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The future of Croatian innovation and entrepreneurship

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Abstract

In a business sense, innovation represents the commercialization of an invention, and, respectively, its efficient introduction to the market. From this definition it is obvious that innovative potential can be increased if we keep working on our creativity on one side and keep creating prerequisites for successful commercialization on the other. These exact prerequisites, formulated by strategic documents and active enticing policies, make up the framework which we call the National Innovation System (NIS). Innovation process consists of three key elements: i) a high quality research base (universities, research institutes), ii) appropriate and sufficient financial resources and iii) technological and business infrastructure. An agency (in Croatia, Business Innovation Center – BICRO) plays a key role within an effective NIS. This agency is connected to the State but operates independently and its people act as a catalyst of connections between all stakeholders. Government should have a leading role and make counter cycle decision in order to maintain persistent level of the investment in R&D. Great achievements in scientific and technological innovation Croatia were made during the period 2003-2009 while currently (mainly because of the economic crisis) Croatia is facing a significant stagnation.

INTRODUCTION

Croatia's economic and social development achievements between 1996 and 2008 showed a growth of approximately 4 % per annum, which was not only an impressive result but also the reason why Croatia was closing in on the income gap it had when compared to the European Union. However, in the last four years Croatia has fallen back to an average pace of 2,6%, with growing account deficits, current external debt which is getting close to 100% of the GDP, small gains in productivity and scarce innovation. This raises a legitimate question whether Croatia has chosen a valid model for its growth.

This review will show that that Croatia has an unleashed potential, and it will state which elements can be a generator for inclusive and sustainable growth.

Croatia is country with a transitional economy, with set methods on how to reach the leading global economies. However, in this model, government spending is set to a very high 38% of GDP in 2008 (Figure 1). In comparison, the EU and USA have just above 20% and Germany has an extremely efficient economy in which the budget spending

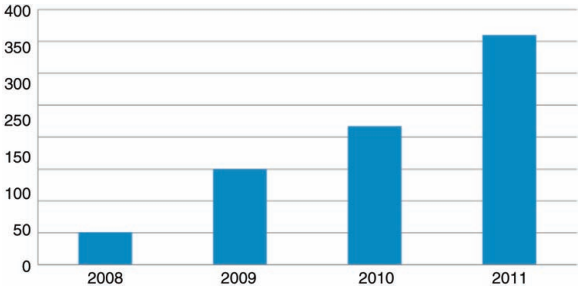

Figure 1. *Number of jobs created in TEHCRO centres.*

represents 13.7% of GDP. If Croatia's high government spending does not result in growth, the government should consider a reallocation of its spending.

NATIONAL INNOVATION SYSTEM

Innovation and entrepreneurship are key drivers of sustainable economic growth. Since 2004, more than 1,000 national and international experts, professors, scientists have worked together to develop a strategy for education/science and technology reforms and their implementation. Implementation of the "Science and Technology Policy of the Republic of Croatia 2006-2010" resulted with significant changes in the country *(1–7)*.

Main goals of the Science and Technology policy 2006–2010 include: *(1)*

– Increased funding of science and technology projects aiming towards 3% of gross domestic product for research and development (R&D), which will in turn entice economic growth and job creation,

– Restructuring of publicly funded research institutes and R&D centres and the redirection of their activities towards areas of national priority and industry needs,

– Encouragement of research partnerships and strengthening of support programs for excellent young researchers, which will facilitate mobility, interdisciplinary and cross-sector cooperation, and build a more flexible research and education system,

– Investment in a science research infrastructure and knowledge transfer institutions to further develop research capacity and provide access to business solutions,

– Introduction of measures to promote commercialisation of academic research in order to entice universities and research institutions to work more closely and effectively with the business sector,

– Introduction of measures to promote technological development and innovation in order to attract people and investments to innovative business ventures,

– Implementation of a more stimulating and business-friendly legislation, including appropriate intellectual property laws and tax incentives for investments in high priority R&D areas in order to build a system that entices innovation,

