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OECD Reviews of Innovation Policy: Croatia 2013

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Foreword

The OECD Review of Croatia's Innovation Policy is part of a series of OECD country reviews of innovation policy.* It was carried out in the framework of the Investment Compact for South East Europe by the OECD Directorate for Science, Technology and Industry (DSTI) – in co-operation with the OECD Investment Compact for South East Europe (SEE), Global Relations Secretariat, (GRS, OECD) – under the auspices of the Committee for Scientific and Technological Policy (CSTP).

The review draws on the results of a series of interviews with major stakeholders of Croatia's innovation system and a background report prepared for the OECD Investment Compact (with the support of the European Union) by Margarita Kalamova, Sarah Perret (both OECD Investment Compact for SEE, GRS, OECD) and Domagoj Racic (consultant to the OECD; Mreza Znanja, Croatia), with input from Barbara Ambrus (consultant to the OECD), under the direction of Alan Paic (Head of OECD Investment Compact for SEE, GRS). The Background Report draws, among others, on consultations with stakeholders of the Croatian innovation system through focus groups and surveys. Domagoj Racic arranged the interviews during fact-finding missions in Croatia, and supported the OECD review team later in the process.

The purpose of this review is to obtain a comprehensive understanding of the key elements, relationships and dynamics that drive Croatia's innovation system and the opportunities to enhance it through government policy. More specifically, the review:

- Provides an independent and comparative assessment of the overall performance of Croatia's innovation system.
- Recommends where improvements can be made within the system.
- Formulates recommendations on how government policies can contribute to such improvements, drawing on the experience of other OECD countries and evidence on innovation processes, systems and policies.

The review is intended to be relevant to a wide range of stakeholders in Croatia, including government officials, entrepreneurs and researchers as well as the general public. It also aims to use the OECD as a communication platform to provide an accessible and comprehensive presentation of the Croatian innovation system and policy to a global audience. Emerging results of the review were presented to the Meeting of the Regional Competitiveness Initiative (RCI) Steering Committee in March 2013. A draft version of the Overall Assessment and Recommendations was presented for a peer review to the Working Party for Innovation and Technology Policy (TIP) of the CSTP in June 2013.

* *www.oecd.org/sti/innovation/reviews*

This report was drafted by Dimitrios Pontikakis (Country Studies and Outlook Division [CSO], DSTI, OECD) and Fritz Ohler (consultant to the OECD; Managing Director, Technopolis, Austria) drawing on the Background Report, under the supervision of and with contributions from Gernot Hutschenreiter (Head, Country Innovation Policy Reviews, CSO, DSTI, OECD). Fernando Galindo-Rueda and Helène Dernis (both Economic Analysis and Statistics Division [EAS], DSTI, OECD) and Daniel Kupka, working at DSTI at the time of his contribution, provided valuable input.

The review owes much to the support and co-operation of Croatian government officials, in particular Kristina Ferara-Blaskovic (Head of Sector, Ministry of Science, Education and Sports), succeeding Hrvoje Mestric (Ministry of Science, Education and Sports, now BICRO), as well as Ivo Radkovic (Head of Sector, Ministry of Economy), supported by Darinka Vedrina (Ministry of Economy). The report has benefited from comments or additional information received from numerous stakeholders in Croatia, distinguished experts in the field including Zoran Aralica (Institute of Economics, Croatia), Martin Bell (Science Policy Research Unit, University of Sussex, United Kingdom), Georgios Chorafakis (University of Cambridge, now European Research Council, Belgium), Slavo Radosevic (UCL School of Slavonic and East European Studies, United Kingdom), Elisabeth Hagen, Hermine Vidovic and Mario Holzner (Vienna Institute for International Economic Studies – wiiw, Austria), and the TIP peer review – in particular Ian Hughes (Forfás – National Policy Advisory Board for Enterprise, Trade, Science, Technology and Innovation, Ireland) and Armin Mahr (Federal Ministry of Science and Research, Austria) who acted as peer reviewers.

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Abbreviations and acronyms

AAGR	Average Annual Growth Rate
AMPEU	Croatian Agency for Mobility and EU Programmes
ASHE	Agency for Science and Higher Education
AVETAE	Agency for Vocational Education and Training and Adult Education
BERD	Business Expenditures for Research and Development
BICRO	Business Innovation Centre of Croatia
CARDS	Community Assistance for Reconstruction, Development and Stabilisation
CBS	Croatian Bureau of Statistics
CCA	Croatian Competition Agency
CEFTA	Central European Free Trade Agreement
CERN	European Organization for Nuclear Research
CESHE	Committee for Ethics in Science and Higher Education
CHFRC	Committee for Hosting Foreign Researchers
CIS	Community Innovation Survey
CRANE	Croatian Business Angel Network
CTT	Centre of Technology Transfer, Zagreb
CMR	Committee for the Mobility of Researchers
CSF	Croatian Science Foundation
EACEA	The Education, Audiovisual and Culture Executive Agency
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EEN	Enterprise Europe Network
EFTA	European Free Trade Association
EIF	European Investment Fund
EIS	European Innovation Scoreboard
ELI	Extreme Light Infrastructure
EMBO	European Molecular Biology Organization
ENIC/NARIC	European Network of Information Centres/National Academic Recognition Information Centres
ENT	Ericsson Nikola Tesla d.d.

