



# ERAWATCH Country Report 2009

Analysis of policy mixes to foster R&D investment  
and to contribute to the ERA

## Croatia

Olana Bojic



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investment and to contribute to the ERA

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## Executive Summary

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Knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Hence, a central task of ERAWATCH is the production of analytical country reports to support the mutual learning process and the monitoring of the efforts in increasing R&D investments and improving the performance of national research systems.

The main objective of the report is to characterise and assess the evolution of the national policy mixes in the perspective of the national goals for R&D investments, and for the contribution to the realisation of the European Research Area, as associate country. This report is building on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

In the period from the mid-1990s up to 2002, R&D investments as a percentage of GDP have constantly grew, totalling 1.04% in 2002. In the period 2002-2007, the share of GERD as a percentage of GDP has declined, amounting to 0.86% in 2007. Croatian business expenditure on R&D (BERD) shows low level of investments measured in absolute terms. In 2002 the business sector invested €115m, with €143.7m in 2004. However, in 2007 the business sector investments into R&D slightly declined to €141.4m.

Current policy mix is oriented more towards increasing R&D investments within firms through financing seed capital, new products and R&D investments within firms. Moreover, several programs schemes have been organized in the last few years with the aim to increase science and industry collaboration, with two high governance bodies, namely the Strategic Council for Science and Technology (SVEZNATE) and the National Innovation System Council (VNIS) aimed at increasing efficiency of the national research system.

However, these measures have failed to significantly contribute towards the increase of R&D investments. The primary reason behind this failure is the fact that the measures have not taken into consideration innovation performance of the business sector characterized by low levels of innovation performance accompanied by low share of R&D personnel in total number of employees as well as low level of innovation cooperation in the national economy. According to the Croatian Employment Service data (HZZ, 2008: 48) civil engineers and information science engineers are degree level occupations with the shortest unemployment periods (December 2008 data).

All these issues were accompanied with low levels of government activity towards fulfilment of these strategic objectives, representing a source of imbalance between policy mix and the national science and research practice.

ERA plays an increasingly important role in national research policy. It seems that the main obstacles to ERA related policies originate in the lack of recognition of its capacity and potential as a stimulus for national research policy development in Croatia. Thus, Croatian ERA efforts are primarily a result of multilateral and bilateral agreements signed and initialized from abroad, and significantly, not through the development of the national research programmes and activities. More precisely there is no initiative to foster joint approaches to research programmes, suggesting lacking aspirations towards stronger internationalization. Moreover there is low level of coordination between the research programs and other national strategies.

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
Low level of innovation performance in the national economy	Current policy package are more oriented towards increasing R&D investments within firms; policy programs should be more oriented toward firms that do not perform R&D activities yet
Very small amount of investments into business R&D	Policy has recognised this barrier, but more could be done (in terms of creating programs aimed at developing a new product and/or new process)
Low share of R&D personnel in total number of Employees	Policy has recognised this barrier, but more could be done (in terms of creating programs aimed at fostering studying in science and engineering)
Low level of cooperation between science and the business sector	Several programs schemes have been organized in the last few years by BICRO, MELE, UKF and NZZ

Ministry of Economy Labour and Entrepreneurship (MELE) has made efforts in order to improve the approach of the Croatian scientists towards EU programs by the establishment of the European Integration Department with six national contact points, founding the National Committee for the Monitoring of the Implementation of FP, the Agency for Mobility and European Programmes and preparing the national program report about MSES activities towards the fulfilment of the criteria for EU membership. The national ERA related policies are based on researcher mobility programs and opening up national research programs. Several financial schemes exist aimed at better inclusion of Croatian scientists within the European Research Area. Moreover, in 2008 Croatia launched the Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010, outlining the strategic objectives and instruments for better inclusion of Croatian scientists to ERA. Unfortunately in the other ERA pillar, the area of research infrastructure governance and national research opening the advance has not been sufficient.

	Short assessment of its importance in the ERA policy mix	Key characteristics of policies
Labour market for researchers	<ul style="list-style-type: none"> <li>Increasingly important, result of programs aimed at removing barriers to mobility</li> </ul>	<ul style="list-style-type: none"> <li>The existence of the programme scheme aimed at human circulation between Croatian scientific organizations and Diaspora</li> <li>Recent policy action aimed at improving scientific mobility</li> </ul>
Governance of research infrastructures	<ul style="list-style-type: none"> <li>Important result of improving and implementation of the research infrastructure projects. MSES has been constantly improving CARNET and in cooperation with <i>Ruđer Bošković</i> Institute is implementing the Center for on-line data base project.</li> </ul>	<ul style="list-style-type: none"> <li>The national character of the research infrastructure</li> <li>Recent broader approach regarding research infrastructure development affected all national science and research system users, not only particular institutions.</li> </ul>
Autonomy of research institutions	<ul style="list-style-type: none"> <li>Very Important, The Autonomy is guaranteed within the Act on Scientific Activity and Higher Education.</li> </ul>	<ul style="list-style-type: none"> <li>The universities and the faculties as scientific units have a large degree of autonomy, tightly connected with students in order to ensure the provision of a qualitative education</li> </ul>
Opening up of national research programmes	<ul style="list-style-type: none"> <li>Low importance</li> </ul>	<ul style="list-style-type: none"> <li>Small number of the instruments are open for foreign researchers managed by NZZ</li> <li>No special programmes or schemes in S&amp;T have been launched so far</li> </ul>

So the main challenges for the national R&D system development in relation to ERA are the following:

- To facilitate additional mobility in the research and increase the participations of Croatia's scientists abroad and the foreign researchers in Croatia
- In terms of the research infrastructure, a precise inventory of research and science infrastructure is required, in addition to a national strategy in accessing inter-governmental European infrastructures.
- In order to internationalize their activities the key challenge for Universities is to introduce quality assurance program and action within the faculties.
- Opening up of national research programmes for foreign participants





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## 1 Introduction

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Knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Hence, a central task of ERAWATCH is the production of analytical country reports to support the mutual learning process and the monitoring of the efforts in increasing R&D investments and improving the performance of national research systems.

The main objective of the report is to characterise and assess the evolution of the national policy mixes in the perspective of the national goals for R&D investments, and for the contribution to the realisation of the European Research Area, as associate country. This report is building on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

In this report we characterise and assess the performance of the national research system and national research policies. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system have been distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. The analysis within each domain is guided by a set of generic "challenges", common to all research systems, which unravel possible bottlenecks, system failures and market failures a research system has to cope with. The main elements of and results from this analysis are presented in Chapter 2, while in the Annex, the reader can find a more detailed account of this exercise.

The need for an effective research policy, appropriately co-ordinated with education, innovation, and other types of policies, is also widely recognised. Therefore, we focus on the following two analytical issues:

- The assessment of the national policy mixes for the achievement of national R&D investment goals set. Particular attention is paid to policies fostering private R&D and addressing barriers (Chapter 3).
- The assessment of national policies contributing to the realisation of the European Research Area, as associate country (Chapter 4).

## 2 Characteristics of the national research system and assessment of recent policy changes

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### *2.1 Structure of the national research system and its governance*

Croatia is a candidate country for EU membership, and according to EUROSTAT has 4.48 million inhabitants, which compared to the estimated EU-27 population of around 499.6m in 2008, presents 0.88%<sup>1</sup> share of the total. In the year 2008,

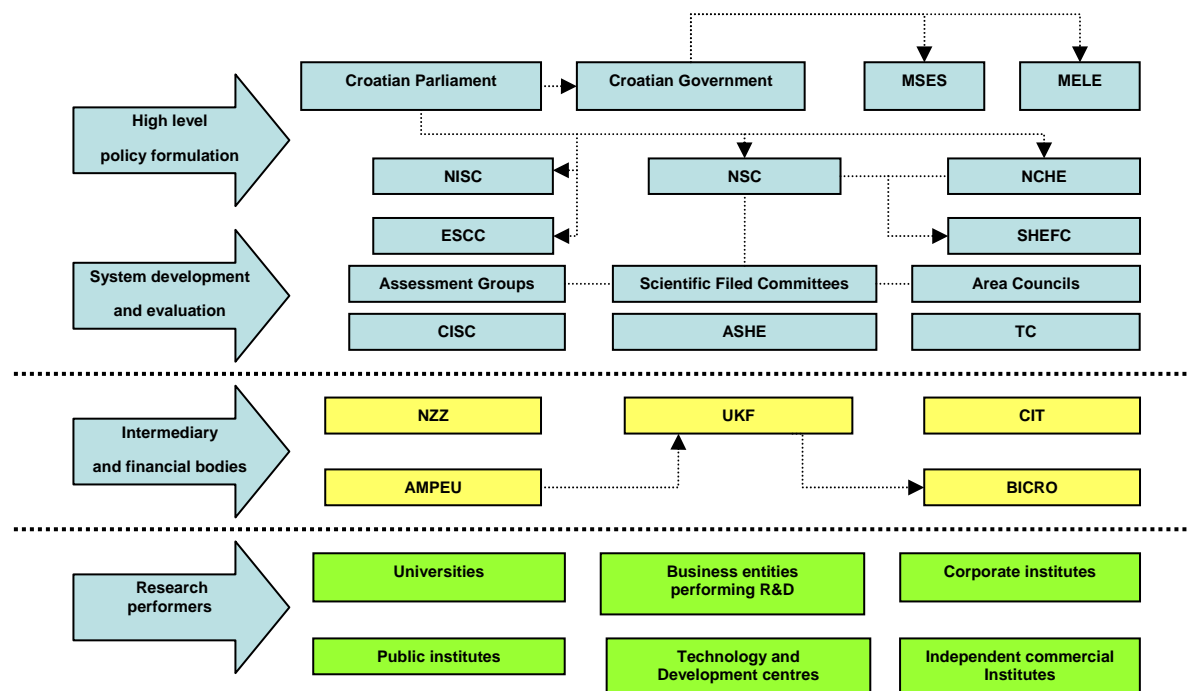
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<sup>1</sup> This estimation is based on the calculation that Croatia becomes the 28th member of the EU. So in this scenario the total sum of the EU population will be the sum of Croatia's population (2008 estimate) and the EU population (2008 estimate).

Croatia's GDP per capita reached 58.4% of the EU-27 average. At the same time Croatia's unemployment rate was 8.5%; slightly higher than the EU-27 average of 7%. In 2007, Croatia's GERD as a percentage of GDP was 0.86% which was significantly lower in comparison to the EU 27 average (1.83%). The main characteristic of these investments were downsizing i.e. in 2004 Croatia's GERD as a percentage of GDP was 1.13% and in 2006 it decreased to 0.87%. By comparison to other Eastern European Countries, Croatia significantly lags behind Slovenia (1.56%), Czech Republic (1.55%), Estonia (1.15%) and Hungary (1%), again using EUROSTAT data.

According to the data provided by the Central Bureau of Statistics (CBS), in 2007 the share of higher education expenditures on R&D (HERD) was 33.7% of GERD, lagging behind the BERD share (40.7%) of GERD. Governmental expenditure on Research and Development was 25.5% whereas non-profit sector amounted to 0.1% of GERD in the same year.

**Figure 1: Overview of the Croatian research system governance structure**



**Legend:**

- MELE – Ministry of Economy Labour and Entrepreneurship
- MSES – Ministry of Science, Education and Sports
- NISC – National Information Society Council
- ESCC – Education, Science and Culture Committee
- NSC – National Scientific Council
- NCHE – National Council for Higher Education
- SHEFC – Science and Higher Education Funding Council
- AMPEU - Agency for Mobility and EU programs
- NZZ – National Foundation for Science, Higher Education and Technological Development
- CISC – Croatian Innovation Systems Council
- ASHE – Agency for Science and Higher Education
- TC – Technological Council of MSES
- CIT – Croatian Institute of Technology
- UKF – Unity through Knowledge Fund
- BICRO – Business Innovation Centre of Croatia

Source: Adapted from [ERAWATCH Research Inventory](#)

The Croatian research system consists of three operational levels: 1) The Parliament and the National government level, represented by the Prime Minister; 2) The ministries and agencies level responsible for the design and implementation of science and research programs on the national level; and 3) performers of R&D activities (Detailed analysis of the national research system is provided in the Appendix).

The National Science Council (NSC) is the strategic body responsible for the scientific activity development and quality in Croatia, appointed by the Government. NSC aims to develop and improve the scientific system. The National Council for Higher Education is another important institution appointed by the Croatian Parliament responsible for monitoring the development and quality of the higher education sector and proposals for public institution network development in Croatia. On the second level the Ministry of Science, Education and Sport (MSES) is a key institution charged with the design of the national research policy, parallel with the Ministry of Economy, Labour and Entrepreneurship (MELE). MELE autonomously designs and finances the programs of strengthening R&D investments, promotion of science and business infrastructure and entrepreneurial education. Moreover, the National Foundation for Science, Higher Education and Technological Development of the Republic of Croatia (NZZ) was established by the Croatian Parliament, with the basic goal of promoting science, higher education and technological development in Croatia in order to ensure economic development and support employment creation. The Agency for Science and Higher Education (ASHE) is a regulator of activities relating to the evaluation of research and higher education systems in Croatia and simultaneously functioning as an intermediary between state policy and the science community. Moreover, the Agency for Mobility and EU programs (AMPEU) is the institution responsible for the provision of the mobility programs through participation of foreign researchers in Croatia and participation of Croatian scientists abroad. Croatian Innovation System Council represents an expert body in charge of efficient coordination of actions aimed at the creation and operation of the Croatian Innovation System. The National Innovation System Council represents a body established by the Ministry of Science Education and Sports (MSES) aimed at improving efficiency of National Innovation System in Croatia. In addition, the Business Innovation Centre of Croatia (BICRO) represents a leading agency responsible for the implementation of innovation policy measures and programs. There are five major programmes herein, all relating to R&D. Croatian Institute for Technology (HIT) was founded in 2006 with the vision of becoming the leading institution for the design and the implementation of the technology policy. Finally, the main mission of Unity through Knowledge Fund (UKF) is to unite the scientific and professional potential in Croatia and abroad (Diaspora) in the development of the knowledge based economy in Croatia. The main research performers are divided into 1) public scientific institutions i.e. higher education institutions and research institutions which apply to the MSES program research projects 2) science and business infrastructure institutions and 3) R&D performing business entities.

