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ACRONYMS

AMPEU	Agency for Mobility and European Programs
ASHE	Agency for Science and Higher Education
BERD	Business Enterprise Research and Development
BICRO	Business Innovation Center of Croatia
CEI	Central European Initiative
CIP	Competitiveness and Innovation Program
CIS	Community Innovation Survey
COST	Cooperation for Science and Technology
EC	European Commission
ECA	Europe and Central Asia
EHEA	European Higher Education Area
EMBO	European Molecular Biology Organization
ENQA	European Quality Assurance Network
EPO	European Patent Office
ERA	European Research Area
ERAC	European Research Area Committee – formerly called CREST
ESU	European Students' Union
EU	European Union
EUA	European University Association
EURASHE	European Association of Institutions in Higher Education
EUREKA	Intergovernmental organization for pan-European research and development funding and coordination
FAO	Food and Agriculture Organization of UN
FDI	Foreign Direct Investment
FP6	Framework Program 6
FP7	Framework Program 7
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GERD	Gross Expenditures for Research and Development
GTZ	German Technical Cooperation Association
HE	Higher Education
HEI	Higher Education Institution
HERD	Higher Education Expenditure on R&D
HIT	Croatian Institute for Technology
ICT	Information and Communication Technologies
IPA	Instrument for Pre-Accession Assistance
IPO	Intellectual Property Office
IPRs	Intellectual Property Rights
IRCRo	R&D Services for Companies
KAM	Knowledge Assessment Methodology
KEI	Knowledge Economy Index

KI	Knowledge Index
KonCro	Business Competitiveness Upgrading Program
MELE	Ministry of Economy, Labor, and Entrepreneurship
MoE	Ministry of Economy
MoEC	Ministry of Entrepreneurship and Crafts
MSES	Ministry of Science, Education, and Sports
NCHE	National Council for Higher Education
NGOs	Non-Governmental Organizations
NSC	National Science Council
NSRF	National Strategic Reference Framework
NZZ	National Foundation for Science, Higher Education and Technological Development
OECD	Organization for Economic Co-operation and Development
PoC	Proof of Concept
PRO	Public Research Organization
R&D	Research and Development
RAZUM	Knowledge Based Companies
RCOP	Regional Competitiveness Operational Program
RDI	Research and Development for Innovation
REDEA	Regional Development Agency Medimurje
S&T	Science and Technology
SIIF	Science and Innovation Investment Fund
SIPO	State Intellectual Property Office
SMEs	Small and Middle-Sized Enterprises
StePRi	Science and Technology Park at the University of Rijeka
STP	Science and Technology Policy
TehCro	Technology Infrastructure
TEST	Technology-Related R&D Program
TTO	Technology Transfer Organization
UKF	Unity through Knowledge Fund
UN	United Nations
VAT	Value-Added Tax
WBCs	Western Balkan Countries

FOREWORD

This *Paper* was prepared under the *Western Balkans Regional R&D Strategy for Innovation* -- World Bank Technical Assistance Project funded by the European Commission (DG ENLARG – TF011064), as part of the *Country Paper Series*.

The *Country Paper Series* aims to provide for each project beneficiary (Albania, Bosnia and Herzegovina, Croatia, Kosovo*, FYR Macedonia, Montenegro and Serbia) a brief profile of the current conditions of the national research system (rather than an exhaustive assessment of the country's national innovation system). Emphasis on selected issues reflected the priorities identified by participants during the implementation of the Technical Assistance.

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DISCLAIMER

* This designation is without prejudice to positions on status, and is in line with UNSC 1244 and the ICJ Opinion on the Kosovo Declaration of Independence.

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EXECUTIVE SUMMARY

1. Croatia has undertaken several steps to make Research and Innovation systems more competitive and have a greater impact on the national economy. Since 2000, the nation's science system has gradually recovered and become more competitive thanks to the substantial efforts of the Croatian government to reform the science and higher education sectors according to European Union (EU) standards and in line with EU policies. The Ministry of Science, Education and Sports has played a proactive role in improving the legal environment, establishing government oversight bodies, and creating programs to support innovating private sector companies.

2. Challenges remain, of course. Final accession to the EU should not permit a reduction in the efforts to create a more technologically modern and innovative private sector, but rather be a pivot point for increased efforts. Notably, three key challenges are outstanding:

- An increase in the level of expenditures for Research and Development (R&D), which should come closer to the EU average of 2 percent of the Gross Domestic Product (GDP). This increase, including the efficiency and effectiveness of the investments, must become the overarching goal as the country becomes an even closer partner of, and competitor with, the most advanced and dynamic economies in the world. Each year that Croatia lags behind the R&D investment efforts of other nations, the more the current gap is compounded. R&D cannot be seen as just another government program sponsored by one ministry in competition with other budget demands. Rather, it should be acknowledged as a critical investment for economic growth, jobs, and higher living standards.
- Intensified efforts are needed to stimulate R&D and innovation by the private sector. Government pronouncements and advisory councils are insufficient if obstacles to entrepreneurs are not fully understood and addressed. There has been several improvements regarding fiscal and tax policies, information exchanges, technology transfer programs, training efforts, small targeted seed money investments, confidence building exercise among officials, academics, business people, and public communications campaigns, etc. These are necessary as they can all play an important role in encouraging domestic business talent to expand and accelerate momentum for a Croatian knowledge based economy.
- Human capital building is critical, requiring efforts to promote science and technology education in the country, keep the expensively educated talent within the country. At the same time, it is necessary to intensify efforts to incorporate diaspora talent by promoting modern research infrastructure, challenging career prospects and attractive remuneration in order to make achievements from initiatives and programs like UKF (Unity through Knowledge Fund) more sustainable.

3. Other necessities for innovation that public policy needs to tackle include: facilitate access to finance for innovation by small and medium size firms, enhance cooperation between academia and business and industry, and provide a clear legal framework for intellectual property protection and commercialization. There is an increasing awareness that to reverse the migration of the highly-skilled workers, the nation must not only improve conditions for researchers – for

example, with better wages, infrastructure, and career prospects – but also address the general conditions, particularly political conditions and stability, and well-functioning business environment.

INTRODUCTION

4. Establishing and implementing an effective research and innovation policy is important for all countries hoping to be competitive and develop the economy in a sustainable way, including the Western Balkans countries.[2] Innovation – the transformation of ideas into economic and development solutions – is critical in creating the competitive advantage of firms and countries, but also plays a key role in productivity growth and improvement of standard of living.

5. In order for the Western Balkans to catch up and effectively integrate into the European Research Area (ERA), to become part of international knowledge networks and to compete in global markets, it is essential to strengthen the research and innovation capacity building at the national level. In order to achieve this, countries have to increase investment in research and innovation substantially and on a sustained basis, while introducing innovation systems – the research base, public institutions, private sector, market actors and linkages across them – into more effective, coherent and competitive systems. Creating the right framework conditions and offering adequate incentives to actors is a prerequisite for stimulating new ideas, their transfer to industry and private sector investment in risky and long-term projects related to innovation. Political commitment by the governments is also crucial in achieving the above mentioned transformations.

6. Croatia has undertaken several steps to make research and innovation systems more competitive, with a greater impact on the national economy. Since 2000, the science system has gradually recovered and became more competitive due to the substantial efforts of the Croatian government to reform the science and higher education sectors according to EU standards and in line with EU policies. Yet, profound challenges still remain. A fundamental challenge is to generate new sources of competitiveness from the local research base, as well as to capitalize on knowledge from the skilled diaspora through enhanced innovation linkages.

7. Other necessities for innovation that public policy needs to tackle include: increasing private sector investment in R&D; facilitating access to finance for innovation for small and medium enterprises; enhancing cooperation between academia and industry and providing a clear legal framework for intellectual property protection and commercialization. There is an increasing awareness that in order to reverse the migration of highly-skilled workers, the country must not only improve conditions for researchers, but also address the general conditions, particularly political conditions and stability and stimulating business environment. It is reassuring to see that several initiatives, including networking programs, are underway.

8. In the context of the recent economic downturn, several European countries have decreased their efforts on research and innovation, while others have actually used innovation policy and increased

[2] Albania, Croatia, Serbia, Former Yugoslav Republic of Macedonia, Bosnia and Herzegovina, Kosovo*, and Montenegro.

investment in R&D as a counter-cyclical instrument to promote sustainable economic recovery. From an economic standpoint, the countries that continued to invest in research and innovation despite the economic crises are the ones that perform best at the EU level. In Croatia, investment in R&D has stagnated since 2009. This trend might widen both technological and economic gap between Croatia and other EU countries. In a context of rising labor costs and a small share of technology-intensive goods in total exports (less than half of the EU-27 average), Croatia and other Western Balkan countries will need to count more on research and innovation to increase the export competitiveness of their national economies. For that to happen, governments will need to spend more in research and innovation.

9. This note describes Croatia's profile in terms of R&D capacity and discusses the main features of the national research system, its strengths and weaknesses, recent policy trends and challenges. The first section details the importance of R&D for Innovation (RDI) and economic development and growth. The second section briefly describes national trends in economic performance and R&D and innovation. The third section outlines the governance system for research, the process of policy making, and main agencies and actors, and briefly discusses recent national strategies for research and innovation. Section five reports the current policy programs and instruments and other important policy developments. The note concludes with a discussion of remaining challenges in the area of research and development, and identifies potential policy areas suitable to policy collaboration among the Western Balkan countries (WBCs).

THE IMPORTANCE OF R&D AND INNOVATION

10. The capacities to undertake scientific and applied industrial research, to transfer, adapt, and assimilate new technologies into economic structures and diffuse them into society, are critical to national competitiveness and growth. This is an obvious conclusion that can be easily drawn just by looking at the ferocious pace of technological change in consumer goods alone.

11. Ample and compelling evidence confirms this perception. Several international studies demonstrate that R&D spending increases result in a corresponding increase in productivity, leading to per capita income growth and long-term sustained growth for the country. At the country level, R&D explains up to 75 percent of the differences in total factor productivity growth, once externalities are taken into consideration.[3] At the firm level, R&D expenditures are often correlated to higher sales and productivity growth, as well as propensity to export. Furthermore, product innovation resulting from R&D efforts leads to employment growth and more qualified and better paid jobs by expanding demand and generating new business opportunities.[4]

12. The potential impact of investments in research and innovation on productivity growth is even higher for developing countries, given the opportunity for catching, up associated with larger investments in innovation.[5]

13. Results from a study using firm-level data for the Western Balkans show that innovative firms grow 15 percent faster in sales and 8 percent faster in labor productivity than non-innovative firms.[6] Business

[3] Griliches 1979.
[4] Harrison *et al* 2008.
[5] See Lederman and Maloney (2003) for estimates of social rates of return for R&D.
[6] Seker 2012.

R&D expenditures significantly contribute to growth in sales by 14 percent and labor productivity by 7 percent. Furthermore, when firm R&D, training, and infrastructure services are compared, R&D is shown to have the highest correlation to sales growth.

14. For neighboring countries, similar evidence is reported.[7] Reaching the Lisbon Agenda target, R&D spending of 3 percent of GDP, could generate a permanent increase between 8 and 13 percent in exports for Bulgaria and Romania, for example.

15. Investing in R&D is necessary not only to enhance firms' innovation capacity but also to absorb external technology properly by: screening and identifying technology options; adopting and adapting foreign technology and know-how; and, benefitting from spillover effects from foreign direct investments and from other sources of knowledge transfer. As is well recognized, informal knowledge activities and day-to-day learning are also sources of ideas. Formal R&D is important, however, as it represents a systematic and more effective approach to technological innovation – radical and incremental innovation – in both the manufacturing and non-manufacturing sectors.