Several important institutions have been established in order to increase competitiveness and efficiency of the Croatian innovation system including Business Innovation Center (BICRO), The Croatian Institute of Technology (HIT) etc.. BICRO is an innovation and investment company established by the Government of the Republic of Croatia in order to facilitate technology transfer and commercialization activities primarily in small and medium size companies; to promote the establishment and development of science and technology incubators and to contribute to the creation and development of the private equity industry. On the other hand HIT's major role is to act as bridge between academic and scientific institutions and industry. It will certainly take time until we reap the first benefits in terms of economic success, however, the examples of other small countries that have made heavy investments in science and education such as Israel, Ireland and Finland and their encouraging successes show that such an investment is probably the most efficient strategy that allows small countries to compete internationally. Croatia has also undertaken major investments and reforms to develop information technology (IT) as the essential infrastructure for a knowledge-based society *(4)*.

National innovation system (NIS) characterizes systemic interdependencies within the country which affect the use, creation and diffusion of innovation in the market. This paper uses this broad definition of the specified NIS. However, the NIS can be defined as:

"... The network of institutions in the public and private sectors whose activities and relationships: initiate, import, modify and expand new technologies." *(8),*

"... The elements and relationships that interact in the creation, dissemination and use of new and economically useful knowledge... which is located within or originates within national borders." *(9),*

"... A number of institutions whose activities determine the innovation process... of national firms." *(10),*

"... national institutions, their incentive structures, skills and knowledge that determine the speed and direction of technological adoption (or change the volume and structure of creative activities) in the country." *(11),*

"... series of remote institutions which together or individually contribute to the development and dissemination of new technologies and which provide a framework in which governments form and implement strategies that affect the innovation process. As such the system related institutions that create, gather and transfer knowledge, skills and actions that define new technologies." *(12),*

"... All the important economic, social, political, organizational, and other factors that influence the development, diffusion and use of innovations." *(13)*.

NIS model shown in Figure 2 illustrates the relationships between the major stakeholders in the Croatian NIS. According to this model, research and the education system interacts with companies to develop and

transfer know-how. BICRO, HIT and Agency for basic research play a key role in formulating and implementing science, technology and innovation policies and financing. On the other side Ministry of Science, Education and Sports with the Government of Croatia adopts and provides support for policy implementation.

Intermediaries play an important role in this transition as well as the elements that constitute the knowledge infrastructure. Market demand acts as a driving force for the companies. If elements and links are missing in the innovation system, then the system is lacking efficiency and speed in terms of adapting to new developments. Therefore, it is important that the public efforts are aimed at balancing national innovation system, enhancing all subsystems and establishing and strengthening relationships as well as the interdependence of these subsystems.

In the last decade, little attention was paid to the regional dimension when innovation systems were shaped *(14)*. Regional Innovation System (RIS) uses the same logic as the NIS in terms of subsystems and their interdependence. It is important to note that even though it is RIS, it should in no way be centralised, instead it should entice the synergy between regions hence providing the multiplicative effect on the national level *(15)*.

There is broad awareness and recognition of the importance of innovation for future growth and competitiveness in the world. Therefore, the Republic of Croatia has made significant efforts in organizing the institutional framework which consists of stakeholders in the national innovation system.

CROATIAN EXPERIENCE

Impact of Business innovation centre (BICRO) programs can be observed through two strategic objectives outlined in their mission: i) adequate source of funding, ii) business and technology infrastructure.

One of the leading programs which are used to reach first objective, is called RAZUM. The rationale of RAZUM is to provide financial support primarily to technology-oriented, knowledge-based businesses for development of new services or products with the following selecting criteria: degree of technological innovation, quality of management, commercial potential, competitive advantage and business plan quality. Only projects that are in concordance with the stated criteria are selected and funded.

RAZUM projects are funded through a conditional grant mechanism in such a way that up to 70% of the total eligible project cost is financed by the RAZUM and the remaining 30% is provided by private sources. Funds contracted through a conditional grant mean that user is obligated to return RAZUM's investment when the project is commercialised.