Formal regional research policy does not exist. In Croatia, regional policy exists on a NUTS 3 level, where the main issues are regional economic development, traffic infrastructure, education, health services and other social and cultural institutions. This is explained by the fact that the research capacity is primarily concentrated in North West Croatia, NUTS 2<sup>2</sup> level, including Zagreb, Croatia's capital and the other counties in the vicinity of Zagreb<sup>3</sup>. North West Croatia is oriented more towards industry and knowledge intensive services development in comparison to Central and

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<sup>2</sup> NUTS 2 level in Croatia consists of the three non-administrative units including the existing counties forming the NUTS 3 level. NUTS 2 level includes: North-West Croatia (Zagreb region including Medimurje and Zgorje), Central and East Croatia (Slavonia) and Adriatic Croatia (Istria and Dalmatia).

<sup>3</sup> Koprivničko-križevačka county, Krapinsko-zagorska county, Međimurska county, Varaždinska county and Zagrebačka county.

East Croatia as well as the Adriatic Croatia where other business activities are dominant. Recently, municipalities in Croatia show more inclination towards supporting R&D primarily through investments into science – business infrastructure (e.g. Technology park in Varaždin and Technology park in Čakovec) and this trend is likely to expand in the future.

## ***2.2 Summary of strengths and weaknesses of the research system***

Human development programmes, oriented towards enhancing rejuvenation of the science community are strength of the national research system and further activities should be oriented towards better circulation of R&D personnel between private and public sectors. Strength of the national research policy is the experience in managing programs aimed at financing business R&D expenditures. However, national research policy action needs to be oriented towards additional promotion of science and industry cooperation. The existing programmes managed by BICRO and HIT<sup>4</sup> need to be enhanced by additional financing and introduction of new programmes such as new product and/or new processes development, where innovative products and/or processes new to the market should be created and commercialized in international markets. National research policy is persistently weakened by the low share of R&D personnel in total number of employees. In 2004, R&D employees in the business sector amounted to 0.16% of the total number whereas the comparable figure in the EU 27 country average was 0.56%. Moreover, compared to the EU 27 average (25.5%) in the period 2002-2004, Croatia's business entities show low levels of innovation cooperation (10.88%)<sup>5</sup> in the period 2004 – 2006 (EUROSTAT). Therefore, science and industrial cooperation still presents a weakness of the national research policy in Croatia. However, since 2001, the governmental structures have undertaken efforts to promote and enhance science industry cooperation, with BICRO and HIT responsible for several programs oriented towards the fulfilment of this objective. Moreover, the participation of Croatian scientists in EU funding schemes has opened additional channels for cooperation enhancement. However, it seems that encouraging the business sector in additional R&D investments is an area where improvements are required. Given the current organisation, the low share of R&D personnel in the total number of employees cannot be improved due to low levels of finance for innovative products and/or process development (area where R&D personnel are primarily engaged). Occasionally the government shows financial commitment towards R&D investments on a national level, but this is followed by low levels of adherence towards the fulfilment of this key objective.

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<sup>4</sup> HIT is in charge of the TEST programme implementation.

<sup>5</sup> Author's calculations based on unpublished CBS data, unfortunately, the EU 27 value for the same period (2004 - 2006) is not yet available on EUROSTAT, hence most recent figure was used.

**Table 1: Summary assessment of strengths and weaknesses of the national research system**

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	<ul style="list-style-type: none"> <li>In the last five years, GERD as percentage of GDP has been declining in Croatia; In the case of BERD investments as percentage of GDP high volatility is observed throughout this period.</li> </ul>
	Securing long term investment in research	<ul style="list-style-type: none"> <li>Occasional government commitment towards R&amp;D investments increase on a national level; However low level of adherence towards fulfilment of the national science technology policy as the key objective has been visible;</li> </ul>
	Dealing with barriers to private R&D investment	<ul style="list-style-type: none"> <li>Strength of the system is the experience in program management, relating to R&amp;D finance in the business sector; Weakness of the Croatian system stems from the fact that the majority of R&amp;D investments are conducted by few business entities.</li> </ul>
	Providing qualified human resources	<ul style="list-style-type: none"> <li>Strength of the system is the presence of successful human development programs aimed at the rejuvenation of science community and strengthening human resources in science and technology. Weakness of the system is the low share of R&amp;D personnel in the total number of business sector employees in comparison to the EU 27 average.</li> </ul>
Knowledge demand	Identifying the drivers of knowledge demand	<ul style="list-style-type: none"> <li>High technology sector is recognized as a key sector by the governmental agencies responsible for innovation programmes (e.g. BICRO and HIT). Majority of the firms financed by BICRO are from the IT sector (7 out of 13).</li> <li>The weakness of the Croatia's research system is the low level of co-operation between public and private sectors regarding identification of the key national areas.</li> </ul>
	Co-ordination and channelling knowledge demands	<ul style="list-style-type: none"> <li>Current R&amp;D programmes schemes not flexible to changes in knowledge demand</li> </ul>
	Monitoring demand fulfilment	<ul style="list-style-type: none"> <li>The evaluation of demand fulfilment is at a low level.</li> </ul>
Knowledge production	Ensuring quality and excellence of knowledge production	<ul style="list-style-type: none"> <li>New scientific opportunities results of Croatia's participation in FP programmes;</li> </ul>
	Ensuring knowledge exploitability	<ul style="list-style-type: none"> <li>New projects for science-industry cooperation recently initiated;</li> <li>Improving mechanisms to match scientific knowledge production to economic and societal needs;</li> </ul>
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	<ul style="list-style-type: none"> <li>The programs aimed at promotion of cooperation between science and industry exist, managed by BICRO and HIT</li> <li>New public and private colleges and polytechnics were recently opened over Croatia</li> </ul>
	Profiting from international knowledge	<ul style="list-style-type: none"> <li>Successful participation of Croatia's scientists in Framework Programmes.</li> <li>Participations of local scientists in other international programs.</li> </ul>
	Enhancing absorptive capacity of knowledge users	<ul style="list-style-type: none"> <li>Low share of R&amp;D personnel in total number of employees in the business sector;</li> <li>Absorptive capacities of knowledge users are low and concentrated on small proportion of the business entities.</li> <li>Participation in specialized programs (e.g. SME association) within FP framework increases Croatian SME absorptive capacity.</li> </ul>

### 2.3 Analysis of policy changes

Over the past 18 years, the science and technology policy has undergone significant transformations. Throughout the turbulent 1990s, the Croatian science system suffered significant losses in terms of research personnel and technological capabilities in the economy. The war in Croatia in the period 1991-1995 and the transition towards a market economy essentially devastated the industrial R&D sector, including the research sector R&D personnel. Since 2000, the science system has been gradually recovering and expanding due to substantial efforts of the Croatian government to reform the science and higher education sectors in accordance with the European standards, with the overall aim to strengthen its capacity to contribute to national development.

The main policy document is «the Science and Technology Policy of the Republic of Croatia 2006-2010», an Act adopted by the Croatian parliament in May 2006, followed by «the Action plan for the period 2007-2010 Science and Technology Policy of the Republic of Croatia» with a detailed outline of the main planned activities for national innovation system development. Finally, another important document is «the Action plan for Fostering Investments in Science and Research», passed by the Croatian parliament in April 2008. This Action Plan, known also as “3% Action Plan”, is aimed at stimulating investments needed for structural reforms of science and higher education sector in order to facilitate Croatian development based on the knowledge-based economy model.

In the last ten years, two main areas of the national research policy in Croatia can be identified; science and industry cooperation and human development within the public sector. Firstly, policy measures oriented towards promotion of science and industry cooperation were launched in 2001 via specially designed programme known as HITRA, the Croatian Programme for Innovative Technological Development. This program aimed to promote science and industry cooperation and presents the foundation of national innovation system in Croatia. Currently, both BICRO and HIT are responsible for conducting innovation policy programmes. Moreover, in 2005, the National Foundation for Science (NZZ) started a programme called "Partnership in basic research, planned for completion by October 2009. Over the past few years, the Ministry of Economy, Labour and Entrepreneurship (MELE) has been conducting programs in the area of the new product development as well as oriented towards the development of science and business infrastructure as a prerequisite for better knowledge utilisation. Results of their efforts were three technology parks; six technology transfer centres and other institutions such as business incubators and business centres, located throughout Croatia. The second area was the human development programmes, primarily oriented towards rejuvenation of scientific population within higher education institutions as well as public institutions. Here the Croatian government made significant efforts in the period 2004-2007, with 1400 new jobs created in science and education, 1280 of which solely for new junior researchers (EC 2008: 5). Another important area is the strengthening of human resources, through the encouragement of research cooperation and mobility between Croatian scientists in the country and Croatian scientists in the foreign countries (Diaspora), with the main goal of stimulating the return of Croatian scientists from abroad. The most important programmes are managed by the Unity through Knowledge Fund (UKF), launched by the MSES in 2004 (fostering international corporation with the Diaspora). The total planned resources for 2006–2009 amount to €5m, including €3.7m of World Bank credit resources. Moreover, NZZ organizes a brain gain program which includes the finance

of five sub-programs (Homing programme, Postdoc, Visitor, Senior and NZZ Installation Grant). Moreover, the Agency for Mobility and European Programmes (AMPEU) organizes an additional program oriented primarily towards student and staff mobility via mechanisms of bilateral agreements.

The other development measures of national research policy in Croatia are the financial incentives for research and development activity stimulation, broadly divided into two groups. The first group consists of incentives oriented towards the innovation investments i.e. purchase of scientific equipment, through the measure of Value Added Tax Return on Equipment for Technology Research and Scientific Research Projects (Official Gazette 96/2003). The second group consists of corporate tax deduction introduced in 2004 (the Act on Income Tax; Official Gazette 177/2004), resulting in the reduction on income taxes for R&D activities within companies. In 2007, new regulation about R&D activities was formulated in the Act on the Amendments and Supplements to the Scientific Activity and Higher Education Act (Official Gazette 46/2007). The taxpayers can lessen the income tax base for justifiable costs of scientific and developmental research projects according to the following rules: a) 50% of justifiable costs for fundamental research; b) 25% of justifiable costs for applied research and c) 100% of justifiable costs for developmental research.

### **2.3.1 Resource mobilisation**

In 2008, research policy has not experienced any dramatic changes, the focus being on the implementation of the current programs in addition to further elaboration of the previous initiatives. VENCRO program is an exception as a new governmental initiative in order to encourage potential fund managers to start venture capital funds. In addition, there have been changes in terms of the institutional framework with the introduction of two new governmental bodies. The first is the Strategic Council for Science and Technology (SVEZNATE), to be established as the permanent high-level coordination body, charged with the harmonization of the governmental efforts in science and research development with MSES and MELE as the governmental bodies involved in achieving the science and technology policy objectives. SVEZNATE is coordinated by the Prime Minister and its membership includes the following: Ministers of Science, Education and Sports; Economy, Labour and Entrepreneurship; Finance, Sea, Transport and Infrastructure; Environmental Protection, Physical Planning and Construction and the President of the Technology Council; and the President of the National Science Council. The National Innovation System Council (VNIS) of MSES is another governmental body composed of academic members bar the coordinator, a government official with the main task to facilitate, implement and evaluate the Action Plan for the implementation of S&T policy 2007-2010. However, it has to be stated that the newly established bodies have not produced any visible results which could be publicly evaluated. On the other hand, the current problems with budgetary incomes, resulting from the financial crisis have made financial resources less available on the financial markets. This scenario could be followed by budgetary revisions, with downsizing of the planned public R&D investments for this year which may consequently hamper efficient functioning of the national research system.



**Table 2: Main policy changes in the resource mobilisation domain**

Challenges	Main Policy Changes
Justifying resource provision for research activities	<ul style="list-style-type: none"> <li>• In 2008 Strategic Council for Science and Technology (SVEZNATE), established as the permanent high-level coordination body, charged with the harmonization of the governmental efforts in science and research development</li> <li>• In 2008 The National Innovation System Council (VNIS) of MSES was found with the main task to facilitate, implement and evaluate the Action Plan for the implementation of S&amp;T policy 2007-2010.</li> </ul>
Securing long term investments in research	<ul style="list-style-type: none"> <li>• No major change since 2008</li> </ul>
Dealing with uncertain returns and other barriers	<ul style="list-style-type: none"> <li>• VENCRO Program - the government initiative encouraging potential fund managers to start venture capital funds</li> </ul>
Providing qualified human resources	<ul style="list-style-type: none"> <li>• No major change since 2008</li> </ul>

### 2.3.2 Knowledge demand

Since 2008, there were no major policy changes in the domain of knowledge demand in Croatia. All activities were in accordance with the Science and Technology Policy of the Republic of Croatia 2006 - 2010.

**Table 3: Main policy changes in the knowledge demand domain**

Challenges	Main Policy Changes
Identifying the drivers of knowledge demand	<ul style="list-style-type: none"> <li>• No major changes since 2008</li> </ul>
Co-ordinating and channelling knowledge demands	<ul style="list-style-type: none"> <li>• No major changes since 2008</li> </ul>
Monitoring demand fulfilment	<ul style="list-style-type: none"> <li>• No major changes since 2008</li> </ul>

### 2.3.3 Knowledge production

Since 2008, no major policy changes have occurred. The activities are in the line with the Science and Technology Policy Action plan for the period 2007-2010.

**Table 4: Main policy changes in the knowledge production domain**

Challenges	Main Policy Changes
Improving quality and excellence of knowledge production	<ul style="list-style-type: none"> <li>• No major change since 2008</li> </ul>
Ensuring exploitability of knowledge production	<ul style="list-style-type: none"> <li>• No major change since 2008</li> </ul>

### 2.3.4 Knowledge circulation

There have been certain policy changes since 2008 in the domain of knowledge circulation. The Agency of the Mobility and the EU programs started to operate, responsible for the mobility programs provision. Moreover, in 2008 Croatia launched the Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010, with researchers mobility highlighted as an important instrument receiving significant attention within the Action plan.