16. Public support of research and innovation is critical particularly in the context of stagnant economies. Public investments in research and innovation have been a priority in economic stimulus packages of OECD economies. In this sense, a growing consensus on the importance of counter-cyclical innovation policies – increasing R&D investment and improving framework conditions – is emerging. Finland and South Korea are at the forefront of this approach, increasing public spending on innovation even in the context of tighter fiscal policies.

17. Building an enduring and conducive environment for innovation requires a comprehensive policy agenda and multiple resources, which are often scarce in developing countries. Smart policy design is needed, which requires devising cost-effective and sustainable strategies that will bring results in both the short and long run. Market and coordination failures may hinder progress. The lack of linkages among actors – between public research institutions and the private sector, within and across industries – can prevent innovation investment, thus preventing businesses from reaching their growth potential. Failures in financial services and other specialized resources discourage private investment in innovation and new business creation leading to an inefficient allocation of resources. Interventions are therefore needed at different levels and through different mechanisms, in collaboration with the private sector and other relevant decision-makers.

1. WHERE THE COUNTRY STANDS

Economic Performance and Structure

18. Croatia is an upper middle-income country with a GDP per capita of €10,300 in 2012 (data from Eurostat). Croatia's GDP per capita in 2012 ranked slightly below GDP per capita levels in Hungary, Poland

[7] World Bank 2009.

and Latvia, and was still far below the EU-27 average, more precisely, at 61%. The country became the 28th member of the EU in July 1, 2013.[8]

19. Croatia experienced relatively high rates of economic growth in the decade preceding the global crisis, driven by a boom in domestic investment and consumption financed by large inflows of foreign capital. The economy of Croatia is now a service-based economy and this sector accounts for 70 percent of total GDP. The industrial sector is responsible for 25 percent of Croatia's GDP, with agriculture, forestry, and fishing accounting for the remaining 5 percent. Annual GDP growth in 2004-2008 was 4.1 percent on average. Growth is primarily driven by domestic demand, credit growth, and large capital inflows.

20. About half of Croatia's trade is with the "Euro-area" – countries that use the Euro – the source of about three-fourths of foreign direct investment (FDI) flows into the country. The EU market represents more than 60 percent of Croatia's total exports. Services accounted for 48 percent of Croatia's total exports in 2010, while manufacturing exports represented 35 percent. In the manufacturing sector, Croatia primarily exports low and medium-low technology. There are about 140,000 registered small and medium size enterprises (SMEs) in the country. The SME sector represents 67.2 percent of total employment, and 39 percent of Croatian SMEs are active in the service sectors.[9]

21. However, like many other countries in Europe, Croatia has been affected by the global financial crisis. Between 2009 and 2010, the economy contracted by around 7 percent, which was followed by a stagnation of 0.04 percent in 2011. Trade and financial flows are the main areas of interaction between Croatia and the Euro–area, leading to economic uncertainty. In addition, low productivity and the lack of competitiveness pose major challenges for Croatia's recovery. To get through these difficulties, Croatia needs to spend more on R&D and demonstrate better innovation performance, both of which play important roles in increasing productivity and competitiveness.

R&D and Innovation Trends

R&D Trends

22. Investments in R&D in Croatia are low compared to similar countries in terms of income level. In 2011 (Table 1), Croatia's gross R&D expenditures (GERD) were 0.75 percent of GDP. That is the lowest national level of investments in R&D since 2006 and considerably below the average of the EU-27 of 2.03 percent of GDP. Based on Eurostat data for 2011, Croatia lags significantly behind comparable countries that recently joined the EU: Slovenia (2.45 percent), the Czech Republic (1.84 percent), Estonia (2.38 percent), and Hungary (1.21 percent).

[8] Subject to satisfactory ratification of accession Treaty by all 27 Member States.
[9] For more information, see: http://hgd.mvpei.hr/hr/gospodarstvo/.

Table 1: Gross Expenditure on R&D by Croatia

	2006	2007	2008	2009	2010	2011	EU-27 average 2011
GERD as % of GDP (R&D intensity)	0.75	0.80	0.90	0.84	0.75	0.75	2.03
GERD per capita	67.0	78.4	95.9	85.8	75.7	76.2	510.5
BERD as % of GDP (Business sector R&D intensity)	0.27	0.33	0.40	0.34	0.33	0.34	1.26

Source: Eurostat.

23. In addition, this is also a significant decrease in comparison to 2009 when GERD was 0.85% of GDP and provisional data indicate that it has stagnated since 2010. The most important source of funding for total domestic investments in R&D stems from the government, which provides about 48 percent of GERD, while the business enterprise sector contributes with less than 40 percent (38.2 percent in 2011). Within the EU 3 percent target, ideally 1 percent should come from the public sector and 2 percent from the private sector. As stated, public resources devoted to R&D declined in absolute terms from 208 million euros in 2008, to 96 million euros in 2009, and 184 million euros in 2010. Unfortunately, fully reliable statistics are not yet available to monitor the level of investment in research by the private sector. However, investment in R&D by the private sector due to the economic crisis seems also to have decreased.

Human Resources and Brain Drain

24. In terms of human capital in science and technology (S&T) and innovation, Croatia shows moderate strength. In 2011, the Croatian scientific community consisted of around 1,552 full-time equivalent (FTE) researchers per million inhabitants, which is less than half of the EU-27 average (3,171 researchers per million inhabitants in 2010).

25. The number of doctoral students in science and technology fields, as a share of the population aged 20-29, has been increasing and catching up with EU standards. The share increased from to 0.02 percent in 2003 to 0.28 percent in 2011, while the average in EU-27 was 0.49 percent .

26. However, the number of researchers has been decreasing over time, notably due to emigration and the lack of new R&D jobs, especially for young researchers. Over the 2000-2010 period, the total number of FTE researchers in Croatia decreased by almost one quarter, from 8,572 to 6,847 between 2002 and 2011. According to Eurostat and available data, Croatia had 8,572 FTE researchers in 2002. In 2010, this number decreased to 7,104 FTE researchers, then to 6,847 in 2011.

With a 0.63 percent share of researchers in the total labor force, Croatia is at 65 percent of the European average of 0.97 percent. Yet, 31 percent of the labor force is employed in science and technology-related activities in Croatia, while the average in EU-27 is 42.3 percent, for the most recent years (see Table 1 and data sources).

27. The demand for scientists is, however, very uneven across sectors. Public higher education institutions and research institutes together employ more than 80 percent of Croatian researchers. The latest

data from Eurostat indicates that the share of FTE researchers employed in the business sector for 2010 was 0.45 for the EU-27, while it was only 0.13 for Croatia in 2010 and 2011.

The degree of brain drain has been quite dramatic in many of the Western Balkan countries since the early 1990s. For Croatia, it has been reported that the number of employees in the research system was cut in half during the 1990s, while the number of researchers declined by more than 24 percent.[10] A recent study by the Organisation for Economic Co-operation and Development (OECD)[11] indicates that emigration by the highly-educated has been decreasing in the last years, with 34 percent of the highly-educated population emigrating in 2000 and 22.6 percent in 2005/2006. Yet these emigration rates are still far above the average of non-OECD European and Central Asian economies (5.9 percent in 2005/2006). Driving forces for the migration of the highly skilled – scientists and engineers and other professionals – are found in the deteriorated economic living conditions, the lack of infrastructure for research and technology, as well as funding.

The Business Sector

28. Business sector investments in R&D were 39.8 percent of GERD (0.34 percent of the GDP) in 2009, and declined slightly to 38.2 percent in 2011. The majority of business enterprise research and development (BERD) is financed by private companies themselves (72 percent in 2008). Foreign investors contribute to 14.7 percent of total business R&D. Although investments by the business sector increased in the 2005-2008 period (from 0.36 percent to 0.40 percent of GDP), the absolute value of these investments is still lower than public investments. Most private sector R&D is conducted by a few large pharmaceutical companies.

29. According to Community Innovation Surveys data for 2008-2010 (7th CIS), only 42.4 percent of Croatian firms are innovative (i.e., introduced innovation), as opposed to the 53 percent average for innovative firms in the EU (Eurostat, 2013).[12] In addition, more than 80 percent of innovation expenditures by Croatian firms are used for acquisition of machinery or equipment, compared to the 50 percent average in EU-15 countries. The tendency to spend such a large share of innovation expenditures on acquiring technology indicates that innovation is mainly imitative and involves adaptation/adoption activities, with a limited role for knowledge and technology transfer effects.

30. In addition to limited access to finance for innovation, firms face widespread intra-organizational constraints to innovation and failures in commercialization (e.g., difficulties in accessing markets), which are obstacles to firm innovation.[13]

Industry-science Linkages

31. One of the barriers to innovation capacity building is the lack of adequate linkages between research institutions and the private sector. Recent data indicate that this pattern is changing, however, and that collaboration for innovation is even above the EU-27 average. The most recent survey data confirm that

[10] Švob-Đokić, N. 2005.
[11] OECD 2012a.
[12] Eurostat 2013.
[13] Prasznicar *et al.* 2008.

co-operative links are quite important for innovators. According to the innovation survey in 2010, 32.6 percent of Croatian firms that have introduced product or process innovation during 2008-2010 conducted innovation activities with partners, while the European average is 26.5 percent. Co-operation, however, is dominated by large firms. SMEs often have weak collaboration networks. According to bibliometric data,[14] collaborations as measured by co-publications between private and higher education institutions in Croatia represent 0.79 percent of total collaborations, far above the WBC average but less than half of the EU-27 average.

32. Data suggest a different trend in the uses of scientific information for innovation, however. Universities and R&D companies are rarely seen as sources of information for innovation: only 6.9 percent of firms in Croatia would look to universities for innovation, and 3.9 percent would seek it from R&D companies. This further explains a weak usage of domestic knowledge by Croatian firms.

33. According to a recent report by the European Commission, universities largely rely on individual initiatives and lack a consistent institutional approach for technology transfer. Most of the universities have neither their own university R&D strategy nor technology transfer infrastructure.[15] To date, there is no clear legal or regulatory framework covering the field of intellectual property rights (IPRs) and technology commercialization in universities. Instead, the sources are provided in the common law. For example, IPR ownership and commercialization rights for inventions are stipulated by the Labor Act, which refers primarily to the inventions and relations between inventors (employee) and employers, and gives the rights of appropriation to the employers.[16]

34. There are no clear guidelines or legal framework regarding spinoff creation by scientists, whether public servants or researchers. Nor is there guidance regarding incentives to researchers to participate in technology transfer activities (e.g., recognition in curricula; researchers' rights to participate in licensing revenues and equity participation in new firms). Several universities are developing their own IPR guidelines. Examples are the University of Zagreb, University of Rijeka, and University of Split.[17] There are ongoing efforts to create a national policy for IPR creation and management at research institutions,[18]and the new national innovation strategy is currently being developed.

S&T Outputs and Innovation Performance

35. According to a bibliometrics study commissioned for this project,[19] Croatia shows the highest levels of scientific publication – as recorded by SCOPUS-Elsevier – within the WBC, where it is the country with the most publications each year and the highest total for the period 2003-2010. Yet the number of publications per thousand inhabitants mostly remained stable over the entire period, at around 1. Further details are provided in Box 1.