ENQA	European Association for Quality Assurance in Higher Education
EPO	European Patent Office
ERA	European Research Area
ERC	European Research Council
ESCC	Education, Science and Culture Committee
ESF	European Science Foundation
ESFRI	European Strategy Forum on Research Infrastructures
ESS	European Social Survey
ETF	European Training Foundation
EU	European Union
EUA	European University Association
EUR	Euros
EUREKA	Raising the Competitiveness of European Business through Technology
FDI	Foreign Direct Investment
FP	Framework Programme
FTE	Full Time Equivalent
GBAORD	Government Budget Appropriations or Outlays for R&D
GDP	Gross Domestic Product
GERD	Gross Expenditures for Research and Development
GOVERD	Governmental Intramural Expenditures for Research and Development
HAMAG-INVEST	Croatian Agency for Small and Medium Sized Enterprises and Investment
HBOR	Croatian Bank for Reconstruction and Development
HEI	Higher Education Institution(s)
HERD	Higher Education Expenditures for Research and Development
HHI	Herfindahl-Hirschman Index
HIT	Croatian Institute of Technology
HITRA	Croatian Programme for Innovative Technological Development
HRK	Croatian Kuna
HRST	Human Resources in Science and Technology
HRZZ	*Hrvatska zaklada za znanost* (see CSF)
ICT	Information and Communication Technologies
IDA	Industrial Development Authority, Ireland
IMF	International Monetary Fund
INA	*Industrija nafte d.d.* (Croatian oil company)
IPA	Instrument for Pre-accession Assistance

IPR	Intellectual Property Rights
IRCRO	R&D Services for Companies
ISCED	International Standard Classification of Education
ISC	International Scientific Council
ISI	Thomson Reuters Web of Knowledge
ISIC	International Standard Industrial Classification of All Economic Activities
ISO	International Organization for Standardization
ISVU	Higher Education Institutions Information System
IUS	Innovation Union Scoreboard
JAPTI	Public Agency for Entrepreneurship and Foreign Investments, Slovenia
JPO	Japan Patent Office
KONCRO	Business competitiveness upgrading programme
LSAHE	Law on Scientific Activities and Higher Education
MARIBIC	Technology and Business Innovation Centre for Mariculture
MELE	Ministry of Economy, Labour and Entrepreneurship
MNE	Multinational Enterprise
MoE	Ministry of Economy
MoEC	Ministry of Entrepreneurship and Crafts
MOMSP	Ministry of Crafts and Small and Medium Sized Enterprises
MoST	Ministry of Science and Technology
MRDEUF	Ministry of Regional Development and EU Funds
MSES	Ministry of Science, Education and Sports
NACE	European Classification of Economic Activities *(Nomenclature des Activités Économiques dans la Communauté Européenne)*
NCC	National Competitiveness Council
NCHE	National Council for Higher Education
NCIS	National Council for the Information Society
NCS	National Council for Science
NDA	Non-disclosure agreement
NIS	National System of Innovation
NSC	National Scientific Council
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
OHIM	The Office for Harmonization in the Internal Market
PCT	Patent Cooperation Treaty
PhD	Doctor of Philosophy

PoC	Proof of Concept programme
PISA	Programme for International Student Assessment
PMR	Product Market Regulation
PPP/PPS	Purchasing Power Parity/Purchasing Power Standard
PRO/PRI	Public Research Organisation / Institute
RAZUM	Development of knowledge-based firms, academic spin-offs
RAE	Research Assessment Exercise
RBI	Ruđer Bošković Institute
RCA	Revealed Comparative Advantage
RDI	Research, Development and Innovation
R&D	Research and Development
SBA	Small Business Act
SEECEL	South East European Centre for Entrepreneurial Learning
S&E	Science and Engineering
S&T	Science and Technology
SF	Structural Funds
SHEFC	Science and Higher Education Funding Council
SIPO	State Intellectual Property Office
SME	Small and Medium-sized Enterprise
STI	Science, technology and innovation
STeP Ri	Science and Technology Park of the University of Rijeka
STP	World Bank's Science and Technology Project
SVEZNATE	Strategic Council for Science and Technology
TCS	Technology Centre Split
TEHCRO	Technology Infrastructure Programme
TEST	Technology projects programme
TIA	Slovenian Technology Agency
TIC	Technology-Innovation Centre of Rijeka
TFP	Total Factor Productivity
TTO	Technology Transfer Office
UKF	Unity through Knowledge Fund
UNCTAD	United Nations Conference on Trade and Development
USAID	United States Agency for International Development
USD	United States Dollars
USPTO	United States Patent and Trademark Office
VENCRO	Venture Capital Industry