**Table 5: Main policy changes in the knowledge circulation domain**

Challenges	Main Policy Changes
Facilitating knowledge circulation between university, PRO and business sectors	<ul style="list-style-type: none"> <li>• No major changes since 2008</li> </ul>
Profiting from access to international knowledge	<ul style="list-style-type: none"> <li>• The Agency of the Mobility and EU programs started to operate</li> </ul>
Absorptive capacity of knowledge users	<ul style="list-style-type: none"> <li>• In 2008 the Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010 was launched.</li> </ul>

## ***2.4 Policy opportunities and risks related to knowledge demand and knowledge production: an assessment***

Following the analysis in the previous sections, this section assesses whether the recent policy changes respond to identified systemic weaknesses and take the identified strengths into account.

The policy opportunities for resource mobilization reflect a systemic strength stemming from long term experience in R&D policy management. However, since the public sector finances the bulk of R&D investments, the budget revision in light of the current economic crises may significantly reduce GERD. Moreover, an additional problem lies in the low share of R&D personnel engaged in business, a potential bottle neck in case of increasing business R&D investments.

Improvement in coordination between MSES and MELE presents the main mechanism which may enhance knowledge demand in Croatia. For example, the policy of national technology platform promotion, envisaged by the new strategic document<sup>6</sup> could be furthered through increased coordination between relevant ministries and agencies under their responsibility. Business R&D Expenditure is concentrated in seven companies, accounting for 85% of R&D investments (EC 2008: 42) highlighting the potential for BERD decreases in case of weak financial results in individual companies. However, the main threat for knowledge demand policy promotion is the lack of programme evaluation which may hamper policy development.

Existing programs managed by BICRO, HIT and *Ruđer Inovacije*, financing start up businesses provide an opportunity to increase competencies in knowledge production in Croatia. However, the financial instruments are applied horizontally, with all research areas receiving equal treatment, implying on average non sufficient financial funds for scientific projects. The introduction of the action plan and the promotion of the Agency of the Mobility and EU programs were important steps towards improvements in knowledge circulation, increasing long term quality of scientific work. These measures directly increase absorptive capacity of knowledge users, thus increasing the opportunities for knowledge use in public and private research sector. However, the low level of innovation performance is a risk which may reduce policy efforts in the dynamics of knowledge production and circulation. In the future much more policy attention should be given to companies without R&D (with lower inclination towards innovation activities).

<sup>6</sup> Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010

**Table 6: Summary of main policy related opportunities and risks**

Domain	Main policy related opportunities	Main policy-related risks
Resource mobilisation	<ul style="list-style-type: none"> <li>• Long term experience in managing R&amp;D policy programmes may enhance efficiency of national research policy for achieving strategic objectives</li> </ul>	<ul style="list-style-type: none"> <li>• The Economic crisis reduces the opportunity for increase of GERD;</li> <li>• Low share of R&amp;D personnel in total number of employees engaged in the business sector which may reduce efforts aimed at increasing R&amp;D investments in the long run</li> </ul>
Knowledge demand	<ul style="list-style-type: none"> <li>• Improvement in coordination between the MSES and MELE in promoting national technology platforms could be more efficient</li> </ul>	<ul style="list-style-type: none"> <li>• Business research investments are concentrated within a few business entities</li> <li>• The evaluation of knowledge demand is on low level</li> </ul>
Knowledge production	<ul style="list-style-type: none"> <li>• Existing programs aimed at financing start up business potentially increases excellence of knowledge production</li> </ul>	<ul style="list-style-type: none"> <li>• The main policy instruments for financing science follow a horizontal approach</li> <li>• Low level of innovation performance within the business sector may in the long run jeopardize policy efforts aimed at increasing knowledge production quality.</li> </ul>
Knowledge circulation	<ul style="list-style-type: none"> <li>• Successful Croatian FP participation provide an opportunity for knowledge circulation</li> <li>• Growing number of financial instruments aimed at improving knowledge commercialization</li> </ul>	<ul style="list-style-type: none"> <li>• Policy instruments for knowledge circulation promotion are more appropriate for firms with continuous R&amp;D investments in comparison to companies without R&amp;D where low levels of innovation performance in the national economy may limit the effects of knowledge circulation.</li> </ul>

### 3 National policy mixes towards R&D investment goals

While the EU27 has essentially maintained stable gross R&D expenditure (GERD) levels over the past few years (1.83% of GDP in 2007, representing a marginal increase from 1.82% of GDP in 2004), Croatia has been experiencing a decline in GERD levels. In 2004 Croatia's GERD was 1.13% of GDP, whereas by 2007 this figure had declined to only 0.86% of GDP. The share of business expenditure in R&D (BERD) is also quite low. In 2007 the Croatian BERD level was 0.35% of GDP, marking a decline from the 0.41% share in 2005, whereas in 2006, BERD had been as low as 0.32% of GDP.

#### 3.1 Barriers in the research system for the achievement of R&D investment objectives

Since 2000, Croatia has placed more emphasis on science and technology development. Each document of the national science and research policy included objectives aimed at increasing R&D investments, simultaneously representing the EU science and technology policy objectives.

However there are number of barriers which jeopardize the achievement of R&D investment goals in public and private sectors.

Low amount of expenditure of the Business Sector on research and development has been observed and presents an obstacle. In 2002, the Business sector invested €115m and in 2007, €141.4m into R&D. The majority of the business sector

investments are by foreign investor enterprises. Moreover, a low number of business entities is actually engaged in R&D. Croatian Bureau of Statistics states that 3.8% of business entities perform R&D on a regular basis whereas 11.9% engage in occasional R&D; results are based on Community Innovation Survey covering the period 2004-2006. The structural weakness of the Croatia's research system is the lack of specialized research and technology organizations and technology agencies which may act to develop absorptive capacities and enhance the number of innovative business entities (primarily SMEs).

Moreover, the government shows occasional commitment towards the fulfilment of Lisbon Criteria i.e. increase of R&D investments on a national level. But, the lack of commitment towards fulfilment of strategic objectives on the national level is visible, exemplified by the declining share of GERD in GDP, which is an additional barrier. A notable example of this practice is the lack of coordination between MSES and MELE where both ministries finance the same activities (e.g. innovation infrastructure) via various program schemes (BICRO is responsible for TEHCRO program financing and maintaining science and technology parks and MELE organizes its own financial scheme for the same purpose). In terms of innovation and R&D programme implementation, a lack of financial resources has been observed. It seems that the problem of creation and implementation needs to be analysed in the context of inadequate vision and strategy in the national economy combined with the presence of industrial programs focusing primarily on privatisation and financial restructuring.

Additionally, the dominance of low technology industry (in 2006, 40.7% of GVA) and business activities require relatively small investments into own knowledge (R&D) in the national economy (in 2007, share of Retail was 10.9% of GDP, and Real Estate was 10.5% of GDP) (CBS) reduces the importance of R&D and innovation activities in Croatia. However, there are business sectors in Croatia with both a considerable share of GDP and large investments into R&D. In 2005, the share of Construction in GDP was 6.1% and R&D investments were 3.6% of BERD. Similarly, in the same year, Manufacturing share was 15.9% of GDP; with R&D investments representing 40.4% of BERD. So we may assume that investments into R&D are primarily connected with the characteristics of the business activities where the firm innovates.

### **3.2 Policy objectives addressing R&D investment and barriers**

The main policy objectives regarding R&D investments are given in The Science and Technology Policy of the Republic of Croatia 2006-2010, where current policy objectives are as follows:

- *Increase funding for excellent science and technology projects to meet the “3% of GDP for research investment”, outlined by the Lisbon Strategy;*
- *Restructure publicly-funded research institutes and R&D centres in order to focus their research towards national priority areas and industry needs;*
- *Encourage research partnerships and strengthen support schemes for quality young researchers - in order to facilitate mobility, interdisciplinary and cross-sector cooperation, and build a more flexible research and education system;*
- *Invest in science research infrastructure and knowledge transfer institutions in order to build research capacity and provide access to business solutions*

- *Introduce measures to promote commercialization of academic research* in order to encourage universities and research institutions to work more closely and effectively with business
- *Introduce measures to promote technological development and innovation in order to attract people and capital into innovative business ventures*
- *Administer stimulating and business-friendly legislation* including appropriate Intellectual property laws and tax incentives for investment into R&D, building a system that encourages innovation

During the period 2007-2008, the Government placed additional efforts in the implementation of national policy goals.

An important aim in the Science and Technology Policy Action plan for the period 2007-2010 is to increase Gross Expenditure on R&D as percentage of the GDP by 10% annually and increase BERD as a percentage of the GDP by 15% annually.

Two high governmental bodies SVEZNATE and VNIS have been founded with the aim to improve coordination between governmental bodies within the national science research system. The Government gives more priority to national science research policy in the national economy with the inclusion of the Ministries into SVEZNATE.

An important theme in the Action Plan to Encourage Investments into Science and Research is strengthening human potential through increasing the number of scientists and fostering science and business cooperation in Croatia.

The same action plan envisaged the design and implementation of R&D and innovation programmes for industry needs. MELE would manage these programmes in cooperation with MSES and the Ministry of Finance (MFIN). This scenario implies an increase of importance for industries with business activities demanding R&D and innovation activities to a large extent.

### **3.3 Characteristics of the policy mix to foster R&D investment**

The activities are oriented towards accomplishing the strategic objectives stated in chapter 3.2, and include five groups of instruments.

**The first group** of instruments are geared towards **research activity** finance:

- Institutional funding (block grants), including salaries for researchers
- Research grants through the competition-based "Research Projects" programme
- Grants for young researchers through the competition-based "Junior Research Programme"
- Research-supporting programmes, additional financial means for specific purposes, e.g. Scientific Publishing Activity, Support for Scientific and Professional Conferences and Associations and Research Equipment.

**The second group** consists of **financial instruments** for **financing science and industry cooperation** and to a large extent include R&D:

- RAZUM for firm seed capital finance, managed by HIT;
- BICRO manages three financial instruments:

- TEHCRO for finance and maintenance of science and technology parks;
- VENCRO supporting innovative start up companies through encouragement of potential private investors to start venture capital funds;
- TEST programme (pre commercial technological projects);
- MELE manages a program called «Technology parks».

"Partnership in basic research", represents the program aimed at the promotion of science and industry cooperation organized by National Foundation for Science (NZZ);

Entrepreneurial activity programme is managed by UKF, and focuses on high technology through special science and industry cooperation, with projects initialized by the Diaspora.

**Third group** of instruments promote **strengthening of business sector R&D investments**, managed by BICRO

- IRCRO programme is oriented towards R&D investments finance within SMEs;
- KONCRO programme is oriented towards SME competitiveness building;

Moreover MELE provides three additional programs:

- New Product development
- Competitiveness Strengthening
- Through cooperation for success

**Fourth group** of instruments promotes **human resources circulation** in the public sector between the domestic scientists and both Diaspora and foreign countries. This program is implemented by Unity through Knowledge Fund (UKF), and focuses on knowledge circulation, with instruments such as financing Post doc, Engagement in Research Project including members from the Diaspora and Short term and Long term visits. Another similar program aimed at strengthening human resources has been implemented by NZZ and consists of four instruments Visitor, Senior, Postdoc and Homing Programme. Finally, AMPEU organizes student and staff mobility program through bilateral agreements.

**Fifth group** includes **financial incentives** implemented by the Ministry of Finance and includes

- Value Added Tax Refund on Equipment for Technology Research and Scientific Research and Projects Procured in Croatia and Abroad;
- Reduction of income tax for R&D in the area of Corporate Tax;

### 3.3.1 Overall funding mechanism

In terms of the sectoral analysis, the public sector consists of two types of institutions - public research organizations (26) and Universities (7). Public research is primarily financed by MSES; via institutional funding, young researcher programmes and scientific projects. In 2006 the Government financed 77.3% of university research and 79.3% of public institutes research. Simultaneously, business sector financed a small portion of university (5.1%) and public institutes research (10.8%).

An analysis of the balance between ministry and agency finance in the last few years shows that the ministries are the predominant source of finance. However, simultaneously with the recent growth in the number of the agencies there has been growing number of financing schemes under their responsibility. Hence, the financial balance has changed slightly to favour Agencies<sup>7</sup>. However, MSES has significantly larger financial resources in comparison, aimed at financing primarily public expenditure (chapter 3.3.2. route 6). Of all the Agencies, BICRO has the most significant financial resources, with almost €10.8m allocated to all program schemes since 2007.

In 2006 the total MSES budget was €1310m, amounting to 9% of the total government budget, slightly more in comparison to the previous year (8.7%). The ministry invested €108m into science and research as well as €313.2m into the higher education sector. Within the investment structure into the science and research activities, the largest share was reserved for institutional funding, €391.3m (35.9%) and junior research programmes i.e. funding salaries and other related costs for young researchers in the assistant positions at researcher organizations and higher education institutions, €319m (29.3%).

Research policy in Croatia is mainly generic in character, where support programmes for specific thematic areas are not very common in policy practice. However, it seems that Biomedicine science (biochemical engineering, molecular biology, medicine, pharmacy and related fields) has marginally higher priority, evident from the allocation for bio-medical research (e.g. 28% in 2005). It seems that favouring Biomedicine will continue in the future, largely due to the solid institutional platform and a critical research mass, including the Medical School of Zagreb, the Medical School of Split, the Medical School of Rijeka, Institute of Immunology, Medils – Mediterranean Institute for Life Science, and research units in polyclinics and hospitals.

### 3.3.2 Policy Mix Routes

The «Policy Mix Project» identified the following six 'routes' to stimulate R&D investments:

1. Promoting the establishment of new indigenous R&D performing firms;
2. Stimulating greater R&D investment in R&D performing firms;
3. Stimulating firms that do not perform R&D yet;
4. Attracting R&D-performing firms from abroad;
5. Increasing extramural R&D carried out in cooperation with the public sector or other firms;
6. Increasing R&D in the public sector.

The routes cover the major efforts to increase public and private R&D expenditures. Each route is associated with a different target group, though there are overlaps across routes. They are not mutually exclusive as, for example, competitiveness poles of cluster strategies aims to affect several routes simultaneously. Within one

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<sup>7</sup> The main problem of the national science research system is a lack of financial resources aimed at financing R&D and innovation related activities.

'route', the policy portfolio varies from country and region depending to policy traditions, specific needs of the system etc.