[14] SCIMAGO Research Group 2012.
[15] European Commission, TEMPUS 2011.
[16] WBC-Inco.net 2011.
[17] University of Zagreb 2009.
[18] First steps have been taken within the CARDS 2003 project entitled "Intellectual Property Infrastructure for the R&D Sector." Based on this project as well as several TEMPUS programs such as the project "Fostering Entrepreneurship in Higher Education," offices for technology transfer (TTO) have been established across Croatia (WBC-Inco.net 2011).
[19] SCIMAGO Research Group 2012. See footnote 14.

36. In terms of quality, however, Croatian scientific research shows a performance close to the regional average and significantly below the EU-27 averages. The average citation impact for Croatia during the period is almost 0.65, while it is 0.62 for the WBCs and 1.31 for the EU-27. The average citation impact, however, increased from around 0.50 to 0.70 during the period of study. Citations per document in Croatia also follow WBC averages, which are below Eastern European and EU-27 averages (see Box 1 for additional indicators).

37. International scientific collaboration is of medium importance, as indicated by the rate of international co-publication: about 27.58 percent of publications are co-authored involving partners from foreign countries. The main scientific fields with publications in international journals are: clinical medicine (about 27.6 percent of all publications), biology (17.6 percent), engineering and technology (15.4 percent), and chemistry (10.8 percent).[20]

38. In terms of research specialization, the activity index (also called "Relative Specialization Index"[21]) per area for the WBC shows that the three areas with the strongest specialization (see table 3) are: Social Sciences (with an index of 2.5), Veterinary (1.8), and Agricultural and Biological Sciences (1.7). Other areas where Croatia has also a relative advantage (index above 1) are: Chemistry (1.18), Environmental Science (1.17), Medicine (1.15), and Pharmacology, Toxicology, and Pharmaceutics (1.54).

Box 1: Scientific Performance of the Croatian Research System

- Croatia's main areas of publication in 2012 were Medicine, Social Sciences, Agricultural and Biological Sciences, Biochemistry, Genetics and Molecular Biology, Physics and Astronomy and Engineering. Within the WBCs, Croatia is the country with the highest number of publications in Medicine (8.798 in the period 2003-2010 and 1.349 in 2012.) and is the field with the highest number of citations per document average (31.63). Fields with the lowest production are Decision Sciences and Nursing.
- Croatia, like the rest of the WBC, concentrates most of its output in higher education institutions (75 percent), followed by health-related institutions (31 percent) and institutions in the public sector (24 percent).
- Institutions with more than 1,000 publications in the period are: University of Zagreb, Rudjer Boskovic Institute, University Hospital Centre Zagreb, University of Split, University of Rijeka, Josip Juraj Strossmayer University of Osijek, and University Hospital Sisters of Mercy. The lowest percentage of documents in international collaboration in this group is held by Josip Juraj Strossmayer University of Osijek, and the University of Split is the exception with a normalized impact above the world average (1.13).
- Croatia presents the lowest share of international co-publication (in total publications) within the WBCs. It has increased from around 25 percent in 2003 to about 33 percent in 2012, which is far below EU-27 (44 percent) and WBC (48 percent) averages. Croatia collaborates mostly with Bosnia and Herzegovina, and Serbia within the WB region. Out of the region, co-publication is mainly with United States and other European countries.
- Intra-sector collaborations between private and government institutions accounts for 0.21 percent of total collaborations in publications in the country, while between a third and half of this type of collaboration is in the EU-27. Collaborations between sectors occur only in Croatia and Serbia within WBC.

Source: SCIMAGO Research Group 2012.

[20] Radosevic 2010.

[21] The activity index indicates the relative research efforts of a country to a given field. The concept was suggested by Frame (1977) to compare any country's performance with the world's performance. The Activity Index (also called "Relative Scientific Specialization" or RSS) is a measure of the degree of specialization of a country in a particular field. It is calculated by dividing the percent of all papers in a field from Country X by the same proportion calculated at the world level. Thus a RSS between 0 and 1 indicates that a country is relatively unspecialized in that field, while any RSS above 1 represents a relative specialization in that field; the higher the RSS above 1, the greater the degree of specialization in that field. SCIMAGO Research Group 2012.

Table 2: Research Specialization Areas in the WBCs (Activity Index of the Total Volume of Publications Over the Period 2003-2010.

		Albania	Bosnia & Herzegovina	Croatia	FYR of Macedonia	Montenegro	Serbia
Most Specialized	1	Earth and Planetary Sciences 3.3	Medicine 2.8	Social Sciences 2.5	Chemistry 2.2	Computer Science 0.6	Mathematics 3.6
	2	Environmental Science 2.9	Social Sciences 2.7	Veterinary 1.8	Mathematics 1.4	Physics and Astronomy 0.5	Chemistry 3.2
	3	Immunology and Microbiology 2.3	Agricultural and Biological Sciences 1.1	Agricultural and Biological Sciences 1.7	Physics and Astronomy 1.3	Agricultural and Biological Sciences 0.,3	Decision Sciences 3.,1
Least Specialized	24	Engineering 0.4	Arts and Humanities 0.,3	Neuroscience 0.4	Arts and Humanities 0.2	Pharmacology, Toxicology and Pharmaceutics 0.03	Economics, Econometrics and Finance 0.6
	25	Health Professions 0.2	Neuroscience 0.3	Decision Sciences 0.3	Nursing 0.2	Veterinary 0.03	Arts and Humanities 0.3
	26	Chemical Engineering 0.2	Nursing 0.04	Nursing 0.1	Health Professions 0.1	Nursing 0.03	Nursing 0.2

Source: SCIMAGO Research Group 2012.

39. In terms of technological performance, Croatia also shows weak development and lags significantly behind the European average. During 2004-2008, the number of European Patent Office (EPO) patent applications per million inhabitants remained constant, at about seven per year. Croatia (7.21) dramatically lagged behind the EU-27 (119.5) in 2008. From 2002 to 2010, this indicator remained around 6.6 (the average of those years, including estimations for 2009 and 2010). From 2003, applications have been dropping from 9.2 to an estimate of 5.7 for 2010. These results are far behind the EU-27, with an average of 111.1 for the same period and an estimated average of 109.2 for 2010. In comparison to new EU member states, Croatia is behind Slovenia (59.12), the Czech Republic (19.26), and Hungary (19.41). Most EPO patents from Croatia are granted in the fields of chemistry and organic chemistry.

40. The low level of technological performance is also reflected in the low export intensity of medium and high technology industries: in 2011 the share of these sectors in total exports was 33 percent in total exports, which is about half the average in EU-27 countries (61 percent of exports).[22] Over the last decade, the number of quality certificates (ISO-9001 and 14001) has rapidly increased, as indicated in the following tables.

[22] World Development Indicators 2012.

Table 3: Number of Quality Certificates

ISO 9001						ISO 14001				
	2007	**2008**	**2009**	**2010**	**2011**		**2008**	**2009**	**2010**	**2011**
Albania	23	43	155	52	164	**Albania**	…	1	…	11
BiH	652	811	909	944	1,119	**BiH**	60	87	100	148
Croatia	**2,073**	**2,302**	**2,567**	**2,102**	**2,117**	**Croatia**	**343**	**469**	**451**	**488**
FYR Macedonia	255	271	…	…	…	**FYR Macedonia**	26	…	…	…
Montenegro	136	160	157	85	146	**Montenegro**	17	18	15	25
Serbia	1,987	2,091	2,733	1,790	2,868	**Serbia**	176	298	318	520

Source: The ISO Survey of Certifications 2011.

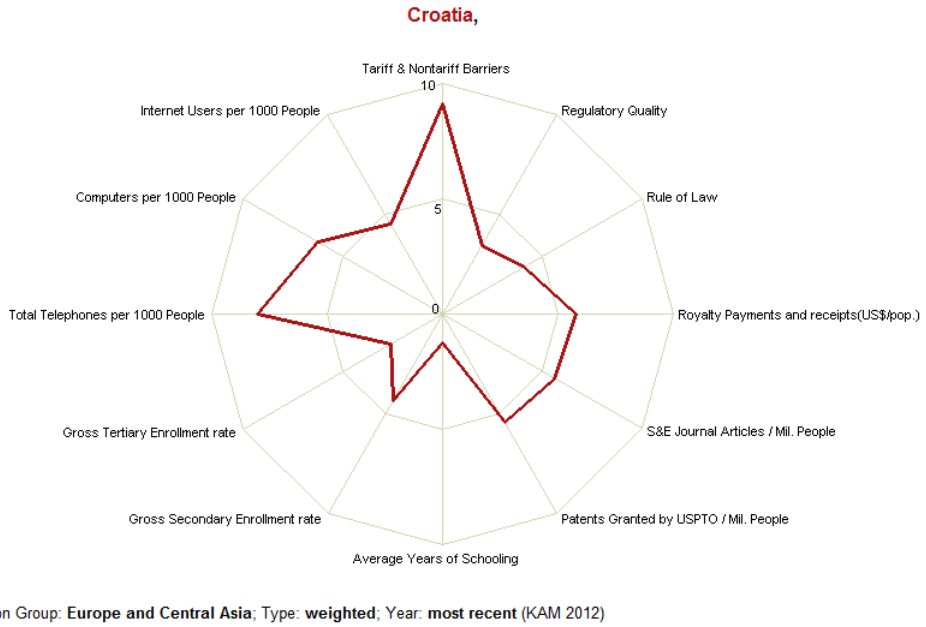
41. Figure 1 illustrates Croatia's performance in comparison to Europe and Central Asia for select indicators spanning the knowledge economy, using the most recent data from the World Bank Knowledge Assessment Methodology.[23] Croatia shows moderate innovation performance: the country ranks about 5 on a scale 0 to 10 for the ECA region in terms of patentability, scientific production, and commercialization of technology as measured by royalty payments and receipts related to technology transactions. It performs exceptionally well, and about the regional average, in terms of commercial regulation (reducing tariff and non-tariff barriers) favoring knowledge economy progress and in terms of computers and telephones per 1,000 people. On the downside, the country performs significantly lower than the ECA average in the quality of regulatory framework (i.e., rule of law and general regulatory quality) and education levels (measured by the average years of schooling, and gross secondary and tertiary enrollment rates).

42. Hence, fundamental components for innovation to succeed in markets are missing (for example, the regulatory framework in terms of business creation, contract enforcement, etc.) as well as improvements in the general education level, which is a pre-condition for having an adequate critical mass of human resources for science and technology.

43. As figure 2 illustrates, Croatia is performing around the regional average on three of the four of the knowledge economy pillars –economic incentives, information and communications technology (ICT), and innovation– but is significantly lagging behind on education compared to the regional average in Europe and Central Asia.