VET	Vocational Education and Training
VNIS	National Innovation System Council
WIPO	World Intellectual Property Organization

Country codes

AUT	Austria	**GBR**	United Kingdom	**MLT**	Malta
BEL	Belgium	**GRC**	Greece	**NLD**	Netherlands
BGR	Bulgaria	**HRV**	Croatia	**NOR**	Norway
CAN	Canada	**HUN**	Hungary	**POL**	Poland
CHE	Switzerland	**IRL**	Ireland	**PRT**	Portugal
CHN	People's Republic of China	**ISL**	Iceland	**ROU**	Romania
CZE	Czech Republic	**ISR**	Israel	**SVK**	Slovak Republic
DEU	Germany	**ITA**	Italy	**SVN**	Slovenia
DNK	Denmark	**JPN**	Japan	**SWE**	Sweden
ESP	Spain	**KOR**	Korea	**TUR**	Turkey
EST	Estonia	**LTU**	Lithuania	**USA**	United States
FIN	Finland	**LUX**	Luxembourg		
FRA	France	**LVA**	Latvia		

Executive summary

Croatia's innovation achievements and challenges

- Croatia has achieved much since independence. A successful transition to an open, market-based economy and institutional reform underpinned fairly strong pre-crisis growth and convergence and culminated in Croatia's accession to the European Union (EU).
- The financial and economic crisis has exposed structural weaknesses of Croatia's economy and its pre-crisis growth model. To achieve sustainable income and employment growth and strengthen international competitiveness, Croatia needs to become more innovative.
- Croatia does not yet have a mature innovation system with a core of highly innovative businesses as a driver. R&D expenditure is low at 0.8% of GDP, compared to 2% in the European Union and 2.4% in the OECD area. Moreover it has been stagnating during the last decade – in sharp contrast to many emerging economies.
- Croatia compares well in Southeast Europe, but lags in innovation performance against comparable EU members. It nevertheless has some of the prerequisites for building a stronger innovation system, including a comparatively well-educated population (especially in terms of secondary education).

EU integration provides a unique window of opportunity for strengthening science, technology and innovation (STI)

- Integration to the EU offers new perspectives for Croatia's development. Access to EU markets provides many opportunities for businesses; more vigorous competition on domestic markets will benefit consumers and increase pressure on firms to innovate. The outcome of the new opportunities and challenges for Croatian firms will critically depend on their innovation capabilities, however.
- Substantially increased and more stable funding for STI through the Structural Funds (SF), together with Horizon 2020 and other sources, offers a unique opportunity to expand – and rebalance –Croatia's innovation system. However, in the absence of effective institutions and governance, absorption and impact are likely to fall short of expectations. It is critical to enhance national capabilities to provide orientation and develop, co-ordinate and deliver STI policy.

Improve governance and rebalance the innovation policy mix

- So far, governance of Croatia's innovation policy has been characterised by lack of co-ordination and continuity. Low commitment has contributed to low levels and high volatility of R&D funding and has hampered long-term orientations as regards human resources, and investment in innovation.
- Effective innovation policy requires commitment at the highest level of government and better co-ordination across its various parts and levels. Some countries have achieved better co-ordination through an innovation council headed by the prime minister.
- Croatia could benefit from further consolidating overlapping competencies and delegating programming/implementation more fully to the agency level (e.g. BICRO, CSF). Fostering professional agencies with operational autonomy and larger portfolios helps enhancing their effectiveness and efficiency.
- Strengthening innovation capacity calls for carefully designed policy instruments and for reforms in governance and funding mechanisms. To enable learning there is a pressing need to develop an evaluation culture at all levels – from individual researchers and projects, through institutions and policies, to the innovation system.

Foster business innovation

- Business expenditure for R&D has been declining – a trend that has to be reversed. Innovative firms seem to have lacked the inclination, resources and in-house capabilities needed to progress towards new-to-the-market and new-to-the-world innovation.
- Policy for business innovation has been focused on the commercialisation of public research and on high-technology firms. However, innovation, in its diverse forms, is relevant to all businesses. Croatia should base its policy on a broad concept of innovation, to include – in addition to R&D – marketing, organisational, and service innovation. Raising the share of innovative firms and their capabilities should be a priority and be reflected in the innovation policy mix.
- A key task is to strengthen companies' in-house skills in engineering, design, information technology and R&D. There is still much scope in improving the framework conditions for innovation and in leveraging other government policies (such as regulation and public procurement) to raise demand for innovation.
- Public financial support for business innovation (including tax incentives) has been relatively low. Necessary increases should happen alongside the professionalisation of delivery, the use of differentiated instruments and rigorous evaluation.
- Funding is not always the main constraint. Professionalised government agencies – together with business associations – can help in providing information, coaching, and in building communities that link parts of the innovation system.

