (WEF). The

aim of the paper is to identify the role of research and development for enhancing the competitiveness. The analysis of the R&D activities in Croatia in the 1997-2001 period is accompanied by the benchmarking analysis of Croatian performance in R&D compared to 12 selected referential countries, including both hard data and the results of the executives survey, contained in the Global Competitiveness Report.

Data suggest that Croatia is lagging behind in technological progress due to low R&D in business sector focused on defensive restructuring, and not recognizing knowledge and technology as important production factor by state. In this regard the paper shows basic policies of R&D stimulation highlighting the role of state in the promotion of modern education system, financing the public research projects, and in stimulating research and development in the business sector. It is of the utmost importance to develop mechanisms for promoting the cooperation between enterprises, university, public and private research institutes.

Key words: knowledge, innovation, technology, research and development, Croatia, competitiveness.

Ilian Petkov Iliev
Domagoj Račić

VENTURE CAPITAL FIRMS AS PRODUCTION NETWORK PARTICIPANTS IN TRANSITION ECONOMIES

A comparison between the industrial structures of developed and Central and East European economies (CEEs) reveals that in CEEs Small & Medium Enterprises (SMEs) play a comparatively smaller role in corporate production networks, and are characterised by lower levels of innovation. This contributes to a lower level competitiveness and flexibility in CEE production networks, which justifies a research focus on the sources of this difference, and the identification of mechanisms to improve this aspect of CEE economies. We focus on Venture Capital firms (VCs) as an organisational form that can contribute to increased levels of innovation in CEE SMEs and increased levels of competitiveness in CEE production networks.

In developed economies VCs play an important role in the identification and development of innovative SMEs and their integration in production networks. By contrast, in CEEs VCs are less important as a source of support for innovative SMEs. We distinguish two areas of interaction between VCs and corporate production networks: directly, through the sale of VC-backed firms to corporations, the use of VCs to develop corporate spin-offs and Corporate Venture Capital (CVC) programs; and indirectly, through VCs facilitating science-industry technology transfer via their supportive role for the selection, development and integration in production networks of Higher Education Institutions (HEIs) spin-offs. In CEEs VC investments have so far been focused on SMEs that are readily integrated in MNE production networks, with very little interaction with domestic corporate production networks and HEIs. This type of investments have tended to be in late-stage companies characterised by low levels of innovation. We see this pattern of development as problematic, as the impact of MNEs is limited to SMEs that fit in with MNE strategies, which leaves out the possibility of developing innovative SMEs and strong linkages with domestic production networks.

We identify two general areas where barriers to the further development of VC role in domestic industry. Firstly, domestic corporate strategies are characterised by low levels of linkages with SMEs, and low levels of technology development, and weak linkages with HEIs. In the VC industry this is manifested by little interest in purchasing innovative SMEs from VCs, few corporate spin-offs that could be supported by VCs, and no significant corporate venturing programs. Secondly, science-industry technology transfer policies remain underdeveloped, with weak technology transfer mechanisms. Consequently, the incentive systems, resources and organisational support are not in place that would allow the development of HEI spin-offs, which in turn has meant few avenues for linkages with VCs. We argue for the urgent need of formulation of policy measures in these two areas, in line with the overall policy maker concern with increasing the knowledge-intensity of CEE economies. This in turn necessitates further research focused on the problems we identify.

Keywords: venture capital, production networks, transition economies, systems of innovation, small and medium size enterprises.

Marina Dabić

TECHNOLOGICAL MANAGEMENT: EXPANDING THE PERSPECTIVE FOR CROATIA

Globalization has increased competition which has shortened the product life cycle forcing firms to integrate product development with development of technologies (Bhalla,

1987; Drejer, 2000). Due to these global pressures, technology management has gained increased attention in the research environment. Unfortunately, there appears to be very little consensus on what technology management actually is. This research illustrates the differences between R&D management, management of technology and technological management. Also, the process that integrates the impact of technology on management functions with the other traditional managerial activities to identify and exploit business opportunities is described utilizing an interdisciplinary vision and multidisciplinary approach. The findings are presented in the transitional economy of Croatia with a focus on technology management in the context of global competitiveness.

Key words: R&D Management, Management of Technology (MOT), Technological Management, technology – knowledge diffusion process, CEE countries and Croatia.

Denisa Krbec

"EUROPEANIZATION" OF EDUCATION: CHALLENGES FOR ACCESSION COUNTRIES

In the Communication "Towards Europe of Knowledge", the European Commission for the first time officially set out the guidelines for future action by EU member-states in the areas of education, training and youth for the period 2000-2006. The process is directly linked to the aim of developing a lifelong learning strategy, which the Union has set itself to promote the highest level of applied knowledge.