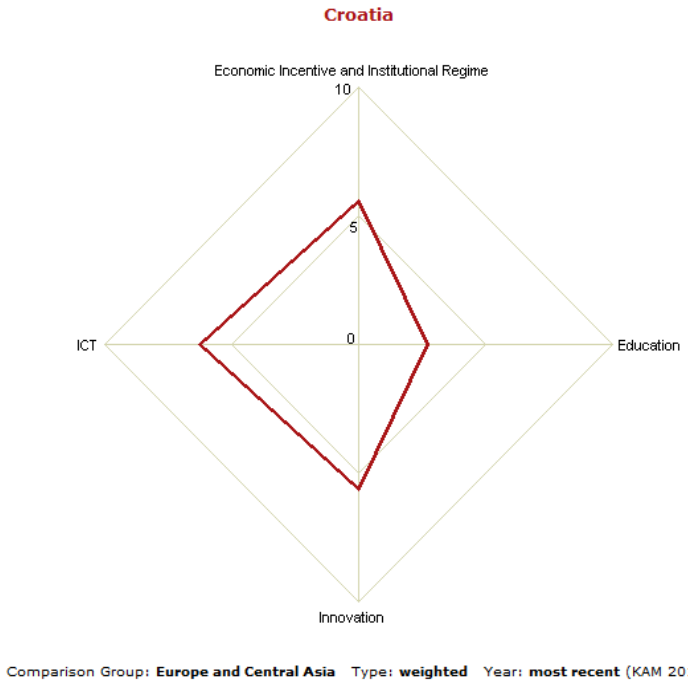
[23] The Knowledge Assessment Methodology (KAM) consists of two indices – Knowledge Economy Index (KEI) and Knowledge Index (KI) – to allow countries to identify the challenges and opportunities they face in making the transition to the knowledge-based economy. The indices provide insight into the conditions facilitating effective use of knowledge for economic development (KEI) and whether the economy has the capacity to generate, adopt and diffuse knowledge (KI). KEI is based on four pillars, including: (1) economic incentives and institutional regime; (2) education; (3) innovation; and, (4) ICT. KI is based on three pillars, including: (1) education; (2) innovation; and, (3) ICT. The economic incentives and institutional regime comprises tariff and non-tariff barriers, regulatory quality, and rule of law. The proxy for education is average years of schooling, and gross enrollment ratios at the secondary and tertiary levels. Innovation in this context spans inputs and outputs of the national innovation system and comprises of three key variables including royalty and license fees payments and receipts, patent applications granted by the U.S. Patent and Trademark Office, and the number of scientific and technical journal articles published. The ICT pillar measures penetration of various technologies including the Internet, telephones, and computers.

Figure 1: Croatia Performance on Key Variables in Comparison to Europe and Central Asia



Source: World Bank KAM 2012.

Figure 2: Knowledge Economy Index Pillars – Croatia vs. Europe and Central Asia



Source: World Bank KAM 2012.

ICT Diffusion

44. In Croatia, the broadband penetration rate has increased slightly, reaching 28,4 percent at the end of 2012, which compares well with the EU average. While mobile broadband is well developed by EU standards, the overall broadband take-up by households needs to be improved.[24] Legislative alignment in the field of electronic communications and ICT, to allow competition and to achieve a higher level of consumer protection, has advanced and is almost complete. Implementation of competitive safeguards and market analysis procedures is well advanced.[25]

45. A broad approach to ICT infrastructure for innovation activities has emerged in the ICT sector, which has applied a top-down approach initiated by the government. e-Hrvatska, the institution responsible for ICT infrastructure development in Croatia, implemented two programs related to ICT infrastructure and education, in addition to Broadband Internet and HitroNet, which are aimed at building a centralized network of public services.[26] Croatia needs to focus now to ensure sustainable competition in ICT markets, including improved access to rights-of-way, and to make finalizing the cost accounting model one of its priorities according to the European Commission. The incumbent company continues to retain a strong position in fixed broadband access and in fixed voice markets.

IPR Systems and Quality Institutes

46. Intellectual property systems – the laws and institutions that manage and enforce IPRs – are one of the main instruments to encourage innovation and diffusion of new ideas. By providing exclusive ownership and commercialization rights to inventors, an IPR system allows inventors to "appropriate" innovation returns – exclude others from exploitation – and thereby recoup costs of R&D and creativity. In addition, by encouraging disclosure of ideas and promoting their exploitation, the IPR system promotes technology diffusion, thereby avoiding duplication of innovation efforts in the economy.

47. Croatia has a modern system of IPR that largely fulfills the *acquis* requirements in the areas of copyright and neighboring rights and industrial property rights. Croatia is a member of the European Patent Office (EPO) and a signatory of all of the most important international treaties in the field. The central body responsible for granting rights and coordinating the national IPR system is the State Intellectual Property Office of the Republic of Croatia (SIPO). Inter-agency cooperation is effective and has made particular progress in the field of public awareness, in line with the European best practices. Individual enforcement bodies have stepped up training activities as well as regional and international cooperation in their respective areas. The Croatian Standards Institute is an autonomous, non-profit, public institution established as the national standards body of the Republic of Croatia. It was set up by the Decree on the Establishment of the Croatian Standards Institute (NN 154/2004; NN 44/2005) based on the Law on Standardization (NN 163/2003), and it began operating on July 1, 2005. The Croatian Standards Institute

[24] European Commission 2012.
[25] A project on broadband services in non-urban areas (islands and mountains) has been launched in order to bring broadband Internet access to schools and hospitals. Measures have also been taken to improve access to electronic communications services for people with disabilities.
[26] MSES has been constantly improving the CARNET network, implementing a distance learning program. MSES, jointly with CARNET and the Ruđer Bošković Institute, launched the Online Database Center Project, which takes a network approach to commercial databases and provides free databases for the science and research communities in Croatia.

acts as the enquiry point for the World Trade Organization Agreement on Technical Barriers to Trade (WTO/TBT) and the contact point for Codex Alimentarius.

2. NATIONAL RESEARCH AND INNOVATION SYSTEMS –FEATURES AND CHALLENGES

48. The following section explores the nature of Croatia's R&D and innovation system—stakeholders, governance, stated strategy, funding, and dynamics—with the aim of identifying possible weaknesses and resultant reform possibilities. It posits, in line with the country's own national strategy plus the emerging Western Balkans R&D Strategy for Innovation, that Croatia can accelerate its path towards research excellence and innovation through selected R&D governance reforms combined with prioritized initiatives to strengthen the research base, enhance effective research commercialization from public funded research institutions, and encourage large expenditures in research and innovation by the business sector.

Need for a Systemic View

49. Given the cross-sector nature of knowledge and innovation, governance for research and innovation policy incorporates a broad set of mechanisms and actors, instruments and institutions in the field of R&D, education, technology and specialized services, and entrepreneurship, which calls for policy coordination across different ministries and agencies.

50. The innovation system in Croatia, as in other countries, comprises many stakeholders within the public and private sectors (universities, research institutes, the Academy of Science, ministries, and private entrepreneurs), spending on R&D and interacting as parts of a value chain that should move ideas to market. When properly functioning, R&D transforms into innovation and lead to products and services that strengthen the country's business investment, technological sophistication, comparative advantage, and economic performance.

51. Performance of national innovation systems depends on both actors' capabilities and well-articulated and strong linkages among them. Different stakeholders act at different stages in the innovation process. Early (basic) research is mostly conducted by publicly-funded research institutes and universities, and it constitutes the main source to advance breakthrough knowledge. R&D can also be conducted in collaboration with firms or simply sponsored or contracted by the private sector. Next, the middle stages (development activities) involve the proof of a concept/invention, early stage technology, and product development as the scientist is joined by business experts and public or private investors. Finally, product launch often involves early public or private financing and complementary support in the case of new firm creation.

52. More simply, in the context of developing countries, a well-functioning innovation system facilitates incremental technological improvements by firms. This occurs either through a variety of means such as employment of highly qualified science and technology personnel, collaboration with researchers, training, and extension services (R&D and engineering services; quality certification and standards), or the ability to access and utilize global technology developments.

53. Improving the knowledge capacity (R&D) and innovation is not a simple or quick task, and it requires the active participation of all stakeholders. The multiplicity of players, difficulty in aligning incentives and establishing modern legal frameworks and government policies, and encouraging private sector actions is challenging. Overcoming ingrained or legacy cultural differences, if not distrust, between entrepreneurs and researchers, reducing red tape requirements, or stimulating the private sector to take a more proactive interest in R&D to gain global market share all require concerted and well-conceived initiatives.

Need for Good Governance

54. In the path to research excellence, it is important to have research systems that are competitive and transparent, with quality-driven recruitment practices and efficient administrative procedures serving the purposes of institutional missions. Better governance of universities and public laboratories can be achieved through the use of new mechanisms, such as greater use of project funding (typically contracts and grants awarded through competition), and selective increases of funding for research fields that are linked to social and economic need. Reform of the steering and funding of higher education and science institutions, by providing incentives that focus on excellence and relevance, can help strengthen the contribution of public investment to scientific progress and innovation.[27]

- Merit-driven research funding means competitive granting, subject to a peer-review system and international criteria in which projects are selected on the basis of the quality of proposals and expected results.
- Good governance in research funding implies meritocracy and transparency in grant funding; accountability, evaluation and monitoring practices, transparency and performance evaluation in terms of contributions to knowledge, local economic and social needs, and growth.
- Evaluation criteria must recognize that excellence in research and training has become, at least in some disciplines, more tied to industry applications and contributions to addressing social problems. [28]

55. In research institutions, appropriate governance mechanisms mean performance-driven career development, clear and transparent recruitment policies, and clear rules regarding ownership and commercialization of intellectual outcomes – revenue participation by researchers – resulting from research. This also implies that results of publicly funded research are protected and published in a way that encourages their exploitation.[29] Examples of governance principles to make research careers more attractive can be found in the European Charter for Researchers and the Code of Conduct for the Recruitment of researchers.

56. In Croatia, increasing funds for research and ensuring research continuity over time remains a great challenge. In parallel, governance of research institutions needs to be improved in line with the aim of

[27] OECD 2011a and OECD 2011b.
[28] OECD 2011a and OECD 2011b.
[29] Merit-based recruitment and implies not only scientific productivity but a wider range of evaluation criteria, such as teaching, supervision, teamwork, knowledge transfer, management, and public awareness activities (see Innovation Union and the Code of Conduct for Recruitment of Researchers, EC).

research excellence and a rational balance between institutional funding, which facilitates funding stability, and competitive (project-based) grant funding, which fosters quality competition in science.

57. Good governance of universities requires enhanced autonomy to organize their activities in the areas of education and training; research and innovation; open transparent and merit-driven recruitment methods; institutional accountability; quality assurance systems; and the ability to access alternative sources of funding and engage in interactions with industry. Competitive education implies more involvement by the business sector in curricula development and doctoral training so that skills better match industry needs.

58. Some of these policy areas are covered by the *Bologna Declaration* within the framework of the European Higher Education Area signed in 2007 by 46 governments. Countries agreed on 10 action lines aimed at making higher education in Europe more compatible and comparable, and more competitive and attractive for students and researchers in Europe and worldwide.[30]

Policy Formulation

59. The Croatian research and innovation policy-making system consists of three strategic and operational levels:

(1) The Parliament and the national government, represented by the prime minister;
(2) The ministries and agencies responsible for the design and implementation of science and research programs on the national level; and,

(3) Research performers (i.e., universities and institutes carrying out R&D activities). There is also a set of institutions that support policy making and that are in charge of system development and monitoring, along with policy evaluation.

60. The Croatian Parliament represents the highest level of government in the national research system. Until recently, bodies responsible for policy and strategy in the advancement of science and education were the *National Science Council (NSC) and* the *National Council for Higher Education (NCHE*). In 2013. the two bodies merged into a single council – *The National Council for Science, Higher Education and Technological Development*. This new Council is appointed by the Parliament and is responsible for the development of entire scientific and technological activity, innovation system, quality of research in Croatia, as well as for monitoring the development and quality of higher education.

61. On the secondary level, the *Ministry of Science, Education, and Sports* (MSES) is responsible for the design of the national research and S&T policy. The legal drafting process includes contributions from the academic and business sectors, NGOs, and relevant ministries. The MSES manages the science and educational system in Croatia. It is the main policymaking body, with responsibility for and control over the budget. It is in charge of institutional funding, young researcher programs, and scientific cooperation projects.