### **Route 1: Promoting the establishment of new indigenous R&D performing firms**

Promotion of new indigenous R&D has been primarily channelled via BICRO and HIT as the agencies responsible for implementation. BICRO has been managing two programs since 2006, RAZUM and VENCRO, aimed at promoting new indigenous R&D performing firms. RAZUM project is oriented toward financing firm's seed capital, aiming to ensure a sustainable increase in the number of knowledge based SME's. Since 2007, eleven projects have been financed through RAZUM, seven of which in the ICT sector (two additional projects have been adapted but not financed up to this point). BICRO has allocated HRK54m so far (approximately €7.3m).

VENCRO program was introduced in 2008 as a government initiative encouraging potential fund managers to start venture capital funds. VENCRO has been designed as public-private partnership through the creation of an investment fund, providing additional finance for innovative companies in their start-up and expansion stage. Such enterprises may be unable to obtain bank loans, and due to risk, they may also be insufficiently attractive to standard private equity or venture capital investors.

The TEST program is aimed at finance of pre-commercial research activities and the development of new product and/or processes up to the prototype point and/or pilot solutions. The Programme also finances research activities which link basic sciences and their technological applications relevant for industry and economic development.

In 2007, *Ruđer Inovacije* presented a new mechanism aimed at the promotion of new R&D performers. Its operations are oriented towards commercialising fundamental scientific research results, and launching them on both domestic and foreign markets. Currently, its portfolio includes three spin offs (two in the bio-medical sector<sup>8</sup>, and one in ICT<sup>9</sup>).

### **Route 2: Stimulating greater R&D investment in R&D performing firms**

This route includes three basic programs initiated in 2006 and organized by BICRO. First, there is the IRCRO programme for R&D investment finance within SME's, which has financed five projects since 2007 (four projects have been accepted but not financed). BICRO has so far allocated HRK2.1m (approximately €292,400) into IRCRO. KONCRO is an additional program scheme for building SME competitiveness. 26 projects have been accepted via this programme scheme (24 out of 26 have been financed), with HRK874,000 (€119,000) allocated.

MELE organized two programs schemes, titled Innovation and New Product and Strengthening of SME Competitiveness. The first programme scheme focuses on new product development finance, closely related to R&D promotion within the business sector. The strategic objectives of the program are 1) Innovation protection 2) Innovation development (via prototype) 3) Innovation presentation 4) Innovative start up and 5) Innovation by-out. In the period 2004-2008, 792 projects have been financed via the project. MELE allocated HRK16.5m (approximately €2.2m), with each participant receiving HRK13,700 (approximately €2750.4) on average. The second program scheme provides finance for business process and product and

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<sup>8</sup> Ruđer Medikol ciklotron and Ruđer Medikol dijagnostika.

<sup>9</sup> Initunum Futura



services competitiveness improvements within the national SME sector. Non refundable finance covers R&D investments through: 1) Equipment Acquisition 2) Know-how procurement 3) Product development with higher value added; 4) Ecology friendly and Energy efficient Investments; 5) Employees training (knowledge application).

### **Route 3: Stimulating firms that do not perform R&D yet**

There are no developed schemes by the national authorities for the stimulation of knowledge transfers from Research Technology Organizations to business entities. However there are several projects within the FP 6 and FP 7 framework called SME Associations where research and technology organisations transfer knowledge to small and medium enterprises, which already include participants from Croatia (Brodarski Institute as research technology organization and Doking, Pewa, Emergo and Damko as participants from the business sector).

### **Route 4: Attracting R&D-performing firms from abroad**

Over the past several years, attracting R&D performing firms from abroad has received little attention. Trade and Investment Promotion Agency (APIU) has been set up for the specific purpose to provide full service in addition to practical information to investors during and after the implementation of their investment projects. Over the past few years, APIU has indicated its willingness to attract foreign investments into high technologies, where R&D and innovation activities are indispensable. However there is no visible strategy by APIU in terms of the ways how these strategic objectives should be attained.

### **Route 5: Increasing extramural R&D carried out in cooperation with the public sector**

TEHCRO is the main policy instrument for finance and maintenance of science and technology parks, managed by BICRO. In total, 9 projects have been established since 2007 (8 have been financed). MSES has allocated HRK22.3m (approx. €3m). Similar project is organized by the Ministry of Economy Labour and Entrepreneurship, titled Technology Parks. In the period 2004 to 2008, MELE has financed 6 technology parks with the total sum of HRK1m (approximately €148,900). National Foundation for Science (NZZ) manages Partnership instruments in basic research. NZZ allocated HRK8.61m (approximately €1.1m) in the period 2006-2008 (also relevant for route two).

Since 2005 MELE has been supporting a project named «Through cooperation for success» with the objective of creating business associations, geared towards the finalization of products with higher value added. Here, clusters have been founded, using both the bottom up and top down approaches. In addition, MSES has recently made efforts to promote regional clusters within Western Balkan countries.

The Croatian Institute for Technology (HIT) was established to become the pivotal institution in Croatian technology networks. In this route, it is undertaking foresight programmes seeking to envisage future technology demand, including R&D investments demand (relevant for route 6).

### **Route 6: Increasing R&D in the public sector**

In the last fourteen years the main achievement of the science and research sector was the significant increase in the number of young researchers employed, from 915

in 1996 to 2,510 in 2005. A majority are employed at universities (72%) ([ERAWATCH research inventory Croatia](#)). However, the noted increase in the number of new universities and public and private polytechnics throughout Croatia has definitely increased the importance of public R&D investments.

In terms of non innovation and R&D measures, MELE placed an emphasis on entrepreneurial promotion with educational programs. This project was divided into five phases, including: 1) education for start up entrepreneurs, craftsmen, and entrepreneurs in growth firms 2) education in high schools and primary schools 3) scientific (academic) entrepreneurship i.e. encouragement of entrepreneurship in higher education institutions, 4) pupil companies, 5) promotion within the young population 6) regional centre for entrepreneurial learning for the Southern Eastern European countries.

Moreover, in the last ten years, it has become evident that the institutional framework in science and research sector has significantly developed which has increased the importance of R&D financing in public sector<sup>10</sup>, with the establishment of NZZ in 2001; ASHE (regulator of activities related to the evaluation of research and higher education systems) in 2004; HITRA with the first programme in the area of science and industry cooperation launched in 2001; as well as a significant stimuli regarding R&D investments increases in the public sector via UKF, launched in 2004 and uniting scientific potential in Croatia and Diaspora (program relevant for route 2) and finally the Agency for Mobility and European Union Programmes.

### The importance of education and innovation policies

Regardless of the fact that MSES is responsible for the education and innovation policy (in cooperation with MELE), it seems that the main challenge in the future of science and research policy development shall be how to improve coordination between these policies. The integral part is the education policy focused on the functioning of the scientific system while innovation programs (controlled by MSES and MELE) are deemed too horizontal in design, lacking clear priority proposals (in terms of the sector and/or activities, a result of a inadequate national industrial policy). Thus, the current education and innovation programs design cannot improve the competitiveness of the business sector and change the structure of economy in terms of the increased use of R&D. As noted above, one of the innovation policy weaknesses is the low share of Science and Engineers students in the total student population.

### Assessment of the importance of policy mix routes and their balance

**Table 7: Importance of routes in the national policy and recent changes**

Route	Short assessment of the importance of the route in the national policy	Main policy changes since 2008
1	Increasingly important, still relatively small in terms of budgetary weight	VENCRO project
2	Very important, especially in terms of budgetary weight	No significant changes
3	Very low importance	No significant changes
4	Very low importance	No significant changes
5	Important	VENCRO project
6	The most important route, primarily in terms of budgetary weight	No significant change

<sup>10</sup> For more detail, please refer to chapter 1.2.

### 3.4 Progress towards national R&D investment targets

The actual Gross Expenditure on R&D in Croatia is still far from the annual 10% increase as a percentage of the GDP goal<sup>11</sup>. The same can be stated for BERD with predicted investments increase of 15% as a percentage of GDP annually. The largest business R&D performers are a relatively small group of both foreign and domestic companies. Therefore, future R&D investments depend on the business outlook in these industries. Since the economic crisis is exhibiting global characteristics, export expansion cannot improve the national economic performance. Even more, Croatia has an external debt problem, totalling €38.3b in November 2008, and is required to finance €13b this year alone for debt servicing. Since additional financing on the foreign markets is becoming increasingly difficult this will probably imply additional savings in all sectors and probably leads towards budgetary revisions sometime this year. Since the public sector represents the bulk of R&D funding in Croatia, this will result in GERD reductions in Croatia.

The main reasons why the investments have not increased so far are the excessive assumptions within the strategic objectives in the Action Plan<sup>12</sup>. The basis for the strategic objectives and proposed actions did not consider innovation performance in the business sector, characterized by low levels of innovation performance accompanied by low share of R&D personnel in total number of employees. No adherence by the Government towards the fulfilment of the strategic objectives outlined in the strategic documents is visible through the low levels of cooperation between Ministries (MSES and MELE) responsible for R&D investments which reduces the chance for increasing R&D investments in both sectors (public and private). The persistence and the deepening of the economic crises in autumn 2008 has surely worsened the situation by making financing from abroad even more difficult which will imply additional risk and most likely to result in further reductions of the public R&D investments.

**Table 8: Main barriers to R&D investments and respective policy opportunities and risks**

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
Low level of innovation performance in the national economy	Current policy package are more focused on increasing R&D investments within firms; policy programs should be more oriented toward firms not yet performing R&D activities
Very small amount of investments into business R&D	Policy has recognised this barrier, but more could be done (in terms of creating programs aimed at developing a new product and/or new process)
Low share of R&D personnel in total number of Employees	Policy has recognised this barrier, but more could be done (in terms of creating programs aimed at fostering studying in science and engineering)
Low level of cooperation between science and the business sector	Several programs schemes have been organized in the last few years by BICRO, MELE, UKF and NZZ

<sup>11</sup> The Action Plan Science and Technology Policy of the Republic of Croatia for the period 2007-2010

<sup>12</sup> See reference 8

## 4 Contributions of national policies to the European Research Area

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This Chapter provides a thorough discussion of the national contributions to the realisation of the European Research Area (ERA). An important background policy document for the definition of ERA policies is the Green paper on ERA<sup>13</sup> which comprises six policy dimensions, the so-called six pillars of ERA. Based on the Green Paper and complementing other ongoing studies and activities, this chapter investigates the main national policy activities contributing to the following four dimensions/pillars of ERA:

- Developing a European labour market of researchers facilitating mobility and promoting researcher careers
- Building world-class infrastructures accessible to research teams
- from across Europe and the world
- Modernising research organisations, in particular universities, with the aim to promote scientific excellence and effective knowledge sharing
- Opening up and co-ordination of national research programmes

In the ERA dimension, the *wider context of internationalization of R&D policies* is also an issue related to all ERA policy pillars and is normally present in the dynamics of national ERA-relevant policies in many countries.

### 4.1 Towards a European labour market for researchers

Croatia's market for researchers has been growing in the last several years. This is a primarily a result of the Grants allocated for new employment positions for young researchers through the competition-based "Junior Research Programme". The increasing demand for research positions is not a result of higher demand by the business sector, but a result of the constant increases in student numbers over the last twenty years (in 2008 the number of students amounted to 110.7 thousand including science and polytechnic studies). Hence, the majority of young researchers work at higher education institutions as assistants. In the past ten years the majority of increases occurred in a smaller number of faculties within the Universities (social and human sciences), consequently changing the structure of students in favour of human and social science. This process has been parallel with an increase of the share of self financing students (partially or fully)<sup>14</sup> in the total number of students, providing extra finance for higher education institutions. At the same time, increasing number of higher education institutions and the financial incentives stimulating employment for new scientists the number of doctoral students has rapidly increased. In the academic year 2006/2007, there were 1766 doctoral students (CBS) compared to 1316 in the academic year 2005/2006. At the same time, the number of master students has decreased from 2.378 in the year 2005/2006 to 2.101 in the year 2006/2007.

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<sup>13</sup> Commission of the European Communities: Green paper: The European Research Area: New perspectives. Brussels 4.4.2007, COM(2007) 161final  
(see [http://ec.europa.eu/research/era/pdf/era\\_gp\\_final\\_en.pdf](http://ec.europa.eu/research/era/pdf/era_gp_final_en.pdf)).

<sup>14</sup> Two categories of self financing students appear 1) students with rights relating to food and accommodation finance (to an extent) and 2) students without rights.

The analysis of the incomes in the research system shows differences, with young researchers (without a PhD degree) earning HRK6,000 (approx. €814) per month on average (depending on the research status and the academic level) while a Research Fellow with a PhD (depending on the scientific degree) earns approximately HRK9,000 (approximately €1,221)<sup>15</sup>. The research assistant salary is higher than Croatia's average salary (In December 2008 it was HRK5,410 (approximately €734). The relative position of the research post in comparison to other jobs depends on the employing Institution as well as the business sector where its counterpart is employed. In general, business sector employment represents a better income opportunity in the long run. However, in a crisis, the business sector advantages in comparison to science have become relative i.e. job positions are more secure. Stimuli within the research institutions relate to the engagement in commercial projects (sponsored by the public and private sector) whereas the stimuli in the higher education institutions include additional engagement in education and involvement in commercial projects. In terms of scientific excellence, MSES outlined measures concerning the stimulation for the work within FP. Positive assessments of the project proposals by the evaluators in the European Commission enable the participant to receive non-refundable grants from MSES amounting to up to HRK100,000 (approximately €13,500). It is common that each institution prescribes the incentives for the stimulation of scientific excellence (e.g. Economic Faculty Zagreb and The Institute of Economics, Zagreb have a financial bonus for their scientists in case of publishing work in Current Contents listed journals).

The assistant position has a temporary character whereas the researcher position is permanent in character. Promotion from the assistant position to researcher positions is traditionally seen as an assurance. Permanent employment in the higher education institutions and research organization has virtually been guaranteed. However, promotions are becoming increasingly complicated, since the length of an assistant's contract is six years and connected more tightly with competition-based "Research Projects" so new research positions cannot be created without a project, hence the temporal nature of these positions. Permanent posts in the future will be more strongly connected with the capability of generating income from the market.

In terms of qualitative assurance within the scientific sector, there is a long tradition through the competitive project evaluation mechanism. In this context, NSC represents an organization responsible for project and programme evaluation. Since 2005 ASHE has been evaluating scientific institutions in terms of university and professional study programmes made in order to implement the Bologna Process.