Strengthen the contribution of universities and public research institutes (PRIs)

- Universities and PRIs are an important part of Croatia's innovation system and the productivity of researchers is rather high. While improving, scientific publications have a low citation impact, and the research system could benefit from further internationalisation.
- Public research has been held back by limited resources *and* complex and inflexible organisation and governance. Fragmentation within universities and between PRIs is a hindrance to effective governance and top performance. Public research funding is insufficiently linked to performance.
- A thorough reform, including the introduction of negotiated performance-based budgeting, would set the basis for entrusting universities and PRIs with more funds, based on improved strategy, autonomy *cum* accountability, and set in motion a virtuous cycle of increasing performance and resources.
- Competitive research funding has been low and volatile. A sufficiently empowered CSF could shift the balance towards competitive funding, and consequently reinforce scientific rigour, encourage internationalisation and social relevance.
- Alignment of universities and industry can be facilitated by systematic consultation on skills and curricula, schemes that encourage industry co-funding of tertiary education, tailored university study programmes for those already in employment, longer and more selective work placements, and a greater quantity and quality of professional tertiary programmes. Gainful international mobility should be a priority.

Use the Structural Funds strategically

- The SF should be used to build capacities and provide a step change in the resources available for innovation (support for skill upgrading, business innovation projects and related equipment, etc.) and to improve the institutional setting for applied research and industry-science collaboration.
- A strategic move towards larger, longer-term programmes would help secure commitment from industry and facilitate a coherent upgrading of both business and public R&D capacities. Among others, this would allow the gradual expansion of doctoral education and post-doctoral research, the establishment of "competence centres" (organised as public-private partnerships), and investment in research infrastructures (provided that they are embedded in long-term research programmes).

Overall assessment and recommendations

Introduction

In the aftermath of independence, Croatia underwent a period of reconstruction and institutional transformation. It has made much progress since, moving successfully to a market-based economy that has become closely integrated into the European and global economy through international trade and cross-border flows of investment and knowledge. Over an extended period, Croatia's solid economic growth resulted in partial convergence to the average European level of income. While it still has considerable room for improvement, Croatia's accession to the European Union can be seen as the culmination of a reform effort aimed, among other things, at facilitating investment, strengthening competition and reducing bureaucracy, and implementing the *acquis communautaire*.

The financial and economic crisis that started in 2008 revealed – even more sharply than in other countries – a number of structural weaknesses and vulnerabilities in the Croatian economy that had gone unnoticed during the period of relatively robust growth. In the years since, evidence that Croatia's erstwhile growth model may not provide a sound basis for the future has been mounting and has highlighted the need to reposition the country's economic growth and development on a more sustainable path. Boosting innovation throughout the Croatian economy and society should be an important element of a strategy for sustainable growth and rising living standards. International experience demonstrates that improved innovation performance is critical for raising productivity and thus strengthening international competitiveness in various sectors of the economy. Innovation is critical for large firms, which tend to be exposed to vigorous international competition in domestic and international markets. It helps small and medium-sized enterprises (SMEs) to modernise their production processes and management practices and find profitable product niches that allow them to be competitive and expand their markets. An innovation-friendly environment and infrastructure contributes to improving a country's attractiveness for investment and fosters structural change towards higher value-added activities. Innovation in the public sector helps provide citizens with better quality services at affordable cost.

Croatia already possesses a number of the prerequisites – relatively high levels of human capital (especially in terms of secondary education attainment, while numbers of tertiary graduates are low), some strong scientific institutions and a fledgling community of innovative start-ups – for improving innovation performance and developing an innovation system that could be a pillar of economic growth and socioeconomic development. However, it does not currently have a mature innovation system built around a highly innovative business sector core. Moreover, innovation policy in the past focused on cutting-edge, research and development (R&D)-driven innovation and on instruments aimed to strengthen the commercialisation of science. The progress made towards developing and interconnecting the elements of its innovation system has not yet resulted in broad-based economic benefits.

Achieving these benefits will hinge on tangible improvements in the framework conditions for innovation, including the regulatory environment, and further improving the human resource base and skills. It will also depend on efforts in all of the major parts of Croatia's innovation system and on developing linkages between them. These efforts include: fostering innovation in the business sector by providing the infrastructure and incentives to increase the capacity to engage in innovation (which for the majority of firms will first entail the accumulation of design, engineering, marketing and information technology capabilities and in more advanced contexts R&D) primarily in-house and, to the extent possible, in co-operation with other firms and research institutions; increasing the contribution of universities and public research institutes (PRIs) to the performance of the innovation system, including through improved steering and funding mechanisms; and improving the overall governance of science, technology and innovation (STI) policy. However, these efforts will have the desired impact only if they are designed and implemented efficiently and coherently.

