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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

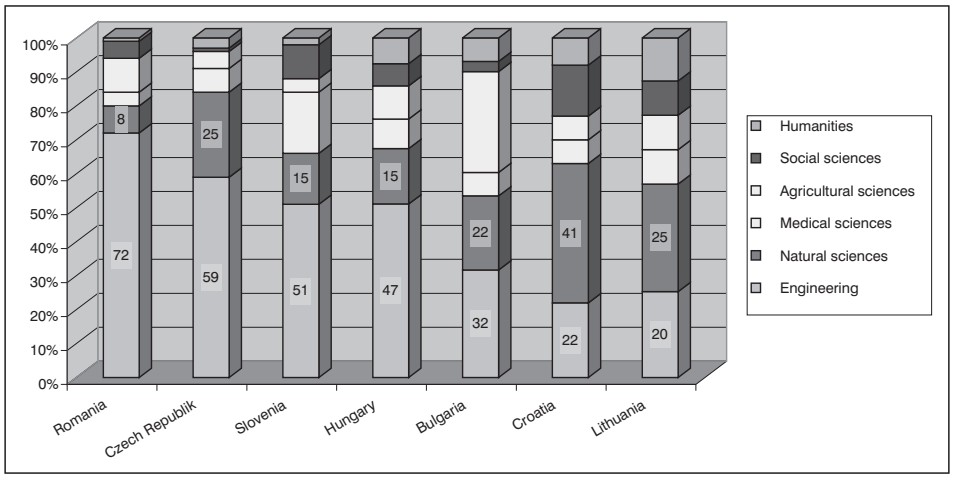
Source: Eurostat, Statistics in focus, Theme 9 – 1/2003, 3-2003 "Research and development 2000", State Bureau of Statisitcs

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 insignifi-

cant 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 37th 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 67th 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

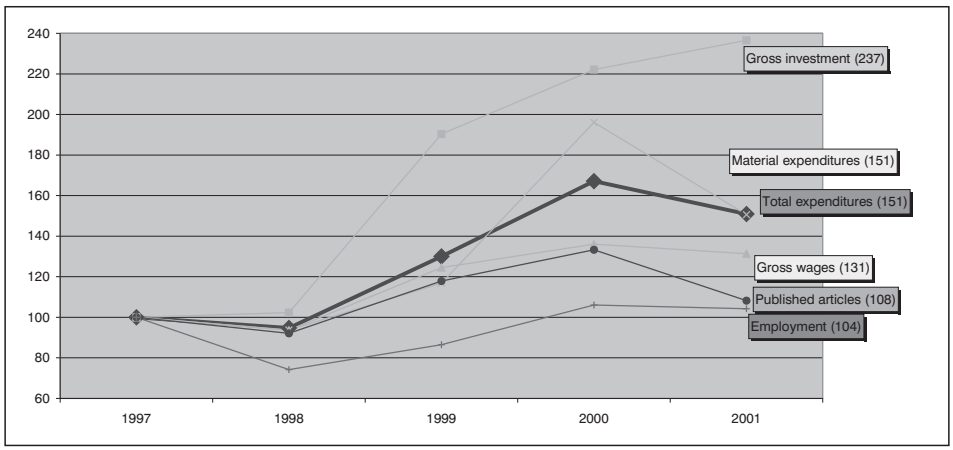
	1997	1998	1999	2000	2001	2001/1997
current prices						
Nominal expenditure (000 Kn)	958.351	981.215	1.397.761	1.881.839	1.780.379	1,86
Business sector	311.182	343.540	609.337	847.874	739.868	2,38
Government sector	326.218	260.683	298.602	405.382	403.311	1,24
Higher education	320.951	376.992	489.822	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.

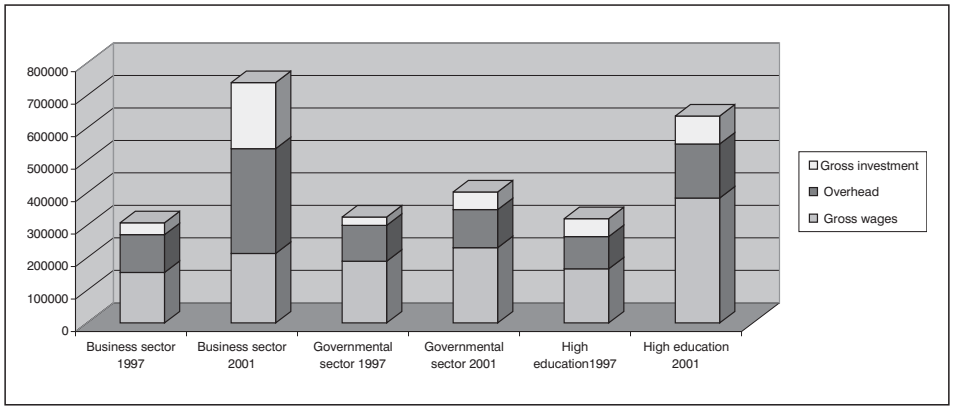


Source: "Research and development" 1997-2001, State Bureau of Statistic

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 re-

placed 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.

LITERATURE

Edvinson, L. (2003), *Corporate longitude. Navigating the Knowledge Economy*, DIFFERO d.o.o., Zagreb.

Eurostat, Statistics in focus, Theme 9-1/2003, 3-2003 "Research and development 2000", State Bureau of Statistics.

National Competitiveness Council (2003), Annual Report on Competitiveness in Croatia 2002.

Posner, M. V. (1961), "International Trade and Technical Change", *Oxford Economic Papers*, 13:323-341.

Research and development 1997-2001, State Bureau of Statistic, Zagreb, 2002.

Simonić, A. (1999), *Znanost: najveća avantura i izazov ljudskog roda*, Vitagraf d.o.o., Rijeka.

Švob-Đokić, N. et al. (2002), *Research and Development Policies in the Southeast Countries in Transition - Republic of Croatia*, Institute for International Relations, Zagreb, 2002.

UNCTAD (1999), "World Investment Report 1999", New York and Geneva.

World Economic Forum (2002), Global Competitiveness Report 2002/2003, Geneva.