#### **4.1.1 Policies for opening up the national labour market for researchers**

Important policy efforts have been made rather recently, aimed at facilitating researcher mobility in Croatia. An important step the passing of the Act on Recognition of Foreign Educational Qualifications, in addition to the establishment of higher education authorities for shaping and monitoring the reform process in the following years - the National Council for Higher Education in 2004, the National Council for Science in 2005, and the Agency for Science and Higher Education, (administering accreditation for the implementation of Bologna at the Croatian institutions for tertiary education). In October 2007 Croatia passed the Act of Foundation of the Agency for Mobility and EU programs (AMPEU). In 2008 Croatia

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<sup>15</sup> The author's calculation since reliable data within the CBS does not exist.

launched the Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010, where the mobility of the scientists represents an instrument of one of the objectives, namely strengthening human capacity.

The policy of opening permanent job positions is autonomous in higher education institutions and research organizations. However, the competition for permanent job position implies several conditions which a foreign researcher needs to fulfil, namely scientific occupation, permanent residence permit as a prerequisite for the work permit, validated scientific degree (doctor's, master's and/or bachelor degree) by ASHE as well as a scientific number. The university commission then allows the foreign researchers to receive a scientific post. Thus, the procedure is not overcomplicated for foreign scientists and depends on the willingness of the scientific organizations to open a post and its cooperation with the university commission. The assumption is that there are low competition levels (i.e. few candidates). In terms of approaches to social security, health insurance and pensions the post usually includes all these facilities. What is more, social security provisions can be achieved even in cases of shorter duration of residence in Croatia, up until one year (not less than one month). In that case the MSES need to issue a special agreement with the scientific organization receiving a foreign researcher. Following that, permission for permanent residence can be issued, as a prerequisite for achieving health security in Croatia. Other facilitates (e.g. pension fund) depend on the level of income which the foreign researcher realizes in Croatia.

The most extensive programme aimed at mobility circulation is the Unity through Knowledge Fund (UKF), launched by the MSES in 2004, aiming to unite the scientific potential in Croatia and Diaspora. The instruments seek to help Croatian scientists from abroad to return as well as to foster institutions and researchers to use potentials of Croatian scientists and professionals from Diaspora. UKF achieves its mission by supporting basic and applied research which is competitive on the international level, co-financing business R&D expenditure and R&D investments made by the project partners in Diaspora as well as supporting the development of research infrastructure projects in Croatia, engaging partners from Diaspora. The money is allocated on a competitive basis through public calls and evaluation procedure is administered by UKF. So far, the Fund has supported 29 projects, with the overall planned project investments amounting to €2.5m mainly through the two policy instruments. The Young Scientists and Experts Programs financed 12 out of 88 projects (13%) in the first call with HRK4.5m (approximately €608,100) overall<sup>16</sup>. NZZ is responsible for the four sub programmes under the Brain Gain programme, enhancing scientific mobility from foreign countries to Croatia and vice versa, titled Post Doc, Visitor, Senior and Homing Programme.

#### **4.1.2 Policies enhancing the attractiveness of research careers in Europe**

In order to reach the number of researchers which the EU will need by 2010 to meet the Lisbon target, research careers in Europe have to become more attractive. Measures enhancing the attractiveness of researcher as occupation include: promoting women's involvement in scientific research; extending the opportunities for training and mobility in research; improving career prospects for researchers in the

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<sup>16</sup> The highest amount allocated to a project was €93,000 and the lowest €24,000.

Community. The European Charter for Researchers sets the general principles and requirements that enable the frame for successful research performance, knowledge dissemination and technological development, and to the career development of researchers. Beyond its uptake, among the many potentially relevant policies, in this section we concentrate on policies affecting researchers' salaries and policies promoting women.

### **Uptake of the Charter of Researchers**

The European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers were developed to help the EU Member States, employers, research financing bodies and researchers develop an appealing, open and sustainable European labour market for researchers. They ensure that selection and recruitment procedures are transparent and internationally comparable. Since Croatia is not a member of the EU it seems that there is no available information in MSES about it.

One of the main goals of the Science and Research policy stated in the Science and Technology Policy of the Republic of Croatia 2006-2010 is to encourage participation of Croatia's scientists and other bodies in EU Framework Programmes. In order to encourage participation of the Croatia's scientists in Europe the Government introduced financial instruments for: doctoral students in the foreign countries, mutual doctoral program with abroad partners, development of joint studies, development of PhD programmes, international programmes (e.g. Support for Joining European Science Research Programme). In addition, AMPEU organizes an additional program oriented primarily towards student and staff mobility via mechanisms of bilateral agreements. Currently, the Agency allocates HRK1.5m (approximately €203,000) to this project, with all EU, EFTA countries and Turkey eligible for bilateral agreements. Since Croatia is not a member of the EU there is no signatory organization in Croatia of the Charter for researchers.

### **Remuneration policies**

The monthly salary in the Science and research sector is the result of the negotiation between the Independent Union of Research and Higher Education Employees of Croatia and the Government. As mentioned above this depends on the scientific status where young researchers as well as scientists are divided into categories. Currently, younger researchers are divided in two groups: PhD candidates and Master degree candidates. Scientists with doctoral degrees are divided into three categories: Research Associate - first doctoral scientific degree, Research Fellow – second doctoral scientific degree and Senior Research Fellow – third scientific degree. Moving to an upper degree (e.g. from the first to the second scientific degree) depends on years of service and scientific excellence which needs to be confirmed by the Scientific Organization Commission (where a scientist is employed) and the University Commission. The move simultaneously implies a salary rise of 8%.

The Research Organizations and Higher Education Institutions are autonomous regarding the stimulation of their employees, especially scientists. Within the public research organizations, the stimulus is linked with engagement in commercial projects (sponsored by the public and private sector) whereas in the case of the higher education institutions it includes additional engagement in education (primarily on the specialist studies where the University expert degree can be achieved) and engagement in commercial projects which includes educational seminars for the public and the business sector as well as work on feasibility studies.

## Promotion of women

Despite the fact that more than half of the European student population is female, women hold less than 15% of full professorships in Europe. While the percentage of female university graduates and PhD holders has increased, the gender gap is not closing as rapidly as expected. Mobilization of the potential of women is therefore seen as one important avenue to increase the number of researchers in the ERA.

Regardless of the fact that women account for 44.3% of the total number of researchers (dominantly employed in human and social science) there is no special measure aimed at promoting the employability of women in the research market in Croatia. It seems that career breaks (i.e. parental leave) generate gaps in career progress, with the final effects depending on the ambitions of female researchers. The law guarantees the return to the same type of work and additionally the employees could opt for part-time contracts. The normal period for parental leave is six months following the birth, after which the female employee returns to work under the same conditions. Moreover, the female employee has an option of returning to work under a part-time contract (four hours work with reduced wages) or extend maternity leave for an additional six months, during which the financial compensation amounts to HRK2,500 (approximately €346). The progress of each scientist, including female researchers, depends on the willingness of the employing scientist organization and on the policy level there is no special regulation to stimulate and/or hinder progression of female researchers in terms of equality to their male counterparts. In 2006 Croatia launched the Gender Equality Act, the main policy document which regulates policy of equal gender opportunities, without mentioning the problem of women representation within research and academic institutions, committees and/or governmental bodies.

## 4.2 Governing research infrastructures

Croatia has experienced moderate development of the research infrastructure network. However, there is no precise infrastructure inventory so only broad estimates can be used (unfortunately GBAORD statistics do not exist in Croatia). According to the CBS, there were 202 institutions in 2005 with infrastructure that could be described as research infrastructure (77 of them in technical sciences whereas 32 out of them in biomedicine as well as human science). The data differs between sectors i.e. the technical sciences dominate in the business sector (67.1%); the biomedicine sciences dominate in the governmental sector (37.5%) whereas the social sciences lead in the higher education sector (28.3%). In terms of the research infrastructure investments, exact data does not exist. But in 2005 the gross investment which includes research infrastructure investments represented 20.1% of total investments in the R&D sector (HRK466m, approximately €63m) (CBS). The largest proportion of the gross investments (33.6%) in total investments was observed in the business sector (HRK320m, approximately €43.3m). In the period 2000 - 2005 the increase of gross investments had been evident; however gross investments as a percentage of total investments remained stable around 20% in the last few years.

The research infrastructure is primarily national in character. The public research (technological) organization and the higher education institutions have a large autonomy within the Universities in Croatia, with significant fragmentation of resources including present research infrastructure. As a result of this process, small research units with research infrastructure tools dominate. The Ruđer Bošković



Institute (807 employees more than 500 scientists) and The Brodarski Institut (169 employees out of them 50 scientists) can be excluded as exceptions.

However, in the last few years a broader approach to research infrastructure has emerged primarily in the ICT sector where development applied a top down approach initialized by the government. «e-Hrvatska» the institution responsible for ICT infrastructure development in Croatia, implemented two programs relating to research infrastructure, in addition to Broadband Internet and HitroNet aimed at building centralized network of public services. Moreover, MSES have been constantly improving the CARNET network implementing the program of distant learning. Moreover, MSES, jointly with CARNET and the Ruđer Bošković Institute launched the «Center for on-line data base» project ensuring a network approach to commercial databases and providing free databases for the science and research communities in Croatia (scientists, assistant and students).

The realization of the MEDILs project i.e. foundation of the life science institute in 2005 and initialization of Bio science incubator within the Regional Competitiveness Operational Programme as an Instrument for Pre-Accession Assistance Programme represent a bottom up approach in building research infrastructure and at the same time a result of a long tradition as well as scientific excellence in biomedicine. Moreover, financing the research infrastructure in order to implement ESFRI (European Strategy Forum on Research Infrastructures) road map is not planned as yet in Croatia.

Croatia has not applied a strategic approach and policy objectives and strategies in accessing intergovernmental European infrastructures. Access to the national research infrastructure within the scientific institutions is organized by the Agency for Mobility and European Programmes (see chapter 4.1.2). Regarding inclusion into Inter-governmental research organisations, as a result of multilateral agreements Croatia is a member of the European Molecular Biology Organization (EMBO), Conference and European Centre for Medium-Range Weather Forecasts as well as engaged in program of the European Organisation for Nuclear Research. Moreover, Croatia has signed more than 200 bilateral agreements in the area of science and research in the last ten years. One of the key aspects within the bilateral agreement is research project cooperation in local science and research infrastructure.

### **4.3 Research organisations**

Universities and their faculties as scientific units in Croatia have a large degree of autonomy. Employment is the responsibility of the faculties. The faculties select and employ professors and other personnel and design their education programs. However the faculties cannot set the basic salary for their employees who receive income from the MSES directly; but the salary represents a part of the block grant, as financial incentives and also a source of revenue for the scientific institutions. The faculties can introduce additional stimulus in addition to the monthly salaries. Research Institutes are the responsibility of the MSES and are not university units. Similar to faculties, the institutes select and employ scientists and other personnel and design their scientific activities. The autonomy of the Universities enhances the autonomy of the internal organization i.e. the faculties. The faculties are responsible for the design of educational and scientific programmes, finances and applications for international projects. The autonomy is tightly connected with obligations of the

university towards the students, ensuring the provision of quality education as well as obligation of accountability towards the public, society and the local community<sup>17</sup>. Recently, quality assurance has become an important issue in order to improve higher education and scientific work. For example, the University of Zagreb established the Quality Assurance Office in 2006 with the mission to promote high education standards and facilitate active support to the faculties in order to improve the quality of scientific and education work.

Regarding the governance practice within the Universities, faculties and research organization the practice of external stakeholders assuming controlling options is rare. In general, the statute regulates appointments of the heads of universities and/or the heads of faculty, with the requirements for the candidate to have a scientific occupation in education (in the case of the head of Zagreb University, a full time professor). The university senate elects the rector; or faculty council members in faculties. Theoretically a candidate may come from the business sector and/or non-profit sector but in practice, this is rare.

Block grants are currently the most important financial source for research organizations. The grants cover employee salaries plus additional social costs relating to employees and material costs within the Research Institutions, where the main criteria include the number of employees within the scientific organizations. Each year, the Institutes send capital investment plans to MSES, in order to finance their additional requirement (e.g. investment in maintenance). There is no clear connection between scientific excellence measured by bibliometric indicators, number of patents and block financing. The flexibility in redirecting block funds is rare. The importance of competition based research projects has grown in the last few years. The procedure regarding evaluation is increasingly stringent, thus the percentage of accepted projects has been decreasing in the last five years (reducing from 90% to 70%). The financial resources allocated in this project scheme as a percentage of total MSES budget has been growing in the last few years.

#### ***4.4 Opening up national research programmes***

Competitive projects finance researchers from the Croatian research organisations. However, small numbers of the grants are open for the researchers abroad via international scientific cooperation with the partners from Croatia (e.g. Program Partnership in Basic Research managed by NZZ) and solo (Support for Laboratory Installation within EMBO program; managed by NZZ). Internationalization of Croatia's research area stems from the obligations of the signed multilateral and bilateral agreements. Here, the national approach to opening up national research area has recently become an important issue primarily through the previously described Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010.

Participation in FP programmes is managed by policy makers within MSES, but there is a low level of coordination with the other national strategies. Croatia participates in The Southeast European Era-Net networking project aimed at integrating EU member states and Southeast European countries in the European Research Area. Croatia's inclusion in the Joint Technology Initiatives (JTI) is modest since there is no participation from Croatia's institutions and/or business entities within the launched

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<sup>17</sup> Act on Scientific Activity and Higher Education (Official Gazette 123/2003)

platforms. The MSES in coordination with HIT establishes new technology and promotes inclusion of companies into JTI. The policy ambition is outlined in the Action plan mentioned above, with the main goal of improving inclusion of the Croatia's participants into the existing technology platform and establishing new national technology platforms, with plans for new financial incentives.

Hence, in terms of the barriers and limits for opening up and enhancing co-ordination of national research programmes from the national authorities viewpoint, the main problem lies in the fact that necessity of this approach has been recently recognized as an important science research policy issue. In terms of joint programming, the main barriers lie in the low capacity of the national research system (e.g. Croatian organizations sporadically participate in Inter-governmental research organizations). Moreover, there is no public research funding scheme allowing researchers to transfer a research grant within a national programme to other countries when moving to another position outside the country.