62. The Ministry of Economy (MoE) and the Ministry of Entrepreneurship and Crafts (MoEC) complement national innovation policy in developing business infrastructure development, fostering

[30] This entails comparability in degrees –countries are setting up national qualifications frameworks that are compatible with the overarching framework; adoption of quality assurance mechanisms in accordance with the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG); and fair recognition of foreign degrees and other higher education qualifications in accordance with the Council of Europe/UNESCO Recognition Convention.

entrepreneurship and technology capabilities of companies, and promoting innovation culture. MoE is responsible for the development of national competitiveness, industrial policy, and the implementation of innovations and new technologies, etc. MoEC focuses on small and medium-sized entrepreneurship and provision of concrete innovation support measures.

63. The National Innovation System Council and the Strategic Council for Science and Technology envisaged in the Action Plan 2007-2010 and established by MSES in 2008, were two bodies of experts mandated to coordinate multiple initiatives aimed at creating the Croatian National Innovation System. Despite high expectations, the expert bodies have had limited success in improving the efficiency of the national research and innovation system and are no longer functional. The National Council for Science, Higher Education and Technological Development has taken over most of their responsibilities.

Implementing Bodies

64. In the area of financing research and technological projects, there are two main institutions: the MSES and the Croatian Science Foundation (NZZ).

65. *The Croatian Science Foundation (NZZ)*, established by the Croatian Parliament in December 2001, aims to promote science, higher education, and technological development. The foundation finances R&D and educational projects and supports international cooperation within the higher education system. This support includes assistance in the realization of fundamental, applied, and developmental research programs in areas of special interest.

66. *The Business Innovation Center of Croatia* (BICRO) is the lead agency for the implementation of innovation policy measures and programs. BICRO used to run five programs targeted at: knowledge-based companies (RAZUM), technology infrastructure (TehCro), risk capital industry (VenCro, which was never implemented), R&D services for companies (IRCro), and a business competitiveness upgrading program (KonCro). BICRO reports to the MSES.[31] Current programs are being evaluated. Based on this evaluation, changes in order to reach higher levels of efficiency and quality will be implemented.

67. *The Croatian Institute for Technology* (HIT) was responsible for improving the conditions for applying new knowledge in the private sector. HIT was in charge of implementing the TEST program (pre-commercial technological projects) and developing the national forecasting and business intelligence program. In addition, HIT used to provide information and assistance to the Croatian scientific community on participation in European programs. In 2012, HIT was merged with BICRO, forming the Business Innovation Agency of Republic of Croatia. The newly established agency should take a role in the management of EU structural funds related to R&D and innovation.

68. *The Unity through Knowledge Fund (UKF)* was established in 2007 by MSES on behalf of the government of the Republic of Croatia. The Fund operated within the Science and Technology Project I, which was financed by a loan of the World Bank. From its establishment until May 2011, the Fund financed 91 scientific and technological projects. The Fund currently supports excellent collaborative research with Croatian scientists living abroad and leading international scientific institutions, while also fostering both

[31] The Government of the Republic of Croatia established the Business and Innovation Center of Croatia – BICRO- in 1998. In November 2010, the new Business Innovation Croatian Agency - BICRO was formed (OG 129/10) and has become the legal successor of the Business and Innovation Center of Croatia.

the professional advancement of young researchers at the doctoral and postdoctoral levels, and industry and academia collaboration. The status of UKF is regulated by the Amendments to the Croatian Science Foundation Act, guaranteeing long-term sustainability of the UKF practice and programs within the Croatian Science Foundation (NZZ).

Monitoring and Policy Evaluation

69. *The Agency for Science and Higher Education (ASHE)* regulates activities relating to the evaluation of research and higher education systems in Croatia. The Agency also functions as an intermediary between state policy and the science community. ASHE collaborates closely with the National Council for Science, Higher Education and Technological Development, also research and higher education institutions, and 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 (ENQA). ASHE is a full member of the European Association for Quality Assurance in Higher Education, and is listed in EQAR (European Quality Assurance Register for Higher Education).

70. Efforts to develop a quality culture have been shaped by the changes in the legal framework and their consistent implementation. Advances in the regulatory framework have contributed to enhanced quality and better defined roles of multiple stakeholders in the Croatian quality assurance systems for both higher education and science. Hence, it has been determined that higher education institutions and scientific organizations are responsible for implementation of quality procedures of educational and research activities. With this in mind, public universities have been entrusted with self-accreditation of their study programs.

71. The National Council, as the highest professional body in the state, assumes a strategic role and is tasked with the creation of national strategies and policies for higher education and science and development of national academic standards. The Croatian Science Foundation was made responsible for evaluating research projects, among other things. The Rectors' Conference is the decision-making body in issues of common interest for the activities and development of universities in the Republic of Croatia; the Student Council is the coordinating body promoting the interests of students.

72. All stakeholders in higher education and science are expected to work in line with the Standards and Guidelines for Quality Assurance in the European Higher Education Area – ESG, which was developed by the E4 group.[32]Evaluation procedures in higher education in ASHE include evaluation of the feasibility of the public financing of study programs of public universities, initial accreditation of study programs, initial accreditation of higher education institutions, re-accreditation of higher education institutions, audit of higher education institution, and thematic evaluation in higher education.

73. Evaluation procedures in science by the ASHE include initial accreditation of scientific organizations, re-accreditation of scientific organizations, and thematic evaluation in science. Thematic evaluation is carried out by the Agency for Science and Higher Education pursuant to Article 24 of the Act on Quality Assurance in Science and Higher Education (Official Gazette 45/09) and Procedure of Thematic Evaluation (Class: 003-08/10-02/0003; Register number 355-01-10-2), in line with good European and

[32] ENQA - European Association for Quality Assurance in Higher Education, EUA –- European University Association, ESU - European Students' Union and EURASHE - European Association of Institutions in Higher Education).

international practice. Thematic evaluation is carried out based on decisions of the Agency's Accreditation Council and may also be carried out on the basis of a corroborated proposal from the minister or a student association of a higher education institution. The outcome of thematic evaluation is the report of the panel of experts, which also includes assessment of alignment with the theme of evaluation. In case of negative assessment, the Agency may initiate the re-accreditation, either on its own or followed by the proposal from the minister.

74. The ASHE gives an opinion relating to the justification of public funding, while public universities, according to the Act on Quality Assurance in Science and Higher Education, are autonomous in checking the minimal criteria contained in the Ordinance on the Content of a License and Conditions for Issuing a License for Performing Higher Education Activity, Carrying out a Study Program and Re-Accreditation of Higher Education Institutions (OG 49/10).[33]

Research Performers

75. The main research performers are: (i) public scientific institutions, that is, higher education institutions and research institutions; (ii) science and business infrastructure institutions; and, (iii) R&D-performing business entities. In Croatia, there are 7 public universities, 25 public research institutes, 11 public polytechnics, 3 public schools of professional higher education, 3 private universities, 4 private polytechnics, 27 private schools of professional higher education, 6 technology transfer offices at universities (four) and research institutes (one), 6 technology centers, 16 research centers in industry, and 1 military research center.

State Universities

76. State universities and schools funded through the national budget for higher education include: the University of Zagreb; the University of Rijeka; the University of Split; the University of Zadar; the University of Dubrovnik; Juraj Dobrila University of Pula; and Josip Juraj Strossmayer University of Osijek.

Public Research Institutes

77. The primary task of public research institutes is to carry out scientific programs of strategic interest to the Republic of Croatia while also establishing, together with universities, the scientific infrastructure for the whole system of science and higher education. According to scientific area of specialization, Croatia has 14 public research institutes in social sciences and humanities, 4 in natural sciences, 4 in biotechnical sciences (agriculture and forestry), and 3 in biomedical sciences (one each for medical research and occupational health, anthropology, and veterinary medicine). In addition, there are about 70 scientific research units classified as other legal entities. These entities are not pure scientific institutions, but a mixture of research institutes and service providers. They are established as independent institutions, such

[33] The opinion on the justifiability of public finding is based on the Network of Higher Education Institutions strategic document, to be proposed by the National Council for Higher Education and adopted by the Parliament that should include guidelines and criteria for establishing of higher education institutions and study programs.

as the Croatian Hydrographic Institute, the Meteorological and Hydrological Service of Croatia, and others. They can also be a part of business, or cultural, health, or state institutions. The majority of such units are medical research units at hospitals.

Institutions of Special Importance for Croatia

78. Other important research performers of special importance for Croatia are:

- Croatian Academy of Sciences and Arts;
- Miroslav Krleža Institute of Lexicography; and,
- National and University Library.

Corporate Institutes

79. Currently there are around 20 private scientific institutions in Croatia. R&D performing business entities include the following corporate institutes:

- Ericsson Nikola Tesla
- INA Oil Company
- KONČAR – Electrical Engineering Institute
- Fidelta Ltd. for research and development
- PLIVA Croatia Ltd

Independent Commercial Institutes

80. There are nine independent commercial institutes (not belonging to business entities). The most important in this group are:

- Energy Institute Hrvoje Požar
- The Zagreb Bc Institute for Breeding and Production of Field Crops
- Brodarski Institute
- Institute IGH

3. POLICY DEVELOPMENTS

National Strategy

81. Governance capability is crucial for the success of any public policy. Good governance for research and innovation policy means having an integrated and coherent policy-making process in place, with stable institutions and deploying policy agencies performing according to policy objectives and well-defined implementing procedures. Elements of good governance are: formulation mechanisms (consultation and

priority identification); target setting and programming (medium and long run); monitoring and accountability; and, information dissemination mechanisms.[34]

82. Definition of policy priority and targets, action lines, and corresponding resource planning are made possible through national strategies for research and innovation. National strategies articulate countries' vision regarding the contribution of research and innovation to national economic development, and are therefore helpful to organize efforts and policy reforms into a specific direction. In some cases, national strategies outline the specific policy instruments to be used to meet a set of goals or objectives.[35]

83. Croatia has been taking important steps to enhance the efficiency and effectiveness of the existing R&D system. However, there are several binding constraints that still hamper the implementation of the national strategy for R&D and innovation. The most important are: the (high) number of regulatory barriers; a relatively fragmented research governance structure; weak science-industry cooperation; and, (even though there are certain financial incentives like tax deduction for technology and innovation projects in commercial sector offered by the Ministry of Finance) insufficient incentives related to private investment in research and research commercialization.

84. During the past decade, the main policy programs that shaped R&D and innovation policy in Croatia include the following:

85. *Science and Technology Policy (STP I) of the Republic of Croatia 2006-2010 (2006):* This is the main policy document in Croatia setting the basis for a modern research and innovation system, adopted by the Parliament in May 2006. The overall aim of the STP 2006-2010 was to stimulate scientific excellence and enable the transfer of knowledge and results of scientific discoveries to industry and business in order to increase competitiveness and generate sustainable growth and productivity. The STP, supported financially by the World Bank, played a major role in forming Croatia's science and technology policy, helping to construct a conductive environment for innovation that serves the country in its development agenda. STP programs contributed to increase collaboration between business and public research organizations, commercialization of public research through technology transfer offices, and strengthening of the science base.

86. More specifically, the policy objectives of STP were to:

- Increase funding for excellent science and technology projects to meet the goal of "3 percent of GDP for research investment" outlined in the Lisbon Strategy;
- Restructure publicly funded research institutes and R&D centers in order to focus their research toward 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 also build a more flexible research and education system;

[34] The European Commission's White Paper on Governance (2001) has set out five principles that underpin good governance. They are: openness, participation, accountability, effectiveness, and coherence. These are required for the sound management of public resources and essential in creating environment conducive to business, as well as a productive partnership between public and private sectors.