The accession to the European Union (EU) offers Croatia new perspectives for the country's future economic and social development. It is clear, nonetheless, that in addition to these opportunities, full integration will also create important challenges that will have to be dealt with proactively by all actors in the economy and the wider innovation system. Notably, while Croatian enterprises will get full access to European markets, they will also face stiffer competition, especially in markets and industries that have not so far been fully exposed to international competition. This is likely to affect industries ranging from agro-food to engineering-based businesses linked to public procurement. Through changes in the external trade regime, EU accession may also result in higher barriers to some traditional markets, including in the western Balkan region. Moreover, international competition is likely to become fiercer with the further rise of a range of (newly) emerging economies and the partial reorientation of Croatian trade away from South Eastern Europe and towards the more competitive EU markets.

Boosting the international competitiveness of business firms is therefore essential. It will require a more forceful, sustained effort to improve innovation performance than Croatia has yet made in order to develop a strong, business-centred, sufficiently performing innovation system. Accession to the EU will also provide Croatia with a unique window of opportunity, including access to substantial amounts of funds for science, technology and innovation, most importantly through the EU Structural Funds (SF), and full participation in European programmes for research, technology and innovation. Finally, accession requires Croatia to adopt European standards and regulations. This will profoundly change the legal and regulatory environment that shapes framework conditions for innovation and can create an opportunity to spur innovation.

However, as in other areas, the availability of new funds and frameworks does not automatically translate into a commensurate improvement in STI performance or a qualitative change in the innovation system. International experience shows that, if insufficiently prepared, countries may have difficulty absorbing the additional funds and may put them to less than optimal use. Making productive use of significant extra funds is a demanding task and calls for good preparation in terms of strategic orientation and institutions. Experience from the use of SF for innovation in other new EU member states suggests that, among others, it is important to build adequate project planning and management capabilities in advance, to adequately involve innovation policy makers and implementation agencies, put in place effective evaluation mechanisms, and stimulate competition to improve the quality of proposals for investment.

In sum, Croatia will need a step change in the priority given to R&D and innovation in all its forms – and the resources devoted to it – to strengthen its competitiveness and move towards more innovation-driven growth. The increase in the resources available for innovation needs to be linked to greater efficiency in the administration of public funding. This in turn requires improved governance and the development of a culture of rigorous and transparent evaluation.

The purpose of this review is to identify both major opportunities and the principal bottlenecks that prevent the actors in the Croatian innovation system from realising their potential and to help them to respond adequately to and benefit from the newly emerging opportunities. The innovation potential is partly constrained by factors outside the remit of STI policy (such as the macroeconomic environment and other framework conditions). This review, however, focuses on how STI policy can make Croatia's innovation system more efficient and thus improve the country's competitiveness and overall economic performance. Mindful of Croatia's specific national context and drawing on the rich experience and good policy practices of OECD countries, this review outlines some guiding principles and provides specific policy recommendations.

Achievements and challenges: Progress on innovation capacity building has not yet yielded the expected results

During the 1990s, the Croatian economy demonstrated a pronounced tendency towards convergence with the average EU income level, with a brief interruption in 1998-99. In the decade preceding the global financial and economic crisis, gross domestic product (GDP) per capita doubled. Income per capita, which was 50% of the EU27 average in 2000, reached 64% of the EU average in 2008 in PPP (purchasing power parities). Underpinning these achievements was increased openness to international trade and investment, the liberalisation of sectors dominated by state-owned enterprises, and a number of regulatory reforms, though it remains a matter of debate whether the transition could have been carried out in ways that would have better maintained industrial and innovation capabilities. Market liberalisation was accompanied by the establishment of independent regulatory agencies. The last decade has also seen the gradual introduction of policy initiatives in support of STI, inspired mainly by the experience of EU countries. Their positive impact is reflected in observable, if modest, improvements on some innovation indicators, including indicators of scientific output, impact and internationalisation and, to a lesser extent, patenting. However, many of the country's achievements do not appear remarkable when compared with those of other former transition economies of similar size and income per capita.

The global financial and economic crisis brought the process of convergence to an abrupt end. After a sharp drop in GDP of nearly 7%, Croatia's economy has not returned to sustained growth, and was in recession again in 2012. Unemployment has reached high levels. Given the current macroeconomic environment, prospects remain subdued. Even if the period between 2000 and 2008 is included, growth has been slower than what might have been expected, and below that of other emerging European economies. Recent developments have cast doubt on whether the previous growth model, which was credit-fuelled to a significant extent, will enable Croatia to achieve high sustainable growth in the future. There is evidence that its GDP growth was mainly driven by capital accumulation. It was much less due to growth of total factor productivity (TFP), which indicates increases in the efficiency of production. Labour productivity growth has also been rather low by international standards, even before the crisis.