During the implementation period from March 2007 to December, 31 of 2011 154 projects in various development stages applied for the RAZUM program, and a total of 18,180,507.00 ($) was contracted for 22 projects with an overall value of 27,437,357 ($), meaning that the program attracted private investments during the implementation process to the value of 9.2 million ($). In the later stage the total size of private investment is

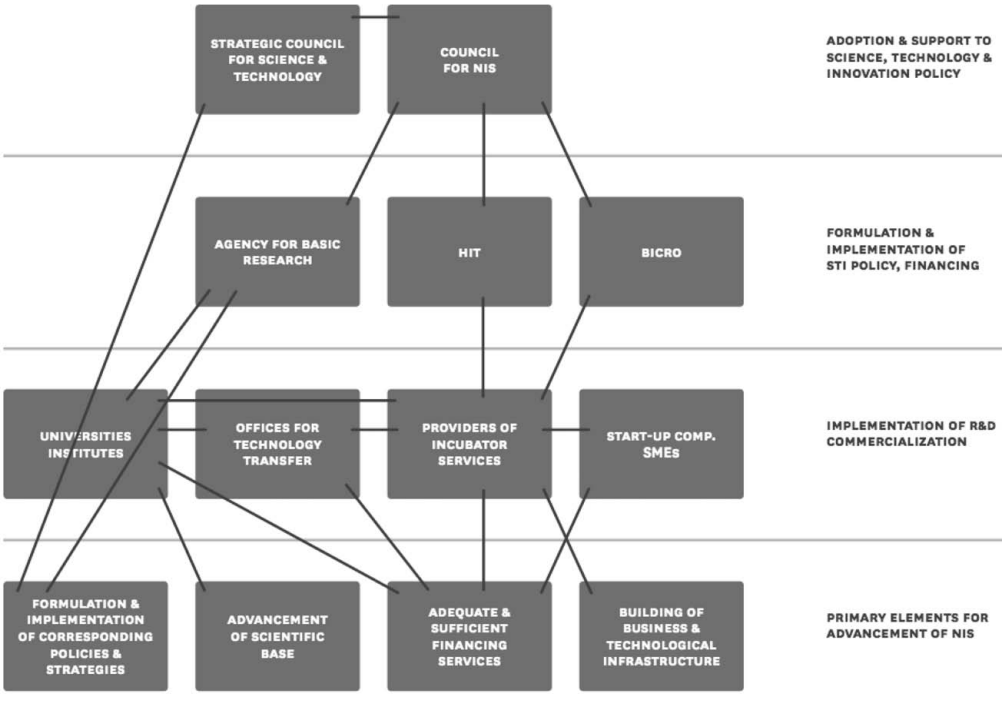

Figure 2. *Model of Croatian National Innovation System.*

TABLE 1

Impact of the RAZUM program between 2006. and 2011.

1	Number of the projects	22
2	Total Revenue (2006-2011)	222,745,751
3	Net Profit (2006-2011)	21,426,819
4	Total employed (on FTE basis in 2011)	628
5	Total investments (2006-2011)	41,983,146
6	Total assets (on 31.12.2011.)	58,051,015
7	RAZUM investment disbursed (by 31.12.2011.)	15,942,615
8	RAZUM investment repaid (by 31.12.2011.)	0
9	Profit tax income (2006-2011)	2,161,219
10	Wages tax income (2006-2011)	10,576,908
11	VAT tax income (2006-2011)	9,229,318
12	Total income (8.+9.+10.+11.)	21,967,446
13	Net income / disbursement (7. – 12.)	6,024,831

Amounts shown are in USD; 1USD = 5.836 HRK on 11/03/2013

multiplied by 1.5 more of total investment (line 5 in Table 1).

When we analyse those 22 projects that belong to 22 different companies and represent different sectors and company development stages we get the results represented in Table 1.

In addition we have found that 129 new jobs were created as a direct result of RAZUM's project investments.

Technology Infrastructure Development Program – TEHCRO is designed to help establish business and technological infrastructure. It is an extensive program of investment in the development of technology infrastructure in Croatia, and it is based on the implementation of three principles: investments in infrastructure – networking, education and training. This program combines the investment funds from both state and local level, it is supported by the Government through the Ministry of Science, Education and Sport (MSES), and the World Bank through the Science and Technology Project (STP). Key principles of the TEHCRO program are: i) a cost benefit analysis plays a major role in funding decision, since this is an infrastructure investment program; ii) program uses additionality principle on proposed activities. The cost of the activities is in the beginning higher than their revenue. TEHCRO program fills this gap by requesting matching funds. After five years of financing activities, project should be mature and self sustainable. There are four program lines within TECHRO program and they refer to the following project categories: i) Technology Business Centres ii) Technology Incubators iii) Research and Development Centres and iv) Competency centres