The Communication was adopted as a further step toward improving the coordination between education policies and their social effects on the development of human potentials. Furthermore, the idea of a "European education space", similar to the proposal for the "European research area" is fundamental to the contemporary structuring of the EU. In this frame of references a particular problem in the "Europeanization" of education is presented with respect to higher education.

This paper focuses the creation of a strategy for changes in Croatian education policy. Despite current debates and adoption of the Scientific Research and Higher Education Law in July 2003, a general academic consensus has already been moving toward establishing a form of international standards, especially in the context of Croatia's approach toward joining the European Union. Despite radical reconstruction of different inter-organizational and procedural academic activities, the creation of a "European education space" at all levels is the basis of a faster and more efficient integration and implementation of knowledge, training and work in this new Europe.

Key words: knowledge, education system re-form, "Europeanization", European Union, Croatia.

Katarina Prpić

GENERATIONAL DIFFERENCES IN RESEARCHERS' PROFESSIONAL ETHICS: AN EMPIRICAL COMPARISON

Empirical studies of research ethics, sociological or other, have been rarely carried out, and the existing ones usually follow two different lines of research interest: interest in scientific misconduct or preoccupation with scientists' cognitive convictions. The latter can be also discerned from the studies of scientific quality, especially research focused on the criteria of evaluation. Yet, such data are partial too. Unless we gain a comprehensive empirical insight into both levels of research ethics – the normative and the behavioural level – the contrasting descriptions of old academic and new research ethics are merely hypothetical models. So, the discussions and controversies concerning that subject remain mainly speculative and thus not very promising.

In order to achieve a better insight, two comparable empirical studies of scientific ethics were carried out in Croatia. These studies started from the sociological concept of professional ethics as a constituent component of a profession. The conceptual framework helps in avoiding the onesidedness of traditional understanding of the scientific ethos as a unitary and static set of norms, from which scientists depart very little in everyday professional life. The concept may be also helpful in avoiding another extreme: equalisation of the research ethics with professional ideology meant for the public, without any deeper importance in scientists' daily work. Research ethics is thus defined as a set of professional values and norms, but also as everyday professional practice of scientists, including their ethically problematic behaviour. On both levels, scientists' professional ethics is seen as composed of cognitive and social elements; it consists of standards of scientific work and standards of behaviour in social relations connected with the performance of this profession. Operationalization of these cognitive and social standards was based on some theoretically articulated and empirically examined normative and behavioural components of scientists' professional ethics.

In both empirical investigations, the same batteries of questions were used: a) respondents' ratings of the importance of professional standards; b) respondents' perceptions of the accordance of scientists' daily behaviour with these standards; c) respondents' perceptions of the incidence of ethically questionable behaviour and research practices in their institutions. Besides, the time interval between the investigations was not long (three years) which makes the comparison acceptable, since there were no radical social, economic or political changes and events that could have influenced the respondents opinions and perceptions. Both studies were carried out by the use of mail surveys; the first one in 1995 and the respondents were eminent Croatian scientists (N=320), and the second in 1998 on a sample of 840 young researchers. Since the eminent were much older, a comparison of two groups can show some generational differences in professional standards and perceptions of daily research practice. To analyse these changes will be the primary aim of this paper.

Key words: scientific ethos, researchers' professional ethics, young scientists, eminent scientists.

Matko Meštrović

INTANGIBLES' VALUE – A CHALLENGE TO POLITICAL ECONOMY OF INFORMATION

I would like to remind us of two extremely important warnings that could serve as a latent or virtual imaginative framework for any serious consideration of what an information society, as a notion or reality, is.

Changing from the perspectives of *restrictive* economy to those of the *general* economy implies a reversal of thinking – and ethics. The possibility of pursuing growth is itself subordinated to giving. An immense industrial network cannot be managed in the same way that one changes a tire... it expresses a circuit of cosmic energy on which it depends, which it cannot limit, and whom laws it cannot ignore without consequences (Bataill).

The differential deployment of technoscience or tele-technology obliges us more than ever to think the virtualization of space and time, the possibility of virtual events whose movement and speed prohibits us more than ever from opposing presence to its representation, "real time" to "deferred time", effectivity to its simulacrum. The mesianic trembles on the edge of this event, it is this hesitation (Derrida).

Key words: value of intangibles, information economy, intellectual capitalism.

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Jasminka Lažnjak
Željka Šporer
Darko Polšek

Reviewer:
Duško Sekulić
Richard Blandy

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