Croatia has not launched a special programme or research scheme in a particular field of science and technology (e.g. biomedicine science where capacity exists, see chapter 3.3.1) which constrains potential for future international scientific collaboration. Croatian researches demonstrate a high absorptive capacity in terms of participation in FP 6 programme. According to MSES, Croatia signed 134 contracts with finance totalling €10.2m for partner activities in majority of the fields, namely Knowledge-Based Society, Information Society Technology and Bio medical science. Within FP 7, Croatian participants signed 28 projects, receiving €3m. Currently, Croatia cooperates in 70 COST projects, eight of which in the R&D sector as well as eight EUREKA projects with the total cost exceeding €15m. In addition, Croatian participants have additional experience in 10 INTERREG projects. All these examples demonstrate that national research programmes should be more oriented towards coordination with the international projects, where the promotion of cross-border cooperation R&D and innovation would be included.

#### ***4.5 National ERA-related policies - a summary***

It seems that the main obstacle regarding topics relating to ERA is the fact that the capacity and potential of the ERA policy which may stimulate national research policy development is not recognized in Croatia. However, ERA related policy activities are financed (e.g. Croatian contribution to EU projects was HRK46m, approximately €6.2m in 2005). Moreover, MSES attempted to improve the approach of the Croatian scientists to EU programs by establishing the European Integration Department with six national contact points, establishing the National Committee for the Monitoring of the Implementation of FP and preparing the national program report about MSES activities towards fulfilment criteria of EU membership. The national ERA related policies are primarily oriented towards capacity building where the existing programs and activities includes the mobility of the researcher programs and opening up national research programs.

In the area of research mobility, several financial schemes exist with the aim of better inclusion of the Croatian scientists within the European Research Area. The 2008 Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010, outlined the strategic objectives and the instruments aimed at better inclusion of Croatian scientists to ERA. The main ambition is to promote the role of the Agency for Mobility and EU programs (AMPEU) as an institution responsible for

participation increase of foreign researchers in Croatia and vice versa, with the overall goal of increasing the participation of Croatian scientists abroad.

The issue of research infrastructure has recently been increasingly recognized as important. The research infrastructure has a national character managed primarily by specific institutions. However, broader approach has emerged in the last few years primarily in the ICT sector providing approach to the infrastructure for the users from the national science and research system not only from a particular institution. Moreover, CARNET, in cooperation with Ruđer Bošković Institute implements the «Center for on line data base» project.

In the long run, Croatian Universities and their components (the faculties) have high degree of autonomy with the relationship with the ERA is characterised policy attempts to improve higher education quality, with the initial step of introducing quality assurance. Further internationalization of the Universities via faculty programmes in foreign languages represents additional key challenges for the future.

The opening up of national research programmes is a result of the bilateral and multilateral agreement i.e. the resulting obligations. The main policy goal in this topic is to improve the inclusion of Croatian participants into the existing technology platform and establish new national technology platforms<sup>18</sup>. However, Croatia has not launched any special programmes or research schemes in a particular field of science and technology which may improve the coordination between national and international research programs.

**Table 9: Importance of the ERA pillars in the ERA policy mix and key characteristics**

	<b>Short assessment of its importance in the ERA policy mix</b>	<b>Key characteristics of policies</b>
Labour market for researchers	<ul style="list-style-type: none"> <li>Increasingly important, result of launching programs aiming at removing barriers to mobility</li> </ul>	<ul style="list-style-type: none"> <li>The existence of the programme scheme aimed at human circulation between Croatian scientific organizations and Diaspora</li> <li>Policy action aimed at improving mobility of the scientists only recent</li> </ul>
Governance of research infrastructures	<ul style="list-style-type: none"> <li>Important result of improving and implementation of the research infrastructure projects. MSES has been constantly improving CARNET and in cooperation with Ruđer Bošković Institute implements the Center for on-line data base project.</li> </ul>	<ul style="list-style-type: none"> <li>The national character of the research infrastructure</li> <li>Recent broader approach regarding research infrastructure development affected all national science and research system users and not only particular institutions.</li> </ul>
Autonomy of research institutions	<ul style="list-style-type: none"> <li>Very Important, The Autonomy is guaranteed within the Act on Scientific Activity and Higher Education.</li> </ul>	<ul style="list-style-type: none"> <li>The universities and the faculties their scientific units have a large degree of autonomy, tightly connected with students to ensure the provision of quality education</li> </ul>
Opening up of national research programmes	<ul style="list-style-type: none"> <li>Low importance</li> </ul>	<ul style="list-style-type: none"> <li>Small number of the instruments are open for foreign researchers managed by NZZ</li> <li>No special programmes or schemes in particular science/technology field have been launched so far</li> </ul>

<sup>18</sup> These goals are settled out within Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010.

## 5 Conclusions and open questions

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### 5.1 Policy mix towards national R&D investment goals

The barriers to private R&D investments are small amounts of expenditure of the Business Sector on research and development accompanied by low proportion of companies performing R&D on a regular basis (3.3%), with 11.9% engaging in occasional R&D (CBS). Additionally, barriers appear in the design and implementation of the national science research programs. The lack of commitment towards the fulfilment of strategic objectives is exemplified by the declining share of GERD in GDP and the lack of coordination between MSES and MELE, with both ministries financing similar activities. Finally, the large proportions of low technologies in overall industry and business activity (e.g. Retail and Real Estate), not requiring investments into own knowledge which reduces the importance of R&D investments on the macro level.

Policy of the Republic Croatia in the period 2007-2010 outlined the basic strategic objectives and proposed actions. It did not, however, consider innovation performance in the private sector characterized by low levels of innovation performance accompanied by low shares of R&D personnel in the total number of employees. Financial crisis worsened the perspective for future government R&D, as investments will depend on debt servicing which imply budgetary revisions due to the increasingly difficult financial terms in the foreign markets. This may lead towards GERD reduction in Croatia. Moreover, the financial crisis will definitely influence future business R&D investments, depending on the business perspectives within R&D performing industries.

Policy program should focus more on firms not performing R&D activities. Extra financial resources should be allocated towards programs stimulating science and industry cooperation. Additional efforts are needed from the public and the private sector to increase the efficiency of the national research system. Moreover, policy should be more focused in terms of creating programs aimed at fostering studying in science and engineering.

Opportunities and Risks generated by the policy mix:

- Current policy package is oriented towards increasing R&D investments within firms; efficiency of the policy programs could be improved through a focus on firms that currently do not perform R&D activities;
- Small amount of investments into business R&D; Policy efforts are not orientated towards developing new products and/or new process programmes.
- Low share of R&D personnel in total number of Employees; the Government is not efficient in creating programs aimed at fostering studying in science and engineering.
- Several programs schemes have been organized in the last few years by BICRO, MELE, UKF and NZZ aimed at increasing cooperation between public and private sector.

## 5.2 ERA-related policies

ERA related policies have played an increasingly important role in Croatia. A stronger participation of the Croatian scientists within the European Framework programme represents a strategic objective of the national science and technology policy. In order to facilitate the participation of Croatia in the FPs, MSES has introduced a number of measures for capacity building, through the establishment of the Agency for Mobility and European Programmes, the European Integration Department with six national contact points and the National Committee for the Monitoring of the Implementation of FP. In terms of policy programs, the largest advance has been made with respect to researcher mobility. Unfortunately in the other ERA (pillar) areas of governance of research infrastructure and opening up of national research the advance is not satisfactory.

It seems that the key obstacle to ERA related policies originates in the lack of recognition of the ERA policy capacity and potential as a stimulus for national research policy development in Croatia. Thus, Croatian approach towards ERA has primarily resulted from multilateral and bilateral agreements signed and initiated from abroad, and significantly, not through the development of the national research programmes and activities.

So the main challenges for the national R&D system development in relation to ERA-development are:

- To facilitate additional mobility in the science and research and increase the participations of Croatia's scientists abroad and the foreign researchers in Croatia
- In terms of the research infrastructure, a precise inventory of research and science infrastructure is required, in addition to the national strategy in accessing inter-governmental European infrastructures.
- In order to internationalize their activities the key challenge for Universities is to introduce quality assurance programs and action within the faculties.
- Opening up of national research programmes for foreign participants

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- UKF- Unity Knowledge Fund; available on <http://www.ukf.hr/default.aspx?id=18>

## List of Abbreviations

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AMPEU	Agency for Mobility and European Programmes
APIU	Trade and Investment Promotion Agency
BERD	Business Expenditure on Research and Development
BICRO	Business Innovation Center of Croatia
CARNET	Croatian Academic and Research Network
CBS	Croatian Bureau of Statistics
CEFTA	Central European Free Trade Agreement
ERP Fund	European Recovery Programme Fund
FP	European Framework Programme for Research and Technology Development

GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
GVA	Gross Value Added
HEI	Higher education institutions
HERD	Higher Education Expenditure on Research and Development
HES	Higher education sector
HIT	Croatian Institute for Technology
JTI	Joint Technology Initiatives
MELE	Ministry of Economy Labour and Entrepreneurship
MFIN	Ministry of Finance
MSES	Ministry Science Education and Sport
NSC	National Science Council
NZZ	National Foundation for Science, Higher Education and Technological Development of the Republic of Croatia
PRO	Public Research Organisations
R&D	Research and development
SF	Structural Funds
SII	Summary Innovation Index
S&T	Science and technology
SME	Small and Medium Enterprises
SVEZNATE	Strategic Council for Science and Technology
UKF	Unity Knowledge Fund
VNIS	National Innovation System Council



# RESEARCH SYSTEM ANALYSIS REPORT

Elements on Research System Analysis relevant for  
the policy Mix Reports 2009 for non EU Member  
States

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Country: Croatia

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# 1 - Introduction and overview of analytical framework

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## ***1.1 Scope and methodology of the report in the context of the renewed Lisbon Strategy and the European Research Area***

Knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the economy are at the heart of the strategy for economic growth of many countries. The aim is to increase and improve investment in research and development (R&D), with a particular focus on the private sector. One task within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts.

The main objective is to analyse the performance of national research systems and related policies in a comparable manner. The desired result is an evidence-based and horizontally comparable assessment of strength and weaknesses and policy-related opportunities and risks.

To ensure comparability across countries, a dual level analytical framework has been developed. On the *first level*, the analysis focuses on key processes relevant to system performance in four policy-relevant domains of the research system:

1. Resource mobilisation: the actors and institutions of the research system have to ensure and justify that adequate public and private financial and human resources are most appropriately mobilised for the operation of the system.
2. Knowledge demand: needs for knowledge have to be identified and governance mechanisms have to determine how these requirements can be met, setting priorities for the use of resources.
3. Knowledge production: the creation and development of scientific and technological knowledge is clearly the fundamental role of a research system.
4. Knowledge circulation: ensuring appropriate flows and distribution of knowledge between actors is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production.

These four domains differ in terms of the scope they offer for governance and policy intervention. Governance issues are therefore treated not as a separate domain but as an integral part of each domain analysis.

**Figure 1: Domains and generic challenges of research systems**

Resource mobilisation	Knowledge demand	Knowledge production	Knowledge circulation
<ul style="list-style-type: none"> <li>• Justifying resource provision</li> <li>• Long term research investment</li> <li>• Barriers to private R&amp;D funding</li> <li>• Qualified human resources</li> </ul>	<ul style="list-style-type: none"> <li>• Identification of knowledge demand drivers</li> <li>• Co-ordination of knowledge demands</li> <li>• Monitoring of demand fulfilment</li> </ul>	<ul style="list-style-type: none"> <li>• Quality and excellence of knowledge production</li> <li>• Exploitability of knowledge production</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge circulation between university, PRO and business sectors</li> <li>• International knowledge access</li> <li>• Absorptive capacity</li> </ul>

On the *second* level, the analysis within each domain is guided by a set of generic "challenges" common to all research systems that reflect conceptions of possible bottlenecks, system failures and market failures (see figure 1). The way in which a specific research system responds to these generic challenges is an important guide for government action. The analytical focus on processes instead of structures is conducive to a dynamic perspective, helps to deal with the considerable institutional diversity observed, and eases the transition from analysis to assessment. Actors, institutions and the interplay between them enter the analysis in terms of how they contribute to system performance in the four domains.

Based on this framework, analysis in each domain proceeds in the following two steps. The first step is to analyse the current situation of the research system with regard to the challenges. The second step in the analysis aims at an evidence-based assessment of the strengths and weaknesses with regard to the challenges.

This report is based on a synthesis of information from the European Commission's ERAWATCH Research Inventory<sup>1</sup> and other important publicly available information sources. In order to enable a proper understanding of the research system, the approach taken is mainly qualitative. Quantitative information and indicators are used, where appropriate, to support the analysis.

After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these chapters contains two main subsections in correspondence with the two steps of the analysis.