[35] OECD 2012b.

- 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; and
- Administer stimulating and business-friendly legislation, including appropriate intellectual property laws and tax incentives for investment in R&D, in order to build a system that encourages innovation.

87. *Action Plan 2007-10 Science and Technology Policy of the Republic of Croatia (2007):* This action plan aimed to define the priorities in implementation of the above STP. The action plan provided a list of actions for individual policy elements and indicators that should be used to monitor the implementation of science and technology policy. The actions also included the founding of a *Strategic Council for Science and Technology* and *a National Innovation System Council* as strategic, expert bodies to facilitate policy implementation.

88. *Guidelines for Promotion of Innovation and Technology System (2006):* This document, adopted by the government in 2006, defines the policy measures within the Program for Promotion of Technology R&D Projects and the Program for Promotion of Innovation- and Technology-Based Entrepreneurship. The former encompasses the policy measures within TEST, whereas the latter encompasses the sub-programs RAZUM, TECHRO, IRCRO, KONCRO and VENCRO.

89. *Strategic Development Framework 2006-2013:* This is the main, over-arching national strategy addressing the competitiveness of the Croatian economy. It defines 10 priority areas, among them knowledge, education, science, and IT.

90. *Action Plan to Encourage Investment in Science and Research (adopted in 2008):* The Action Plan, known also as "3 percent Action Plan," is aimed at stimulating investments needed for structural reforms of science and higher education sectors in order to facilitate Croatian development based on the knowledge-based economy model. It includes an analysis of the current situation, and delineates tasks, measures, and indicators related to three areas of intervention: capacity for research and innovation (including people, infrastructure, financing public research, and quality assurance), research for economic development (R&D subsidies), and popularization of science and research. In the areas related to innovation policy, this document addresses only tax subsidies for R&D.

91. *Strategic Plan of the National Foundation for Science, Higher Education, and Technological Development (NZZ) 2004-2008:* The document, the strategic plan of NZZ, defines its vision and strategic focus in the period 2004-2008.

92. *Regional Competitiveness Operational Program 2007-2013 (RCOP):* RCOP represents one of the five program documents that the Republic of Croatia prepared for the Competitiveness Component under the Structural Funds of the EU Cohesion Policy allocated to Croatia for the financial period 2007-2013. RCOP directly responds to the strategic objectives in the National Strategic Reference Framework (NSRF). It is a tool for implementing the thematic priority "raising regional competitiveness on the basis of a knowledge-based economy" and strongly supports the horizontal priority "internal country cohesion and

balanced regional development." The overall objective of the RCOP is being pursued through the following three strategic objectives: (i) developing entrepreneurship; (ii) fostering innovation and research excellence; and, (iii) increasing regional potential for economic development.

4. FUNDING AND POLICY INSTRUMENTS

Scientific Research

93. Public research activities in Croatia are predominantly financed by budget resources allocated by MSES through two main channels: *institutional funding* (block grants) and *research grants* based on competitive bidding. The total budget of MSES in the area of R&D (science & technology) in 2007 was 119 million euros; in 2012, the budget was 135.5 million euros.

94. MSES is the government body that commands the largest share of public expenditures for R&D (85 percent of total). However, most of these resources are used to pay salaries and other earmarked expenditures, leaving few resources for investments in programs. Around a quarter of the overall expenditures of the ministry are allocated on a per capita basis to 25 public research institutes. Starting from 2013, a new model of dedicated institutional financing for science activity has been introduced. Three-year contracts have been signed with the directors of public research institutes and rectors of public universities, enabling financing according to the transparent set of indicators for science activity implementation. The goal is to ensure structured and balanced institutional financing, inducing more responsible and competitive management of research institutes and universities.

95. Institutional funding (33 percent of the MSES budget for R&D in 2012) is the most important source of funding for research organizations. It covers employee salaries plus additional benefit costs relating to employees, as well as material costs within the research institutions. Research grants represent 9 percent of the MSES budget for R&D in 2012. Grants support all fields of science regardless of thematic area and type of research. The grants are designed to assure balanced development of the six main fields of science (technical sciences, bio-medical sciences, bio-technical sciences, natural sciences, social sciences, and humanities). Bio-medical and natural sciences are allotted a slightly higher priority.

96. The importance of competition-based research projects has grown in the last few years. The procedure for evaluation has become increasingly stringent; thus, the percentage of accepted projects has been decreasing. In other words, the national success rate has shifted from 80 percent to less than 40 percent, which indicates that funding has become more competitive. The total financial resources allocated in this project scheme have been growing in the last few years, although as a percentage of the total MSES budget for R&D they have been decreasing. The reason is that employee salaries and other costs relating to employees in the research institutions have been rapidly growing, and these costs take the most financial resources in R&D budget. In 2007, this percentage was approximately 16 percent of the total MSES research budget, though it was only 9 percent in 2012.

97. Research grants through national scientific projects are entering their final phase, since the financial resources for this purpose will be redirected to the Croatian Science Foundation, which will establish a new scheme of competitive projects and programs of international quality, pursuant to the model of collaborative

programs of EU. Basic funding of scientific activities within research institutions will be carried out through long-term institutional funding, via 3-year funding of scientific activities within public research institutes and public universities. This will be a base for introduction of complete funding agreements for comprehensive institutional funding.

98. MSES uses two other instruments to finance research: (i) grants for new employment positions for young researchers through the competition-based "Junior Research Program;" and, (ii) research-supported programs, which provide additional financial resources for specific purposes, such as scientific publishing, support for scientific and professional conferences and associations, support for programs and projects for popularization of science, and research equipment (animal laboratories and science units).

Table 4: Broad Share of Available Budgets by Main Categories of Research and Innovation Measures

Broad category of research and innovation policy measure	Approximate total annual budget for 2010 (in euro)	Commentary
Governance & horizontal research and innovation policies	EUR17,880,586.76 (direct support)	Actual expenditure in 2010
Research and Technologies	EUR9,214,880.53	Actual expenditure in 2010
Human Resources (education and skills)	EUR46,495,244.05 (direct suport)	Both actual and planned expenditures
Promote and sustain the creation and growth of innovative enterprises	EUR1,253,401.08 (direct suport)	Actual expenditure in 2010

Human Capital, Mobility and Diaspora

99. Croatia has implemented several policy initiatives to facilitate mobility of researchers and linking with the Croatian scientific diaspora. These policy actions include legislation for recognition of foreign education, immigration policies, mobility programs, internships/fellowships, and research collaboration with Croatian scientists abroad.

100. Policy has aimed at facilitating researchers' mobility. An important step was the acceptance of the Act on Recognition of Foreign Educational Qualifications and establishment of higher education authorities for shaping and monitoring the reform process in the following years. These include: the National Council for Science, Higher Education and Technological Development, created in 2013 (previously the National Council for Higher Education, created in 2004 and the National Council for Science, created in 2005) and the Agency for Science and Higher Education, which administered the accreditation for the implementation of the Bologna Process 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.

101. Another important task is strengthening human resources by encouraging research cooperation and mobility between Croatian scientists both in the country and abroad, and encouraging Croatian scientists working abroad to return home. The most important program is managed by the Unity through Knowledge Fund (UKF), launched in 2007 by MSES through the World Bank Science and Technology Project I. The program focuses on knowledge dissemination, using instruments such as financing post-doctoral studies, and engaging scientists from the diaspora in research projects and in short-term and long-term visits.

102. The UKF program "Research in Industry and Academia Grant" aims at increasing the mobility of young researchers and professionals between academia and Croatian industry, as well as strengthening long-term cooperation between the two sectors. The grant supports engagement of excellent young researchers and professionals in Croatian enterprises. Eligible applicants come from Croatian public scientific research institutions or the diaspora at doctoral and post-doctoral levels. In addition, grants support engagement of outstanding young researchers and professionals in Croatian public scientific research institutions. The grant program allows co-financing of salaries for young researchers and professionals, who will work on scientific and technology projects in Croatian companies or in public scientific research institutions. Finally, the Agency for Mobility and European Programs (AMPEU) organizes a program oriented primarily toward student and staff mobility via bilateral agreements.

103. The participation of foreign scientists in research programs in Croatia was simplified in 2008 with the adoption of the Ordinance on Determining the Requirements for Granting Temporary Residence to Foreigners for the Purpose of Scientific Research (Official Gazette No. 42/08). This new ordinance was adopted in July 2012 and amended in February 2013. In addition, the MSES established in 2009 the Committee for the Hosting Foreign Researchers in Croatia to assist the process of hosting foreign researchers on research projects implemented at Croatian universities and institutes. Foreign researchers are allowed to work in the private and public research and education institutions without being obliged to have a work permit. However, national research programs are open only for participation of foreign individual researchers regardless of the resident country, and are not available to foreign nationals.

Private Sector Research and Innovation

104. Among the programs that are managed by BICRO (now called the Agency for Business Innovation) to support innovation in firms and new firm creation are: (i) RAZUM, a conditional loan that covers a maximum of 70 percent of the total development budget for a period of 3 years and aims at raising the competitiveness of domestic companies and products, along with creating other conditions necessary for successful transfer of technology; (ii) the collaborative research development –IRCRO program–[36] is a program targeting small and medium-size businesses to help them set up their R&D activities by linking with research institutions; (iii) the competitiveness upgrading program (KonCro); and, (iv) the Proof of Concept Program (POC), among other policy programs.

105. Major initiatives to promote collaboration and networking among private firms include grants for joint R&D programs and consortia (private, and public-private), and public financing of regional innovative clusters and science and technology parks (see further details in the next section).

106. In 2012, the MoEC introduced "Business Impulse," the Plan for Supporting Entrepreneurship. The Plan comprises the following priority areas: (i) competitive entrepreneurship; (ii) affordable financing and guarantees; (iii) education for entrepreneurship and crafts; and, (iv) improved business infrastructure. The main objectives of the program are creation of a more competitive environment and enabling faster and better development of entrepreneurship in Croatia, providing support to entrepreneurs in realizing their projects, absorption of the EU funds, and the strengthening and development (regional) business

[36] Maximum amount of grant support for individual project is 900,000 HRK or up to 50 percent of the total eligible project costs. Duration of the development part of the project is a maximum of 2 years.

infrastructure. Grants are awarded under the rules for *de minimis,* i.e., rules for the use of state aid to the equivalent of 200,000 euros in 3 years.[37]

107. Fiscal Policies: Financial incentives for technology and innovation investment offered by the Ministry of Finance are divided into two basic groups: customs duties and value-added tax (VAT).

- *Customs Duties:* The Instructions for VAT Return on Equipment for Technology Research and Scientific Research Projects Procured in Croatia and Abroad have been in force since 2003 *(Official Gazette, No. 96/2003).* According to the regulation, imports of scientific research equipment are exempt from customs duties. Research organizations and other entities involved in scientific research are allowed to file for a return of VAT paid for the procurement of scientific research equipment both in Croatia and abroad. MSES issues certificates for the import of donated equipment for scientific research to scientific institutions. These certificates are used to claim the exemption from customs duty and VAT. An estimated HRK 52.7 million (7.2 million euros) was provided by the return of VAT between 2003 and 2005.