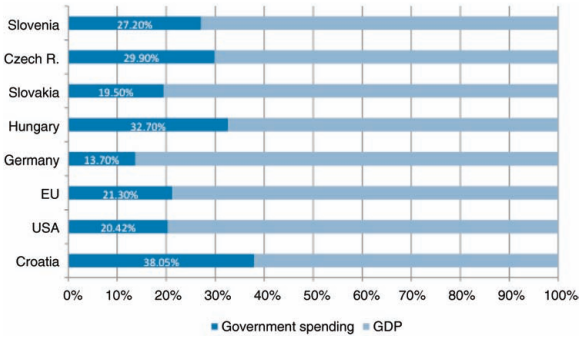

Figure 3. *Government spending as part in Gross Domestic Product (GDP) in 2008. This graph show, how efficient or expensive public sector is in overall economy. Higher percentage represents less efficient or more expansive public sector.*

Until 31.12.2011, a total of eight infrastructure projects were in their implementation stage through the TEHCRO program, and in the period 2007 – 2011 more than 9.2 million ($) of program funds were allocated. TEHCRO program investments fall under one of the following categories i) infrastructure (26%) ii) equipment (36%) or iii) business development (38%)

At the same time TEHCRO centres have 77 companies – tenants, out of which 55 are included in the incubation programs of TEHCRO centres, which employed a total of 650 full-time employees. 255 jobs out of 650 within these companies are high value-added jobs in research and development. According to the CBS data, of all the companies that have submitted their IR-1 form (R&D form) in Croatia, percentage of R & D in the total number of employees is below 10%, while this percentage in TEHRO centres, companies/ tenants is nearly 40%. In four years, tenants have created 360 new jobs (Figure 3). TEHCRO centres play an important role in the development of the local economy and technology transfer. Number of services shows scope and volume of their work (Table 2)

Just like other BICRO programs, TEHCRO, along with its results has a big impact on job creation and it is self-sustainable on government budget level (Table 3).

The uncertainty of developing innovations represents time and negative diffusion, the negative impact on the environment in terms of the development of innovation and money invested in this process. This first part is a natural process that cannot be influenced, because it goes deep into human curiosity. It is important to understand that the diffusion of innovation is like any other natural process (e.g. osmosis or pressure equalization). Therefore, some steps cannot be skipped, and it is important to build the ecosystem (holistic approach to building systems), which favours the diffusion of innovation. Invested time in unsuccessful innovation cannot be turned back. However, entrepreneur is left with the experience of participating in innovation process (tacit knowledge). It is important to recover the entrepreneur from the businesses failure and to encourage him to start new

TABLE 2

Services provided in TEHCRO centres 2009-2011.

Number of SMEs used TEHCRO centre services	1689
Number of training programs provided	177
Number of start-ups or entrepreneurial ventures	46
Number of business plan or feasibility studies provided	326
Number of requests for TEHCRO centre services	1066
Number of technology transfer contracts signed	27
Number of new products developed	31
Number of prototypes developed	35
Number of new jobs created (tenants only)	360

ventures (serial entrepreneur). At this stage we come to one variable that cannot be controlled by the state and, and that is the risk of losing money. Since the state has multiplicative benefits and the development of the product is distant from the market, the state is the one who needs to share the risk of investment with entrepreneurs *(16)*. Therefore, it is important to have programs without guaranties for the State investment. Instead the focus should be on the joint investments with the private partners by additionality principle (e.g. matching grants, venture capital, business angels). With the state's investment in project development, time to market is significantly reduced *(17)*.

Equally challenging is the acceptance of a new product by the existing market, which is a characteristic of the second phase. That is a concept of diffusion, dissemination and adoption of innovations by the market.