## ***1.2 Overview of the structure of the national research system and its governance***

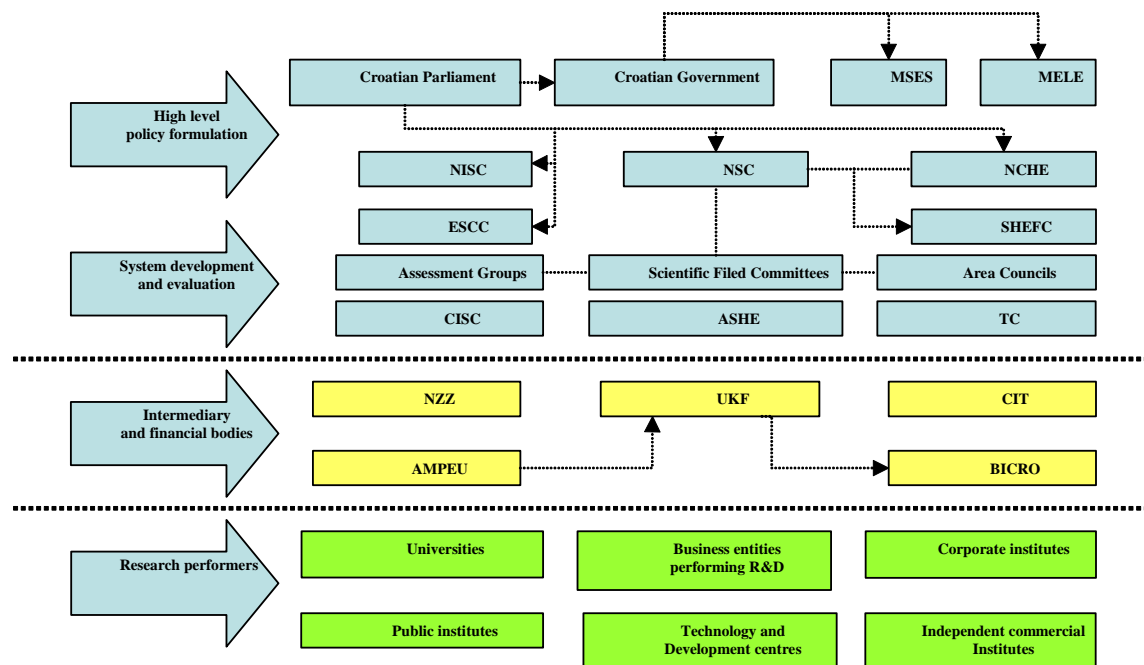
Croatia is a candidate country for EU membership, and according to EUROSTAT has 4.48 million inhabitants, which compared to the estimated EU-27 population of

<sup>1</sup> ERAWATCH is a cooperative undertaking between DG Research and DG Joint Research Centre and is implemented by the IPTS. The ERAWATCH Research Inventory is accessible at <http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home>. Other sources are explicitly referenced.

around 499.6m in 2008, presents 0.88%<sup>2</sup> share of the total. In the year 2008, Croatia's GDP per capita reached 58.4% of the EU-27 average. At the same time Croatia's unemployment rate was 8.5%; slightly higher than the EU-27 average of 7%. In 2007, Croatia's GERD as a percentage of GDP was 0.86% which was significantly lower in comparison to the EU 27 average (1.83%). The main characteristic of these investments were downsizing i.e. in 2004 Croatia's GERD as a percentage of GDP was 1.13% and in 2006 it decreased to 0.87%. By comparison to other Eastern European Countries, Croatia significantly lags behind Slovenia (1.56%), Czech Republic (1.55%), Estonia (1.15%) and Hungary (1%), again using EUROSTAT data.

According to the data provided by the Central Bureau of Statistics (CBS), in 2007 the share of higher education expenditures on R&D (HERD) was 33.7% of GERD, lagging behind the BERD share (40.7%) of GERD. Governmental expenditure on Research and Development was 25.5% whereas non-profit sector amounted to 0.1% of GERD in the same year.

**Figure 1: Overview of the Croatian research system governance structure**



Legend:  
 MELE – Ministry of Economy Labour and Entrepreneurship  
 MSES – Ministry of Science, Education and Sports  
 NISC – National Information Society Council  
 ESCC – Education, Science and Culture Committee  
 NSC – National Scientific Council  
 NCHE – National Council for Higher Education  
 SHEFC – Science and Higher Education Funding Council  
 AMPEU – Agency for Mobility and EU programs  
 NZZ – National Foundation for Science, Higher Education and Technological Development  
 CISC – Croatian Innovation Systems Council  
 ASHE – Agency for Science and Higher Education  
 TC – Technological Council of MSES  
 CIT – Croatian Institute of Technology  
 UKF – Unity through Knowledge Fund  
 BICRO – Business Innovation Centre of Croatia

Source: Adapted from [ERAWATCH Research Inventory](#)

The Croatian research system consists of three operational levels: 1) The Parliament and the National government level, represented by the Prime Minister; 2) The ministries and agencies level responsible for the design and implementation of

<sup>2</sup> This estimation is based on the calculation that Croatia becomes the 28th member of the EU. So in this scenario the total sum of the EU population will be the sum of Croatia's population (2008 estimate) and the EU population (2008 estimate).

science and research programs on the national level; and 3) performers of R&D activities (Detailed analysis of the national research system is provided in the Appendix).

The National Science Council (NSC) is the strategic body responsible for the scientific activity development and quality in Croatia, appointed by the Government. NSC aims to develop and improve the scientific system. The National Council for Higher Education is another important institution appointed by the Croatian Parliament responsible for monitoring the development and quality of the higher education sector and proposals for public institution network development in Croatia. On the second level the Ministry of Science, Education and Sport (MSES) is a key institution charged with the design of the national research policy, parallel with the Ministry of Economy, Labour and Entrepreneurship (MELE). MELE autonomously designs and finances the programs of strengthening R&D investments, promotion of science and business infrastructure and entrepreneurial education. Moreover, the National Foundation for Science, Higher Education and Technological Development of the Republic of Croatia (NZZ) was established by the Croatian Parliament, with the basic goal of promoting science, higher education and technological development in Croatia in order to ensure economic development and support employment creation. The Agency for Science and Higher Education (ASHE) is a regulator of activities relating to the evaluation of research and higher education systems in Croatia and simultaneously functioning as an intermediary between state policy and the science community. Moreover, the Agency for Mobility and EU programs (AMPEU) is the institution responsible for the provision of the mobility programs through participation of foreign researchers in Croatia and participation of Croatian scientists abroad. Croatian Innovation System Council represents an expert body in charge of efficient coordination of actions aimed at the creation and operation of the Croatian Innovation System. The National Innovation System Council represents a body established by the Ministry of Science Education and Sports (MSES) aimed at improving efficiency of National Innovation System in Croatia. In addition, the Business Innovation Centre of Croatia (BICRO) represents a leading agency responsible for the implementation of innovation policy measures and programs. There are five major programmes herein, all relating to R&D. Croatian Institute for Technology (HIT) was founded in 2006 with the vision of becoming the leading institution for the design and the implementation of the technology policy. Finally, the main mission of Unity through Knowledge Fund (UKF) is to unite the scientific and professional potential in Croatia and abroad (Diaspora) in the development of the knowledge based economy in Croatia. The main research performers are divided into 1) public scientific institutions i.e. higher education institutions and research institutions which apply to the MSES program research projects 2) science and business infrastructure institutions and 3) R&D performing business entities.

Formal regional research policy does not exist. In Croatia, regional policy exists on a NUTS 3 level, where the main issues are regional economic development, traffic infrastructure, education, health services and other social and cultural institutions. This is explained by the fact that the research capacity is primarily concentrated in North West Croatia, NUTS 2<sup>3</sup> level, including Zagreb, Croatia's capital and the other

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<sup>3</sup> NUTS 2 level in Croatia consists of the three non-administrative units including the existing counties forming the NUTS 3 level. NUTS 2 level includes: North-West Croatia (Zagreb region including Medimurje and Zagorje), Central and East Croatia (Slavonia) and Adriatic Croatia (Istria and Dalmatia).

counties in the vicinity of Zagreb<sup>4</sup>. North West Croatia is oriented more towards industry and knowledge intensive services development in comparison to Central and East Croatia as well as the Adriatic Croatia where other business activities are dominant. Recently, municipalities in Croatia show more inclination towards supporting R&D primarily through investments into science – business infrastructure (e.g. Technology park in Varaždin and Technology park in Čakovec) and this trend is likely to expand in the future.

## 2 - Resource mobilisation

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The purpose of this chapter is to analyse and assess how challenges related to the provision of inputs for research activities are addressed by the national research system. Its actors have to ensure and justify that adequate financial and human resources are most appropriately mobilised for the operation of the system. A central issue in this domain is the long time horizon required until the effects of the mobilisation become visible. Increasing system performance in this domain is a focal point of the Lisbon Strategy, with the Barcelona EU overall objective of a R&D investment of 3% of GDP and an appropriate public/private split as orientation, but also highlighting the need for a sufficient supply of qualified researchers.

Four different challenges in the domain of resource mobilisation for research which need to be addressed appropriately by the research system can be distinguished:

- Justifying resource provision for research activities;
- Securing long term investment in research;
- Dealing with uncertain returns and other barriers to private R&D investment; and
- Providing qualified human resources.

### 2.1 *Analysis of system characteristics*

#### 2.1.1 **Justifying resource provision for research activities**

In the period from the mid-1990s up to 2002, R&D investments as a percentage of GDP had been constantly growing, with 1.1% in 2002. Unfortunately in the period 2002-2007, GERD as a percentage of GDP had declined and amounted to 0.93% in the 2007.

In the nineties Croatian approach towards the EU stagnated as a result of the armed conflict in the region. Croatian transition towards a market economy has been closely connected with the privatization process which reduced business R&D as well as the for R&D personnel. In that period Croatian GERD represented a fractional share of GDP, at less than 1% (0.77% in 1997) as science and research development was not a priority on the policy agenda.

Since 2000, the Government has placed more emphasis on the promotion of R&D funding. «The Science and Technology Policy of the Republic of Croatia 2006-2010», represents the main document (see chapter 2.3) aimed at Increasing funds for

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<sup>4</sup> Koprivničko-križevačka county, Krapinsko-zagorska county, Međimurska county, Varaždinska county and Zagrebačka county.

excellent science and technology projects in order to meet the «3% of the GDP rule». This policy document was followed by two action plans. «The Action plan for the period 2007-2010 - Science and Technology Policy of the Republic of Croatia» is oriented towards national innovation system development. This document, also known as the “3% Action Plan”, aimed to stimulate investments required for science and higher education structural reforms. In addition, internationalization of the national science research system has recently become increasingly important, hence the publication of the second action plan in 2008, the «Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010.»

### **2.1.2 Securing long term investment in research**

In 2007, higher education R&D investments amounted to 33.7% of GERD, slightly less than in comparison to 34.6% in 2005. MSES is the key institution charged with the design of the national research policy and public research finance, via the three main instruments of institutional funding (35.9% of the MSES budget for R&D in 2006), young researcher programmes (29.3% of MSES budget for R&D in 2006) and scientific projects (16.4% of the MSES budget for R&D in 2006).

The Croatian Parliament represents the highest level of government in the national research system. In that context, The Parliament appointed the National Science Council (NSC) as the strategic body responsible for development and quality of scientific activity in Croatia. Independent, NSC is charged with the proposing and promoting measures for development and improvement of the scientific system. Additionally, NSC evaluates scientific organizations, projects and programmes. In terms of efficient national research system functioning, NSC has submitted an opinion concerning the foundation of scientific technology parks and has proposed a proclamation about centres of excellences in science. The National Council for Higher Education is another important institution appointed by the Croatian Parliament responsible for monitoring the development and quality on higher education and proposals for public institution network development. Additionally, its role is to provide an opinion concerning the foundation and evaluation in higher education institutions and their programs. In coordination with the NSC, it submits annual proposals on budget resources allocation to the Croatian Government. The Ministry of Economy, Labour and Entrepreneurship is charged with the design and implementation of several program schemes in the areas of product and process development, human resources development within the private sector and in the area business and science infrastructure (for more, see chapter 3.3.2). Apart from the ministries, there are several specialized institutions within the system responsible for the development and evaluation of the research system. The National Foundation for Science, Higher Education and Technological Development of the Republic of Croatia (NZZ), established by the Croatian Parliament, aims to promote science, higher education and technological development. NZZ finances research, development and educational projects. In terms of the research system development, several important programs need to be emphasised, namely higher education programs (e.g. PhD studies development); brain gain programs (enabling research activities for researchers who have built their career abroad); doctoral student training as well as finance of partnerships in basic research. The Agency for Science and Higher Education (ASHE) is a regulator of activities relating to the evaluation of research and higher education systems in Croatia and simultaneously functions as an intermediary between state policy and the science community. In order to fulfil this



aim ASHE collaborates closely with the NSC, research and higher education institutions, and even performs activities related to the creation of the National Network for Quality Assurance of Higher Education and its integration into the European Quality Assurance Network (ENIC/NARIC). The newly established entity, Croatian Innovation System Council (established in 2008) represents an expert body in charge of efficient coordination of actions aimed at the creation and operation of the Croatian Innovation System. Additionally, the Agency for Mobility and EU programs (AMPEU) is responsible for the provision of the mobility programs through participation of foreign researchers in Croatia and participation of Croatian scientists abroad. The National Innovation System Council is a body established by MSES aimed at improving the efficiency of National Innovation System and responsible for the action plan evaluation, titled 'To Encourage Investment into Science and Research'. In addition, the Business Innovation Centre of Croatia (BICRO) is the leading agency for the implementation of innovation policy measures and programs. BICRO runs five programmes relating to R&D, titled RAZUM, TEHCRO, VENCRO, IRCRO, and KONCRO (for more, see chapter 3.3) Croatian Institute for Technology (HIT) is responsible for facilitating conditions for better application of new knowledge into the private sector. HIT is in charge of implementation for the TEST programme (pre-commercial technological projects) as well as developing the national foresight and business intelligence programme. Moreover, HIT provides information and assistance to the Croatian scientific community in terms of European programs participation. Finally, the goal of the Unity through Knowledge Fund (UKF) is to unite the scientific and professional potential at home and abroad (Diaspora) in the development of the knowledge based economy. UKF aims to encourage Croatian scientists working abroad to return to Croatia and/or connect with local scientists and assist Croatian institutions and researchers in using the potential of Croatian scientists and professionals employed abroad.

The research performers are divided into 1) public scientific institutions i.e. higher education institutions and research institutions which apply for MSES research projects 2) science and business infrastructure institutions and 3) R&D performing business entities. Higher education institutions consist of 7 universities (University of Zagreb, Rijeka, Split, Zadar, Dubrovnik, Pula and Josip Juraj Strossmayer University of Osijek); 26 Public research organisations, 14 public polytechnics and 13 private polytechnics. The second group includes specialized business entities which enhance innovation cooperation between science and industry; 3 technology parks (Technology Parks - Zagreb, Varaždin and Čakovec) and 6 transfer technology centres (Centre of Technology Transfer Zagreb, Technology Development Centre Osijek, Technology Innovation Centre Rijeka, Technology Centre Split, Research and Development Centre for Mari culture and Technology Transfer Office in Split) as well as business incubators and centres. In the third group there are currently four corporate institutes (Ericsson Nikola Tesla, telecoms, INA oil company, Koncar – Electrotechnical Institute, electricity company and GlaxoSmithKline Research Centre Zagreb ex Pliva center) and nine Independent commercial Institutes - not part of business entities with the Energy Institute, the Bc Institute for the Improvement and Production of Crops, the Ship-building Institute, the Civil Engineering Institute of Croatia, the Mediterranean Institute for Life Sciences etc. as the most important in this group. Moreover, business entities which perform R&D need to be included in this group.