108. *Tax Deductions:* In the area of corporate tax deductions, income taxes are reduced for R&D activities within companies, as stipulated in the 2004 Act on Income Tax *(Official Gazette, No. 177/2004)* and in the Instructions on Income Tax (*Official Gazette, No. 95/2005).* In 2007, the new regulations on the reduction of profit tax for R&D activities in companies included in the Act on the Amendments and Supplements to the Scientific Activity and Higher Education Act (*Official Gazette, No. 46/2007).* The new regulations simplify the old regulations on profit tax and harmonize them with EU rules. Those taxpayers liable for the profit tax can lower their tax base for justifiable costs of scientific and developmental research projects according to the following rules: (i) 50 percent of justifiable costs for fundamental research; (ii) 25 percent of justifiable costs for applied research; and, (iii) 100 percent of justifiable costs for developmental research. The tax base may be changed according to the size of a company.

109. With respect to industry-science/research cooperation, several technology development programs have been launched by BICRO and HIT. These institutions have a vast array of policy instruments to foster innovation, entrepreneurship, and technology transfer. The main programs fostering public-private partnership and technology transfer are:

- Technology-Related Research and Development Program (TEST), managed by HIT and no longer in existence, aimed at supporting development and feasibility testing of pre-commercial technological projects. The program also financed research activities that link basic sciences and their technological applications, and that are relevant for industry and economic development.
- Proof-of-Concept Grant Fund (PoC), managed under the BICRO program and still operating, finances development activities to demonstrate the feasibility of a new process or technique and its potential for commercial application;
- Partnership in Basic Research aims at increasing non-governmental investment in basic research by supporting collaborative research;
- Entrepreneurial Activity Program (UKF), focusing on high technology through special science and industry cooperation, with projects initiated by the diaspora; and,
- TEHCRO for financing and maintenance of science and technology parks.

[37] Ministry of Business and Trade 2012.

110. UKF launched a program called "Research in Industry Grant," which provides a subsidy for young researchers who want to work on projects in Croatian industry.

111. There is also the objective of increasing extramural R&D by the business sector, carried out in co-operation with the public sector. In recent years, there has been strong public policy support to build technology transfer and commercialization capacities of Higher Education Institutions (HEI) and Public Research Organizations (PRO). The creation of technology transfer organizations (TTOs) and related mechanisms are facilitated through the Science and Innovation Investment Fund/ RCOP 2007- 2011 (IPA 3C, EU funds/). The instrument is structured as a grant that covers up to 85 percent of the project costs. These projects will be also targeted by the STP II.[38]

112. In 2010, BICRO, in collaboration with a group of universities, launched the PoC program, which aims to accelerate transformation of research discoveries into technology applications. [39] The program delivers funding of up to 75 percent of the total expenses, whereas the remaining 25 percent will have to be secured by the companies participating in the project, either by their own devices or via third-party sources. The PoC provides non-refundable financing to facilitate verification and protection of IPR, demonstration of practical technical feasibility, and assessments of the commercial potential of research outputs.

Innovation Infrastructure (S&T Parks and Clusters)

113. As regards S&T parks, in recent years BICRO has been actively working on TEHCRO, a government program for financing Croatian research and innovation infrastructure, including science and technology parks. The program has produced very favorable results, directly contributing to the creation of five innovation centers. In total, nine projects have been established since 2007, of which eight have been financed so far. MSES has allocated HRK22.3 million (approximately 3 million euros). A similar project, called Technology Parks, is organized by the Ministry of Economy, Labor, and Entrepreneurship (MELE). Supporting programs of the (former) Ministry of Economy, Labour, and Entrepreneurship for innovation infrastructure include the development of entrepreneurial zones, business incubation centers, development agencies, and clusters

114. Between 2004 and 2008, MELE financed six technology parks for a total of HRK1 million (approximately 148,900 euros). NZZ manages partnership instruments in basic research and allocated HRK8.61 million (approximately 1.1 million euros) between 2006 and 2008. Since 2005, MELE has been supporting the project "Success through Cooperation," with the objective of creating business associations geared towards producing products with higher value-added. Such "clusters" have been formed using both bottom-up and top-down approaches. In addition, the MSES has recently made efforts to promote regional clusters within Western Balkan countries.

[38] Moreover, there are several projects within the FP6 and FP7 framework called SME Associations, where research and technology organizations transfer knowledge to SMEs that already include participants from Croatia (Brodarski Institute as the research technology organization, and Doking, Pewa, Emergo and Damko as participants from the business sector).

[39] This initiative was launched in cooperation with the Technology Transfer Office at the University of Zagreb, Science and Technology Park (StePRi) at the University of Rijeka, Technology Park Varaždin, Tera Tehnopolis, and Regional Development Agency Međimurje (REDEA).

Box 2: The Science and Innovation Investment Fund (SIIF)

Science and Innovation Investment Fund (SIIF) is the program funded by two EU RCOP projects and implemented by the Ministry of Science, Education and Sports: SIIF grant-scheme and Technical Assistance to SIIF.

The SIIF grant-scheme project was launched in 2009 with an overall budget of € 5 million. The grant-scheme covers nearly all possible activities on the area of technology transfer. In terms of beneficiaries, the call for proposals is limited to higher educational institutions (HEI) and public research organizations (PRO).

Technical Assistance to SIIF was launched in 2010 with the goal to help SIIF in project pipe-line building through trainings and advisory services for project applicants, providing on-going help for grantees during the implementation period of the projects. New Call (SIIF 2) was launched in 2011 with an overall budget of €7 million.

115. Information Services and Technology networks: The Croatian Institute for Technology (HIT) was established to become the pivotal institution in Croatian technology networks. In this role, it was undertaking forecasting programs that seek to envisage future technology demand, including demand for R&D investments.[40] Since HIT was merged with BICRO in 2012 (forming the Business Innovation Agency of Republic of Croatia), this task is now within BICRO's responsibilities.

116. Steps have been taken to improve information on technology projects by the scientific community and information on industry-science collaboration opportunities. Among these initiatives are the following: (i) MSES has established a database with business registers (Register of the capital equipment; 30,000 euros or more); and, (ii) under the Science and Innovation Investment Fund (SIIF), an IPA 3C funded program, the University of Zagreb, Rudjer Boskovic Institute, and the University of Rijeka have initiated a technology mapping project in order to develop a public database to enable the business sector to obtain better insight into the service capabilities of the academic community.[41]

Technology Transfer and Innovation Supportive Infrastructure

117. In 2010, Croatia had:

- Six technology parks, including parks in Zagreb, Varaždin and Čakovec;
- Six transfer technology centers (Center of Technology Transfer Zagreb, Technology Development Center Osijek, Technology Innovation Center Rijeka, Technology Center Split, Research and Development Center for Mari culture and Technology Transfer Office in Split) with a surface area of 11,651 m^2 and 76 entrepreneurs who employed 284 people;
- Thirty-two entrepreneurial centers; and,
- Twenty-nine business incubators (with a surface area of 301,374 m^2 and 426 entrepreneurs who employed 1,473 people).

118. Between 2004 and 2009, MELE co-financed the construction and development of 293 enterprise zones which, according to the data submitted by the local self-governing units, occupied around 8,000 hectares and had approximately 1,800 active entrepreneurs employing 31,000 people.

[40] The Croatia Science and Technology Project (2005-2011); and Science and Innovation Investment Fund, a EU (IPA 3C)-funded program for the development of technology transfer services within Croatian public HEI and PROs and enhancement of cooperation between academia and business (MSES).
[41] http://ipainno.irb.hr/en.html.

119. Cluster development has been strongly emphasized in recent programs. The few clusters that exist in Croatia are the result of local initiatives, and do not stem from a comprehensive national strategy for the development of science-industry linkages. In 2006, MELE supported the development of 18 clusters in six sectors with the participation of 401 businesses (760,000 euros). For many years, MELE has been cooperating with the German Technical Cooperation Association (GTZ) on projects related to SMEs. One of the most important projects was a training program for cluster managers that began in 2005. A major task of cluster development is the provision of education for efficacious cluster management.

120. ICT infrastructure is a core element in support of innovation, technology transfer, and, more broadly, firm competitiveness. Croatia has made good progress in the field of information society services and media, and has achieved a high level of alignment with the *acquis* in this area. Additional efforts are needed to sustain the liberalization of all segments of electronic communications markets, to further facilitate the development of an information society, and to promote competition in the broadcasting market and the independence of public service broadcasters.

121. Amendments to the Electronic Communications Act were adopted in July 2011, aimed at aligning the electronic communications reform package with the EU. Market analysis procedures and regulations are well advanced. Preparations in the area of *information society services* are also well advanced. Croatia plays an active role in many related EU initiatives. An *electronic business council* was established to provide private sector input into government policies. A national structure to monitor and implement national actions relating to the European Digital Agenda is being developed. Good progress can be reported in the field of *audiovisual policy*. A new Croatian Radio and Television Act was adopted in December 2010, in line with EU state aid rules. By-laws implementing the Electronic Media Act have been adopted by the Electronic Media Council. Amendments to the Media Act and to the Electronic Media Act, aimed at ensuring transparency of ownership in the media, were adopted in July 2011.

5. EU PROGRAMS, EUROPEAN RESEARCH AREA (ERA), AND INTERNATIONAL COLLABORATION

122. Croatia has signed more than 200 bilateral agreements in the area of science and research in the last 10 years. While being the candidate country to the EU, Croatia was eligible to participate in several EU programs and received funding supporting the development of its research and innovation capacity building. The most important support came from the Pre-Accession Instrument (IPA) 2007-2013, particularly Component II, which provides funding in preparation of the use of the Structural Funds.

123. The European Council granted the status of candidate country to Croatia in June 2004 and accession negotiations were opened in October 2005. The first negotiation chapter to open and provisionally close was on research and science. This was also the beginning of the more fundamental reforms in Croatia for science, research, and technological development. As candidate country, Croatia was associated to the Seventh EU research and development program (FP7), which meant that the research entities from Croatia could participate on the same footing as Member States. Croatia has done rather well under FP7, reaching an average success rate of 17.5 percent between 2006 and 2013, compared to the EU-27 success rate of 20 percent. Cooperation under FP7 is not only a source for funding but also a mean for knowledge transfer, integration into EU networks, and contributions to the EU's scientific excellence base.

124. Croatia actively participated in, and benefited from, the FP7 WBC INCO.NET, a project aiming at enhancing the integration of the WBCs in the European Research Area. The SMEPASS project is another example of a EU co-funded program aimed at improving the market competitiveness of SMEs in Croatia by providing practical, professional support to Croatia's small and medium-sized businesses via marketing and product development, quality control, and quality management.

125. Croatia's integration into ERA and the European Higher Education Area (EHEA) is a strategic aim of the entire research and education policy in Croatia, and one of the national priorities related to technological development and transition to a knowledge economy. Further development of the national policy on research and innovation has significantly intensified since June 2006, when the accession negotiations on science and research (chapter 25) were successfully concluded and the chapter provisionally closed. Croatia became also an observer in the European Research Area Committee (ERAC, formerly called CREST), which allowed it to follow closely and become familiar with the EU policy and targets on research and innovation. The impact of Croatia's participation in the EU framework programs should not been underestimated in terms of the country's overall objective of strengthening its national research and innovation capacity building.

126. Consequently, MSES supported actively the participation of Croatia in FP7 by organizing "Info Days" and promotion events, and giving financial support to the Croatian institutes that were successful in EU projects. In 2007, the National Commission for Monitoring Framework Programs drafted the Action Plan to strengthen the absorptive capacity of Croatian scientific organizations for FP7 in the period 2008-2013. One of the most important measures was related to the inclusion of Croatia into the EU Technology Platforms and Joint Technology Initiatives, since Croatia was participating in only one technology platform, the European Construction Technology Platform.