There are two types of innovations: radical and incremental. In the case of incremental, product already exists on the market, the market is used to initiate innovation and there is no need for intervention here, however, a radical innovation needs support from the system. Radical innovations are most often created in the public domain. The research that led to the conditions for further development of a radical innovation is financed by public funds and it belongs to non-profit scientific organizations. How can this innovation be used to generate public benefits? Processes that follow are uncertain *(18)*, than lengthy, and require new skills and large investments. This means that public scientific organizations can no longer deal with it. Several things should be regulated in order to raise the efficiency of innovation systems. First, regulations should make clear how the publicly funded research can go into the field of industry and market competition. Bayh-Dole Act. (1980) in the United States is an example of how to solve this problem. Croatia has not resolved it at a legislator level, however bylaws exist with which each university builds its own strategy of intellectual property management. Technology transfer offices have created rules on the management of intellectual property which clearly imply what is the output of a scientist, his group / institute, or college and university from his research. Their rights and responsibilities should not be ignored because it is a property. However, this legal framework which is a prerequisite of innovation can only take place in publicly funded research institutions, but the question remains on how to help increase their numbers, and how to shorten „time to market". Specifically, a platform should exist for starting up companies to which the intellectual property will be transferred, and this platform should include all forms of commercialization, sales and licensing rights. Those platforms have similar activities and they are called incubators, science-technology parks, science parks, research and development centres, competence centres or technological centres. They perform various activities, including incubation, (i.e. the provision of facilities and services to newly established companies, as well as access to some specialized equipment). Furthermore, they provide business consulting, for example they help businesses

TABLE 3

TEHCRO tenants data cumulative between 2008 and 2011.

	2008	2009	2010	2011
Net Profit	599,181.78	1,392,997.08	1,188,502.63	7,156,338.53
Total Revenue	19,759,868.09	25,567,216.63	25,451,236.37	34,112,881.83
Total Wages	3,312,973.51	4,398,877.29	5,042,970.22	5,051,066.21
Wages tax income	2,328,763.48	3,069,928.91	3,425,438.43	3,092,122.23
Profit tax income	156,294.15	258,746.32	229,564.48	1,718,348.55
Total value added	6,506,218.03	10,252,849.15	10,827,544.21	19,082,305.33
Total value added per employee	21,472.67	23,678.63	21,918.11	29,357.39
Total taxes and contribution	2,485,057.63	3,328,675.23	3,655,002.91	4,810,470.79
Number of employees	303	433	494	650
New jobs created (cumulative)	51	150	217	360

Amounts shown are in USD; 1USD = 5.836 HRK on 11/03/2013

with their accounting, determine a business model and select a partner who will assist them in achieving their entrepreneurial ventures. Some centres also have development activities offered by the market, and some are involved in the protection and management of intellectual property. Often these centres need investment to build a facilities that gather different stakeholders or they need an investment in research equipment. Besides facilities and equipment it is essential to establish a virtual infrastucture – collaborations with the industry, the network professionals, additional capital, business angels network, and venture capital. Altogether makes a solid ground for technology, innovation and business. Innovation infrastructure is not aimed at making a profit for sustainability. Interested partners who would invest in innovation infrastructure are scientific organizations, local communities (cities and counties) and private partners under the principle of public-private partnerships. The role of the whole innovation infrastructure is to be a catalyst for change, to create conditions that will enable a single innovation to shorten the time invested in the diffusion. Eventually, innovation infrastructure becomes the critical mass. Various ideas collide, there is access to equipment, space, human knowledge and experience that results in raising the level of critical mass that exploits, runs faster and more efficiently. Infrastructure is the largest contributor to radical innovation *(19)*. However, it contributes as well to the total number of innovations.