Stronger innovation performance will be an important part of a Croatian strategy for a transition to a trajectory of high, sustainable growth and better living standards for its population. It is fair to say that Croatia does not currently have a mature innovation system, although some elements of such a system and pockets of excellence are in place or emerging. Its innovation system remains small in both absolute and relative terms. Gross expenditure for R&D (GERD) has been stagnating, and this funding shortfall has affected the employment of researchers. Both public and private R&D budgets were particularly affected by the crisis; in fact, Croatia was one of the least resilient countries in Europe in this respect. Moreover, in a longer-term perspective, aggregate research intensity – the ratio of GERD to GDP – declined over the last decade. The magnitude of this decline is exceptional by international standards and contrasts strongly with progress made by many countries, including emerging economies. The decline in R&D intensity is also suggestive of an absence of structural change towards knowledge-intensive sectors that would create employment opportunities for the highly skilled.

While the propensity of companies in Croatia to engage in innovation seems broadly in line with countries of similar income per capita, innovation outcomes appear low compared to other countries and in relation to the resources devoted to innovation. Technological and scientific output has relatively low impact as measured by patent and article citations. The above-average productivity of Croatian scientists and their relative cost effectiveness are the positive exceptions in a system that is operating considerably below potential.

Given the rather small contribution of TFP to economic growth, the Croatian economy has not yet benefited significantly from its incipient national innovation system, which is characterised as much by pronounced resource constraints and considerable volatility as by a weak governance record and suboptimal funding arrangements, accompanied by unsystematic monitoring and evaluation. It is therefore not enough simply to address resource constraints, although a steady allocation of sufficient funding would be necessary to enhance the innovation system.

Main strengths and weaknesses of the Croatian innovation system

History and geography have given Croatia certain strengths and conditioned its development trajectory. Overall, and until relatively recently, the institutional framework did not facilitate market-oriented innovation. Capabilities in the business sector have tended to decline over time and the country's current industrial strengths are mostly those of the twentieth century. The country's geography and the prospects opened by joining the EU, while they offer many opportunities, may also carry risks, some of which appear not to have been fully appreciated and adequately dealt with in advance.

Main strengths

- *Croatia has a well-educated population, especially in terms of secondary education.* The share of the adult population having completed upper secondary education is above the EU27 average. The country has a tradition of learning and scholarship, with pronounced strengths in the sciences, law and the humanities. It possesses a diverse portfolio of higher education institutions catering to a large array of regional and sectoral education niches. Both universities (the University of Zagreb features in global rankings of leading universities) and PRIs (notably the Rudjer Boskovic Institute) have pockets of research excellence. Recent years have also seen an increase in scientific publications and an improvement in the

impact of scientific output. There are indications that Croatian scientists are more productive than scientists in many comparable countries and are relatively cost-efficient.

- *Croatian firms possess export strengths in a range of industries and there is also a small number of relatively strong R&D performers.* Relatively strong R&D performance, notably in pharmaceuticals and electrical and electronic equipment, including information and communication technology (ICT), has attracted the interest of multinational enterprises and led to restructuring in the wake of mergers and acquisitions. "Greenfield investment", instead, has been largely absent, thereby limiting a potentially important source of industrial renewal. Even the "large" R&D performers are small by international standards.
- *A community of innovation-oriented start-ups and established enterprises can be found among the country's SMEs*, sometimes in specialised niches where they have developed significant competences and some export strengths, especially to south-eastern Europe.
- *A privileged geographic location* on the Adriatic coast and at the crossroads of central and south-eastern Europe, as well as historical links with several OECD and emerging economies. These advantages have contributed to inward foreign direct investment (FDI), a small part of which is in knowledge-intensive or R&D-performing sectors. Overall, these inflows have been smaller than in comparable countries. Joining the EU will further open the Croatian economy to international trade and investment and will create opportunities for increased international knowledge flows which should be seized. Croatia will also participate in EU programmes for research, development and innovation on an equal footing.

Main weaknesses

- *Weak macroeconomic performance in the wake of the financial and economic crisis.* The crisis laid bare structural weaknesses that had gone unnoticed. Croatia's gap in per capita income is partly due to lagging labour productivity *vis-à-vis* the European or OECD averages. This suggests the need to focus on enhancing productivity, most importantly through broad-based improvement in the innovation performance of Croatian companies.
- *Inadequate framework conditions for innovation owing to an incomplete reform process.* There is still much room for improvement in the regulation of product markets, investment (facilitation of firm entry and exit), and labour markets (labour force participation and turnover). Despite progress, bureaucratic red tape remains burdensome, with delays and difficulties in obtaining licences and in contracting utilities, and there is considerable ground to cover to adopt and implement EU regulations. Corruption continues to be an important barrier to innovation.
- *Weak innovation capabilities in the business sector.* Business R&D expenditures are exceptionally low by international standards, even after accounting for differences in industrial structure. Inputs to innovation and the associated human resources and physical infrastructure lag comparable countries. Low levels of innovation and research activity translate into weak in-house capabilities and absorptive capacity, an important obstacle to collaboration with universities and other knowledge providers. Yet, Croatia has some dynamic SMEs that benefit