Formal regional research policy does not exist, except on a NUTS 3 level, mainly dealing with regional economic development, traffic infrastructure, education, health

services and other social and cultural institutions. It has to be noted however, that the regional research practice has been growing recently via the network of higher education institutions, universities and polytechnics, perceived as important stakeholders of the local development and suppliers of qualified work force. Recently, municipalities in Croatia have started to support R&D related projects in the field of public infrastructure (e.g. Technology park in Varaždin and Technology park in Čakovec) with indication of other municipalities joining this trend in the future.

### **2.1.3 Dealing with uncertain returns and other barriers to business R&D investment**

Croatian business expenditure on R&D (BERD) is markedly low. In 2006, BERD amounted to 0.32% of total GDP, a reduction in comparison to 0.41% in 2005. The share in 2007 totalled 0.35%. As a consequence, Croatia lags behind the leading Central and Eastern European countries, for instance Slovenia (2006 - 0.94%) and Czech Republic (2006 - 1.03%). Low level of investments is a result of concentrated domination in BERD by few business entities. The largest performers are foreign companies, namely GlaxoSmithKline Research Centre and Ericsson – Tesla Institute, with other important investors being Podravka, in food industry, Koncar–Electrotechnical Institute, Belupo, a pharmaceutical company, the INA–Oil Company and the Civil Engineering Institute of Croatia. Recently, the government has made efforts to promote Business Expenditure on R&D, by allocating resources in four areas – firm seed capital, business sector R&D investments, science business infrastructure and human resource programmes within the public sector (e.g. Junior Research Programme) and the private sector (e.g. program scheme education of entrepreneurs, see chapter 3.3.2. for additional info)

### **2.1.4 Providing qualified human resources**

The budget for scientific projects amounted to €19.5m in 2005 and Croatia's investment into HERD was €108m in the same year. However, the share of R&D personnel in the total number of employees is still weak in comparison to EU 27 average (0.16%, compared to 0.57% in EU 27 in 2004). To an extent, this could be explained by the structure of new capacities within higher education institutions, with the majority of newly founded institutions in social and human sciences. Croatian researchers market has grown in the last several years, primarily a consequence of the Grants allocated for new employment positions for young researchers through the competition-based "Junior Research Programme" (29.3% of MSES budget for R&D in 2006). Increasing demand stems from the constant increases in student numbers over the past twenty years (in 2008, there were 110.7 thousand students including science and polytechnic studies), hence the majority of young researchers work at higher education institutions as assistants.

Here, MELE manages «education for entrepreneurship» programmes and allocates financial resources into 1) entrepreneurship education in high schools and primary schools 2) scientific (academic) entrepreneurship i.e. encouragement of academic entrepreneurship in higher education, 3) pupil companies, 4) entrepreneurship promotion within the young population increasing the quality of human resources supply.

## 3 - Knowledge demand

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The purpose of this chapter is to analyse and assess how research related knowledge demand contributes to the performance of the national research system. It is concerned with the mechanisms to determine the most appropriate use of and targets for resource inputs.

The setting and implementation of priorities can lead to co-ordination problems. Monitoring processes identifying the extent to which demand requirements are met are necessary but difficult to effectively implement due to the characteristics of knowledge outputs. Main challenges in this domain are therefore:

- Identifying the drivers of knowledge demand;
- Co-ordinating and channelling knowledge demands; and
- Monitoring demand fulfilment

Responses to these challenges are of key importance for the more effective and efficient public expenditure on R&D targeted country's strategy.

### 3.1 Analysis of system characteristics

#### 3.1.1 Identifying the drivers of knowledge demand

Main Croatian R&D performers are four corporate institutes (see chapter 1.2 in appendix) and nine Independent commercial Institutes (not part of business entities). At the same time the industrial sectors in which they operate are the main sources of R&D demand in Croatia (pharmaceuticals, food, electrical machinery, oil and telecommunications).

Future important source of knowledge demand is cluster development, implying the unification of resources aimed at creation and finalization of the higher value added products. In 2005, MELE started «Through cooperation for success» project, initiating the establishment of clusters using both the bottom up and top down approaches. So far, MELE supported cluster initiatives in civil engineering, wood production, leather and footwear production, food production, metal products manufacturing, building and repairing ships and production of communal equipment.

In terms of foreign direct investments as a source of knowledge demand authors Aralica, Račić Redžepagić (2009) showed that R&D activities within foreign enterprises cannot explain firm performance measured by increases in total revenue and number of employees. However, it seems that on the national science research system level, the importance of foreign knowledge has increased in the business sector. In 2007, the bulk of business research was financed by companies themselves (58.2%), with other participants in the business sector representing a 17.0% share while the government represented 2.3% and foreign investors 22.5% share. Compared to 2006, dramatic changes occurred in terms of foreign investor relevance, since their share grew by more than seven times (3% in 2006)<sup>5</sup>.

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<sup>5</sup> Throughout the same period the governmental share declined by more than seven times, at only 2.3% in 2007.

### 3.1.2 Co-ordinating and channelling knowledge demands

Coordination and channelling of knowledge demands is currently relatively low in Croatia. HIT is still in the initial development stages of the foresight studies. Moreover, no special programmes or research schemes have been launched in particular fields of science and technology, which potential business investors could recognize as important for the national economy (e.g. biomedicine). The governmental action plan<sup>6</sup> outlined an ambitious agenda for improving the inclusion of the Croatian participants into the existing EU technology platform and establishes new national technology platforms. This could potentially create a source of knowledge demands in the future. Moreover, the analysis of future R&D demand via foresight studies should assume a more active role in the national economy.

### 3.1.3 Monitoring demand fulfilment

Evaluation exists in scientific competitive projects, organizations and programs i.e. relating to basic research. In this context, NSC is responsible for the evaluation of scientific projects and programmes. However, science and technology policy monitoring is at a very low level, but steps have been taken to improve on the situation with the establishment of two governmental bodies in 2008 – the Strategic Council for Science and Technology (SVEZNATE) and the National Innovation System Council (VNIS), both aiming to increase the efficiency of the national research system. In that context one of the key roles of VNIS should be the evaluation of the Action plan for the implementation Science and Technology Policy of the Republic of Croatia in the period 2007-2010.

## 4 - Knowledge production

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The purpose of this chapter is to analyse and assess how the research system fulfils its fundamental role to create and develop excellent and useful scientific and technological knowledge. A response to knowledge demand has to balance two main generic challenges:

- On the one hand, ensuring knowledge quality and excellence is the basis for scientific and technological advance. It requires considerable prior knowledge accumulation and specialisation as well as openness to new scientific opportunities which often emerge at the frontiers of scientific disciplines. Quality assurance processes are here mainly the task of scientific actors due to the expertise required, but subject to corresponding institutional rigidities.
- On the other hand there is a high interest in producing new knowledge which is useful for economic and other problem solving purposes. Spillovers which are non-appropriable for economic knowledge producers as well as the lack of possibilities and incentives for scientific actors to link to societal demands lead to a corresponding exploitability challenge.

Both challenges are addressed in the research-related Integrated Guideline and in the ERA green paper.

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<sup>6</sup> Action plan to encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010

## **4.1 Analysis of system characteristics**

### **4.1.1 Improving quality and excellence of knowledge production**

Croatian approach towards the EU enhanced the evaluation mechanisms within the national science and research system. As mentioned above, since 2005 ASHE has provided the evaluation of the scientific institutions, namely university and professional study programmes in order to implement the Bologna Process. During the academic year 2004/2005, more than 820 study programmes were reviewed by more than 1050 domestic and foreign reviewers and prepared according to the Bologna system (EC 2008: 36) assuring the quality for the whole science and research system in Croatia. Recently, qualitative assurance has become an important issue in order to improve higher education and scientific work. In 2006 the University of Zagreb established the Quality Assurance Office with the mission to promote high education standards on the University and facilitate active support to the faculties in order to improve the quality of scientific and education work.

### **4.1.2 Improving exploitability of knowledge production**

The analysis of EPO patent applications per million inhabitants shows that Croatia (5) dramatically lags behind the EU 27 (105.65) in the year 2005 (EUROSTAT). However, in the comparison to New Member States Croatia achieves similar results, with Slovenia as the only exception (32.15). Improving mechanisms to match scientific knowledge production to economic and societal needs is an area where significant efforts were made. Two agencies under the responsibility of MSES, BICRO and HIT provide several programs aimed at knowledge exploitation in Croatia (see chapter 3.3.2). MELE has been allocating financial resources in business science infrastructure whereas NZZ has allocated financial resources in the Partnership instruments program (see chapter 3.3.2) which enhances knowledge exploitability in Croatia.

Regional analysis (NUTS 2 level) shows that North West Croatia (191) has the highest number of recognised patents with the State Intellectual Property Organization, followed by Adriatic Croatia (125) and Central and East Croatia (31) in the period 2000-2007 (EFZG, 2008: 129). Regional research practices have been strengthened primarily via the growing network of higher education institutions, universities and polytechnics. In the last few years, municipalities have been financing science – business infrastructure projects (e.g. Technology park in Varazdin and Technology park in Čakovec) and this trend is likely to increase.

## **5 - Knowledge circulation**

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The purpose of this chapter is to analyse and assess how the research system ensures appropriate flows and sharing of the knowledge produced. This is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production. Knowledge circulation is expected to happen naturally to some extent, due to the mobility of knowledge holders, e.g. university graduates who continue working in industry, and the comparatively low cost of the reproduction of knowledge once it is codified. However, there remain three challenges related to specific barriers to this circulation which need to be addressed by the research system in this domain:

- Facilitating knowledge circulation between university, PRO and business sectors to overcome institutional barriers;
- Profiting from access to international knowledge by reducing barriers and increasing openness; and
- Enhancing absorptive capacity of knowledge users to mediate limited firm expertise and learning capabilities.

## **5.1 Analysis of system characteristics**

### **5.1.1 Facilitating knowledge circulation between university, PRO and business sectors**

Improvement of the science and industry cooperation represents one of the key challenges for the Croatian science and research policy. Currently several program schemes exist: RAZUM, TEHCRO, VENCRO managed by BICRO as well as the TEST programme, managed by HIT. Elsewhere, "Partnership in basic research" is a program aimed at the promotion of science and industry cooperation, managed by National Foundation for Science (NZZ); and „Entrepreneurial activity based on high technology“ is a special type of science and industry cooperation for projects initialized by the Diaspora, and managed by UKF (for more information about the programmes see chapter 3.3).

### **5.1.2 Profiting from access to international knowledge**

A stronger participation by the Croatian scientists in the European Framework programme is a strategic objective of the national science and technology policy in order to facilitate the Croatian participation in the FPs. In the last few years important policy efforts have been made aimed at facilitating mobility of researchers in Croatia. An important step was the acceptance of the Act on Recognition of Foreign Educational Qualifications - and establishing higher education authorities for shaping and monitoring of the reform process in the following years: in 2004 the National Council for Higher Education, in 2005 the National Council for Science, and the Agency for Science and Higher Education, which administered accreditation for the implementation of Bologna at the Croatian institutions for tertiary education. In October 2007 the Parliament passed the «Act of Foundation of the Agency for Mobility and EU programs». This agency is responsible for the provision of the mobility programs. In addition, scientific mobility is an instrument within the objective of strengthening human capacity within one of the Action Plans<sup>7</sup>. Croatian scientists have demonstrated high capacity for participation within Framework Programmes, with 162 contracts signed (134 programmes within FP 6 and 28 within FP 7), according to MSES.

### **5.1.3 Absorptive capacity of knowledge users**

Low level of innovation performance measured by Summary Innovation Index (EC 2008: 7) relates to the low share of R&D personnel in total number of business sector employees. Moreover, it implies a low absorptive capacity concentrated in a small

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<sup>7</sup> Action Plan to Encourage Absorptive Capacity of the Republic of Croatia for the Framework Programme 7 for Research and Technological Development in the period 2009-2010.

proportion of business entities. An improvement in this area could be the creation of science and research programmes oriented towards non-innovators as well stronger participation in specialized programmes (e.g. SME association programmes within the FP framework programme) which may enhance SME innovation capacity, already a positive factor (see chapter 3.3.2). Since improving absorptive capacity requires the promotion of innovation and R&D investments within business enterprises, policy needs to be oriented towards promotion of innovative start up enterprises.

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- UKF- Unity Knowledge Fund; available on <http://www.ukf.hr/default.aspx?id=18>

## List of Abbreviations

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AMPEU	Agency for Mobility and European Programmes
APIU	Trade and Investment Promotion Agency
BERD	Business Expenditure on Research and Development
BICRO	Business Innovation Center of Croatia
CARNET	Croatian Academic and Research Network
CBS	Croatian Bureau of Statistics
CEFTA	Central European Free Trade Agreement
ERP Fund	European Recovery Programme Fund
FP	European Framework Programme for Research and Technology Development



GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
GVA	Gross Value Added
HEI	Higher education institutions
HERD	Higher Education Expenditure on Research and Development
HES	Higher education sector
HIT	Croatian Institute for Technology
JTI	Joint Technology Initiatives
MELE	Ministry of Economy Labour and Entrepreneurship
MFIN	Ministry of Finance
MSES	Ministry Science Education and Sport
NSC	National Science Council
NZZ	National Foundation for Science, Higher Education and Technological Development of the Republic of Croatia
PRO	Public Research Organisations
R&D	Research and development
SF	Structural Funds
SII	Summary Innovation Index
S&T	Science and technology
SME	Small and Medium Enterprises
SVEZNATE	Strategic Council for Science and Technology
UKF	Unity Knowledge Fund
VNIS	National Innovation System Council

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### **Abstract**

The main objective of the ERAWATCH Policy Mix Country reports 2009 is to characterise and assess in a structured manner the evolution of the national policy mixes in the perspective of the Lisbon goals, with a particular focus on the national R&D investments targets and on the realisation and better governance of the European Research Area. The reports were produced for all EU Member State and six Associated States to support the mutual learning process and the monitoring of Member and Associated States' efforts by DG-RTD in the context of the Lisbon Strategy and the European Research Area. The country reports 2009 build and extend on the analysis provided by analytical country reports 2008 and on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

This report encompasses an analysis of the research system and policies in Croatia.

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