Most renowned agency and one of the pioneers transferring budget funds is DARPA (Defence Advanced Research Projects Agency). It has a budget of U.S. $ 3 billion, 240 employees very low fixed cost and it is connected, yet still independent of the U.S. government. It has been successfully employing professionals as project managers who are willing to take the risk, given that all contracts are short term and signed for an average period of 4 to 6 years *(20)*. DARPA was established to bridge the gap between highly academic work and long-term objectives of more incremental technological development for the military. Prior to founding DARPA in 1958, the military managed financial investments in R & D. This way, DARPA's hands are free to invest in technological horizons that will be applicable in 20 years. This raised the opportunity for many scientists to find research and development funding for their innovative projects. The result is that the development of semiconductors, human computer equipment, personal computers and the early development of Internet were all funded by DARPA. Later in 1957, first spin-offs appeared in the field of semiconductors allowing DARPA to develop even further *(20)*. These companies have been recognized as a highly ambitious and innovative, and they successfully integrated on the market. As the things started to change, the Government was able to play a leading role in mobilising innovation. DARPA's flexible structure, with professional project managers was in complete contrast to existing formal establishments, bureaucratic and other government programs, and it offered maximum efficiency in order to entice real competition with only the best projects moving forward. Using its network of users DARPA funded the increased flow of knowledge and skills across all competing research groups. DARPA managers are involved in business and technology brokering, linking university researchers with entrepreneurs interested in starting a new venture, bringing together start-up companies with venture capitalists, looking for bigger companies that could commercialize technology or to assist in the procurement process that would support commercialization *(21)*. DARPA managers are constatntly expanding the network of scientists and experts, who supports the system. This is the exact responsibility of agencies like DARPA or BICRO, to drive the national innovation system.

CONCLUSION

Science, technological development and innovation are the essential elements of a country's economic development and its long-term sustainability. The process of innovation is necessary in order to maintain or improve the competitive position of a country in the global economy. Dynamic, technology-oriented small business and excellent universities play a key role in the innovation process. In order to successfully compete, it is mandatory to constantly improve the institutional framework which supports the innovation process. In the centre of the system is an agency (in our case BICRO) that is associated with the state, but that acts independently. The role of the agency is to continuously work on the improvement and development of institutional frameworks. Strength of the agency lies in the people, their expertise and willingness to take on the role of a catalyst for connections between all stakeholders. The system should also have access to sufficient financial resources in order to develop. If this requirement is not fullfiled it is almost impossible to establish functional networks. Therefore, the promotion of research and development together with the introduction of measures to encourage innovation is one of Croatia's priorities. The current target is to realize the development of existing scientific and technological potential and achieve a high level of innovation capacity. In the last decade, and especially during the period of EU accession negotiations, Croatia made significant organizational, institutional, legal and administrative changes in order to create a better environment for entrepreneurship based on knowledge and innovation. However, even with these efforts the sector of research, development and innovation in Croatia still trails behind developed innovation based economies both in and outside the EU, and therefore there is significant room for improvement. Three key elements in the innovation process are: i) a high quality research base (universities, research institutes), ii) appropriate and sufficient financial resources and iii) technological and business infrastructure. The development of new and innovative products is an expensive, complex, lengthy and extremely uncertain process. Therefore, conventional sources of financing (e.g. loans) are not appropriate, instead they

are financed with a mixture of grants, matching grants, conditional grants and venture capital. Technological and business infrastructure (technology incubators, competence centres, scientific and technological parks) enables small and newly established businesses to develop and commercialize their products.

During the last years Croatia significantly increased the number of professors, young researchers, students and created processes that support innovation *(22)*. Numerous efforts made in the Croatian educational system were recognised by the famous survey conducted by the renowned Newsweek magazine which rated Croatia 22nd in education ahead of 12 countries from the G20 group *(23)*. Further, during the period 2003-2009 Croatian Government launched two very successful projects in order to return some of the top scientists back to Croatia and to encourage Croatian scientists and professionals working abroad to return and work in Croatia or to develop connections with local scientists; "From brain drain to the brain gain" and "Unity through knowledge fund" respectively *(24)*.

However, in terms of technology and innovation readiness, Croatia is missing a strong immediate political commitment to the processes which could provide sustainable and inclusive growth. The ongoing integration of the European Research Area (ERA) offers enormous opportunities for collaboration and cross-fertilization between the more and the less scientifically developed parts of Europe. Among many, these opportunities include the participation in international, or preferably European evaluation processes for scientists, research projects and research institutions. Two decisions we made in 2005. have had far-reaching consequences for the Croatian research system; the first when we decided that Croatia should join the Sixth Framework program, and soon after when Croatia has jointed the Seventh Framework program, the main EU program to fund research and technological development in Europe. Recently published data describing the gross domestic expenditure on R&D (GERD) by source of funds, has shown that during 2005. Croatia was receiving 2.6% of the funds from abroad to support Croatian science while in 2010. that percentage increased to 9.9% or more than 3 times, mainly due to EU funding *(25)*.

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