from R&D and from non-R&D-driven forms of innovation such as organisational and marketing innovation. Businesses in some knowledge-intensive industries depend on public procurement and are likely to face more vigorous competition in the future. Relative export unit values – the value of exports per unit of quantity, which, under certain conditions can be interpreted as an indicator of product quality – suggest that the competitiveness of Croatian exports continues to be based on cost rather than quality, which is associated with investments in human capital and innovation.

- *A skills profile that is unfavourable to innovation in the business sector*. Business innovation capability depends crucially on specialised skills in design, engineering, marketing and information technology, among others, and on the innovation demands and activities that the presence of such skills generates in firms. International evidence suggests that it is largely firms themselves that create such capabilities in the course of their activities. Yet, businesses based in Croatia lag internationally, even compared to other countries in the region, in terms of investment and participation in formal firm training. Moreover, Croatia lags comparable countries in terms of the share of employment accounted for by knowledge-intensive sectors, the rate of employment of tertiary-educated and their share in total employment, as well as the employment of ICT specialists. Evidence from the latest Community Innovation Survey (2008-10) and a more recent OECD survey (conducted in 2012) suggests that lack of qualified personnel is a significant barrier to innovation in Croatian companies. The education system does not appear to address this weakness, and Croatia lags comparable countries in terms of participation in adult education. Past studies have also highlighted mismatches between industry demand and education system supply. The mismatches include entrepreneurship skills as well as a range of science, engineering and mathematics disciplines, given the bias towards the social sciences and the humanities among Croatian tertiary education graduates. There are some indications that the share of professionally oriented tertiary graduates and of secondary-level vocational graduates may be insufficient. Internationally comparable student assessments of the quality of science and mathematics education place Croatia below similar countries and the EU average. This can be a cause for particular concern as cross-country evidence suggests that the quality of science and mathematics education is a predictor of long-run technological dynamism.

- *Weaknesses in the organisation and governance of universities and PRIs*. Current university management structures, in which each faculty is a separate legal entity, make institution-wide strategic planning almost impossible and potentially hinder even routine activities such as monitoring and evaluation. Croatian universities and PRIs are difficult to steer, as the "locus of control" is not the top management but committees composed of second-level managers and representatives of academic staff. This mode of governance or management tends to support reciprocal behaviour and structural dependencies and thus to prohibit the adaptations in internal organisation, priorities and incentives that are required to build strong, high-performing universities. Past attempts by the Croatian government to reform the higher education sector have met with strong resistance and were abandoned. PRIs are also fragmented but in a different way; the fragmentation is between rather than within organisations. This fragmentation may have prevented large-scale, long-term projects and is confirmed by the low level of capital investment and the modest expansion of the last decade.

- *Failure to adapt international policy practices sufficiently to national settings*. In the last two decades, Croatia has set up many programmes and instruments to foster STI. Their choice and design were often influenced by developments in advanced innovation systems. The past decade has been characterised by a predominance of instruments to transfer technology between academia and industry, including through technology parks and incubators, public-private partnerships, etc. While this has been useful in particular contexts, an excessive orientation towards R&D-intensive modes of innovation and technology transfer may not fit the primary needs of an emerging innovation system such as Croatia's, notably if it is not accompanied by systematic support for broad accumulation of innovation capacity, especially in the business sector.
- *An inadequate division of labour between the government and the agency level*. While government ministries have delegated a number of programmes and measures to institutions such as the Croatian Business Innovation Agency (BICRO) and the Croatian Science Foundation (CSF), they have kept others within their own organisation and responsibility. This arrangement has been unsatisfactory from various perspectives: separation prohibits pooling and the creation of critical mass in terms of stability, managerial capacity and intelligence at both the policy and agency levels. It also hinders economies of scale and scope. In addition, the smaller the number of programmes and measures, the lower the readiness to change the portfolio, as the various parts of the administration tend to protect "their" programmes.
- *A lack of trust* has pervasive consequences as it prevents inventors from seeking the needed investment for commercialisation, central government from delegating responsibilities, university-industry collaboration and investment in innovation, and may influence the government's choice and design of support instruments. The problem is compounded by a lack of transparency in public dealings, weak monitoring and evaluation of government-financed schemes, and lack of feedback once schemes have been completed. Confidence in the system will inevitably be a reflection of its long-term success, but greater transparency, better monitoring and evaluation, and community-building schemes that cut across ministerial/departmental and institutional boundaries would be steps in the right direction.
- *A lack of sustained political commitment to matters of innovation*, finally, is one of the most important constraints. Practically all of the important "success stories" about countries catching up to become major players in innovation (from Korea to Finland) were backed by strong, sustained political commitment. The lack of high-level political commitment is at the root of several problems for the Croatian innovation system: the proliferation of plans and policies without adequate endowment, councils that are not operational, the lack of policy continuity and strategic outlook, the limited resources devoted to R&D and innovation in general, the extraordinary vulnerability of STI budgets, the success of special interests in resisting change, inefficient governance arrangements, and the difficulty of co-ordinating policy and implementing needed complementary changes in other parts of the innovation system. This contributes to a "credibility gap" between the promise of innovation for economic growth and development (based on theory and international experience) and what many in the country believe can be achieved in Croatia. The problem is probably not unrelated to the general lack of trust mentioned above.