127. Among the candidate countries in all FP7 grant agreements, Croatia ranked second in both participation and budget share (Tables 1 and 2 in the Annex). Among candidate countries, Croatia ranked fourth in terms of applicant success rate and third in EC financial contribution success rate. The applicant success rate of 17.7 percent is similar to the average candidate country applicant success rate of 17.9 percent. As of March 2011, 998 eligible proposals had been submitted in response to 248 FP7 calls for proposals, involving 1,238 applicants from Croatia (20.09 percent of candidate countries).[42] As a result of multilateral agreements, Croatia is a member of the European Molecular Biology Organization (EMBO) and the Conference and European Center for Medium-Range Weather Forecasts. It is also engaged in the European Organization for Nuclear Research. Croatia has had a long tradition of participation in COST, EUREKA and CEEPUS programs. Croatia has been a full member of COST since 1992. It has participated in the EUREKA program since 2000 and had the most successful EUREKA projects in 2006. Among 14 countries, Croatia won both EUREKA program awards for 2006, the Lillehammer Award for the best research-technological project in the field of environmental protection technology, and the Lynx Award for a fast-growing small- or medium-size company.[43] Croatia also participates in other European initiatives, such as the Southeast Europe-European Research Area-Network (SEE-ERA-NET) project, aimed at the integration of the countries of Southeastern Europe into ERA. Other programs in which Croatia participates

[42] As of March 2011, Croatia participated in 132 signed grant agreements involving 2,113 participants, of which 164 (7.76 percent) were from Croatia. They benefited from 511.80 million euros of EC financial contribution, of which 27.47 million euros (5.37 percent) were dedicated to participants from Croatia.

[43] Croatia joined the CEEPUS program in Vienna on January 22, 1995, at the First Ministers' Conference of Member States, and at the Ministers' Conference held in Ljubljana in February 2006, Croatia assumed the presidency of CEEPUS.

include the Central European Initiative (CEI), the Alps-Adriatic Task Force, and the Adriatic-Ionian Initiative, EUMSTAT (meteorological satellites).

128. International cooperation in higher education encompasses inter-university cooperation, intergovernmental cooperation, and cooperation on the basis of various programs, namely Erasmus (Lifelong Learning Program), Erasmus Mundus, Marie Currie (FP7), and CEEPUS. MSES funded over 500 months of scholarships per year for incoming student exchanges on the basis of bilateral agreements and operational programs of cooperation concluded between the Croatian government and 44 other countries. MSES also funds over 100 months of scholarships for teaching staff under the CEEPUS program.

6. CONCLUSIONS

129. Croatia has made significant progress in recent years in the area of RDI. Spurred in part by the pending accession to the EU, its leaders have taken advantage of EU resources to effect major reforms in the legislative environment, design policies and strategies to promote the creation of a knowledge-based economy, establish a governance structure to better oversee and prioritize the system, and create agencies designed to promote and shepherd the transfer of research ideas to market.

130. Croatia's recognition of the need for a systemic approach to RDI, pro-active high-quality leadership, and commitment to the development of well-designed strategies vetted with all relevant stakeholders within and outside government has brought outside financial support, further leveraging the reform effort.

131. Challenges remain. Recent accession to the EU should not permit a lessening in the efforts to create a more technologically modern and innovative private sector. Rather, membership should be a pivot point for increased efforts. Three key challenges are outstanding:

- An increase in the level of expenditures for RDI, which should come to 3 percent of GDP. This increase, as well as the efficiency and effectiveness of the investments, must become an overarching goal as the country becomes an even closer partner of, and competitor with, the most advanced and dynamic economies in the world. Each year that Croatia lags behind the R&D investment efforts of other nations, the more the current gap is compounded. R&D cannot be seen as just another government program sponsored by one ministry in competition with other budget demands. Rather, it should be acknowledges as a critical investment for economic growth, jobs, and higher standard of living.
- Intensified efforts are needed to stimulate RDI by the private sector. Government pronouncements and advisory councils are insufficient if obstacles to entrepreneurs are not fully understood and addressed. Improvements regarding fiscal and tax policies, information exchanges, technology transfer programs, training efforts, small targeted seed money investments, confidence building exercise among officials, academics, and business people, public communications campaigns, etc. can all play a role in encouraging domestic business talent to expand and accelerate momentum for a Croatian knowledge- based economy.
- Human capital building is critical, requiring efforts to promote science and technology education in the country, keep the expensively educated talent within the country. At the same time it is

necessary to intensify efforts to incorporate diaspora talent by promoting modern research infrastructure, challenging career prospects, and attractive remuneration.

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ANNEX

Table A 1: Statistical Profile of Croatia

	CROATIA	WBC	EU-27
ECONOMY & BUSINESS ENVIRONMENT			
GDP (2010)	€44,893 M	€15,523 M	€12,279,401 M
GDP per Capita (2011)	€10,500	€4,454	€23,400
Population (2011)	4,407,000	22,832,917	502,404,702
Exports to GDP ratio (2010)	18.9	19.2%[44]	-
Imports to GDP ratio (2010)	32.7	40.3%[45]	-
Trade to GDP ratio (2010)	51.6	60.5%[46]	-
Net Foreign Direct Investment, % GDP (2011)	1.97 (inflows)	4.92 (inflows)	2.86 (outflows)
HUMAN CAPITAL AND RESEARCH & DEVELOPMENT (R&D)			
Gross Domestic Expenditure on R&D, % GDP (2009)	0.74	0.33	2.03
Percentage of R&D Expenditures performed by the Private Sector (2010)	38.8	-	53.9
Researchers[47] per Million population (2010)	1,615	787[48]	3,166[49]
Doctorate students in S&T–as share of the population aged 20-29 (Eurostat).	0.26 (2011)	-	0.30 (2007)
Percentage Labor Force Employed in Science & Technology	30.9	-	42.3
University-Industry Collaboration Rank 2012 (of 144 countries)[50]	77	88[51]	40[52]
TECHNOLOGY TRANSFER & INFRASTRUCTURE			
Percentage of Firms Using Technology Licensed from Foreign Companies (2007, Enterprise Survey)	16.5	25.7	-
Percentage of Enterprises with Internationally Recognized Quality Certification (2009, Enterprise Survey)	30.1	19.3[53]	-
Royalties & License Fees Payments, % GDP (2011)	0.41	0.23[54]	0.58
Royalties & License Fees Receipts, % GDP (2011)	0.04	0.09[55]	0.42
Internet Users per 100 People (2011)	59.6	54[56]	72
Mobile Cellular Subscriptions per 100 People (2011)	116	106	125
Intellectual Property Protection Ranking 2012 (of 144 countries)[57]	76	95[58]	40[59]
S&T OUTPUTS AND INNOVATION PERFORMANCE			
Utility Patents Filed in the US per Million Population (2009)	7.5	2.8[60]	117
Scientific & Technical Journal Articles per Million Population (2009)	16.9	125[61]	496
High-technology Exports, % Manufactured Exports (2010)	3	4.3[62]	15.3
Global Innovation Index Rank 2012 (of 125 countries)[63]	72	60[64]	24[65]
Trademark Applications per Million Population (2010)	1,034	1,832[66]	130[67]

Note: If not indicated otherwise, indicators are from World Development Indicators (see footnotes). "-": Not available.

[44] Excluding Kosovo (This designation is without prejudice to positions on status, and is in line with UNSC 1244 and the ICJ Opinion on the Kosovo Declaration of Independence.)

[45] Ibid

[46] Ibid

[47] Full-time equivalents – one person-year for example 30% time spent on R&D would count as 0.3 FTE.

[48] Average of UNESCO's data on Albania, Bosnia & Herzegovina, Croatia, Macedonia, and Serbia.

[49] World Bank calculations

[50] Global Competitiveness Report 2012.

[51] Average of Global Competitiveness Report ranks for Albania, Bosnia, Croatia, FYR Macedonia, Montenegro, and Serbia.

[52] Average of Global Competitiveness Report data on EU 27 countries

[53] Average of Enterprise Survey data on Albania, Bosnia, Croatia, Kosovo, FYR Macedonia, Montenegro, and Serbia.

[54] Average of World Development Indicators data on Albania, Bosnia, Croatia, Macedonia and Serbia.

[55] Average of World Development Indicators data on Albania, Bosnia, Croatia, Macedonia and Serbia.

[56] Average of World Development Indicators data on internet users per 100 people in Albania, Bosnia & Herzegovina, Croatia, FYR Macedonia, Montenegro, and Serbia.

[57] Global Competitiveness Report 2012.

[58] Average of Global Competitiveness Report ranks for Albania, Bosnia, Croatia, FYR Macedonia, Montenegro, and Serbia.

[59] Average of ranks of the EU 27

[60] Average of USPTO data on Albania, Croatia, Macedonia, and Serbia.

[61] Average of World Development Indicators data on Albania, Bosnia, Croatia, Kosovo, Macedonia, Montenegro and Serbia.

[62] Average of World Development Indicators' available data for Albania, Bosnia and Herzegovina, and Croatia for 2010.

[63] GII 2012 (INSEAD and WIPO).

[64] Average of ranks of 6 Western Balkan countries – Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro and Serbia.

[65] Average of ranks of the EU 27.

[66] World Intellectual Property Organization.

[67] Total trademark applications per million population in the EU 27 from World Development Indicators.

Table 2: Croatia - Most Active FP7 Research Priority Areas by Number of Applicants for Research Projects

FP7 priority area	No. of applicants	Requested EC contribution by applicants (M euro)	No. of main-listed applicants	Success Rate (applicants)	Requested EC contribution by mainlisted applicants (M euro)	Success Rate (requested EC contribution)
Research for the benefit of SMEs	174	19.05	46	26.44 %	4.41	23.14 %
ICT	136	30.77	12	8.82 %	1.50	4.88 %
Research Potential	107	118.36	11	10.28 %	7.44	6.29 %
Marie-Curie Actions	106	n/a	24	22.64 %	n/a	n/a
Food, Agriculture and Fisheries, and Biotech.	95	15.31	14	14.74 %	1.41	9.22 %
Environment (including Climate Change)	93	16.40	18	19.35 %	2.29	13.96 %

Table A 2: Croatia - Most Active FP7 Research Priority Areas by EC Contribution Granted to Research Projects

FP7 Priority Area	Number of grant holders	% of all HR grant holders	EC contribution (EUR million)	% of total EC contribution to HR
Research Potential	11	6.71%	7.44	27.10 %
Transport (including Aeronautics)	18	10.98%	4.49	16.34 %
Research for the benefit of SMEs	26	15.85%	2.19	7.99 %
Energy	13	7.93%	2.03	7.39 %
Environment (including Climate	14	8.54%	1.65	6.01 %
Health	6	3.66%	1.45	5.26 %

Table A 3: Croatia - Most Active Organizations in Terms of EC Contribution Granted to FP7 research Projects

Legal Name	Number of Participations	% of all HR grant holders	EC contribution (M euro)	% of total EC contribution to HR grant holders
Ruder Boskovic Institute (Rbi)	11	6.71%	2.99	10.90%
Rijeka University, Medical Faculty	3	1.83%	2.94	10.70%
Zagreb University, Electrotech. Faculty	7	4.27%	1.53	5.58%
Zagreb Cityholding Ltd (Cistoca)	2	1.22%	1.09	3.97%
Zagreb University, Textile-Technical Faculty	2	1.22%	0.96	3.49%