Opportunities and threats

- *The use of EU Structural Funds and greater use of national funds* provide an unprecedented opportunity to upgrade innovation capabilities across the Croatian innovation system. In the absence of the positive feedback processes characteristic of successful innovation systems, a sustained initial stimulus is usually required to kick-start a virtuous circle. The absorption of EU Structural Funds (SF) and further mobilisation of Framework Programme (FP) funds could help provide that stimulus but would generally aim at capacity building (SF) and precompetitive R&D (FP). National public funds, especially when they leverage private R&D investment, may complement the European funding "push" e.g. in providing support for near-to-market innovation and commercialisation. Such support should be strategic and conditional on strict criteria of quality.
- *Nurturing the development of a dynamic business sector that thrives on innovation.* Full access to EU markets presents opportunities for expanding exports, including in high value-added sectors, if the business sector develops the innovation capabilities to sustain a path of productivity, quality improvement and thus international competitiveness. Government policy can help by supporting better utilisation of Croatia's labour pool and comprehensive upgrading of skills that are relevant to industry. Improvements in framework conditions for innovation and in the institutional and material infrastructure that will support a dynamic innovation system can also contribute. Nurturing innovative, export-oriented firms may also require initiatives to lower costs of entry to and transactions in international markets, as well as a supporting regulatory environment and information and logistical infrastructure.
- *Increasing the contribution of public research to social and economic development*. Croatia's public research – both universities and PRIs – has the potential to contribute more to the country's socioeconomic development. The binding constraints are not simply the volume of funding but also the organisational, governance and management practices, incentives and perceptions that prevail in the public research sector, which are in many respects not well suited to this effort. A shift towards performance-related governance and results-based management models may facilitate a paradigm shift. EU Structural Funds could contribute significantly to the implementation of such models owing both to the substantial amount of funding and to fact that their rather long duration provides a stable environment for (institutional) learning.
- *Use of sectoral policies to foster innovation in the relevant sectors (such as energy, transport and agriculture)*. Clusters and mission-oriented PRIs typically have a strong sectoral orientation. At the same time Croatia has been establishing and strengthening specialised agencies (in areas such as water, energy, environment and food) in charge of supervising and implementing regulations. Collaboration by the different actors can provide substantial leverage for performing research and for designing and launching related support services, training and consulting.

At the same time, the Croatian innovation system faces a number of *threats*:

- Volatility of the international macroeconomic environment, including in Croatia's European neighbourhood.

- *Failure to prepare for increased competition following EU accession.* Fiercer international competition may threaten the viability of previously sheltered or less exposed industries. Croatian firms participating in the Central European Free Trade Agreement (CEFTA) area may have difficulty shifting from regional markets to the EU market. In particular, reinforced specialisation in sectors with adverse terms of trade over the long term and limited opportunities for innovation and productivity improvements must be avoided.
- *Failure to generate a tangible economic impact from increased investment in STI.* In the absence of adequate institutional reform and preparation, a sudden increase in resources devoted to innovation (primarily from EU Structural Funds, but also from other sources) may not be accompanied by a proportionate increase in outputs or meaningful impacts on the Croatian economy.
- *Increasing bias towards rent-seeking activities*. Large amounts of Structural Funds may reinforce tendencies towards redistributive "rent-seeking" entrepreneurship, objective of which is to maximise the appropriation of the funding windfall rather than the accumulation of productive and innovative capabilities. The risk would be heightened by a lack of economic dynamism and by difficulties in identifying profitable opportunities for investment.

Scope for improving innovation policy

In Croatia, market-oriented innovation policy is a relatively recent undertaking. Some key actors, supporting processes and institutions have had to be created. Specialised government institutions or agencies, such as the Croatian Business Innovation Agency (BICRO), the Croatian Science Foundation (CSF) and the Agency for Science and Higher Education (ASHE), address important innovation system functions, from implementation and delivery of public research programmes and support for business innovation to evaluation of research and quality assurance. These intermediary organisations have already experimented with a variety of support instruments and amassed considerable context-specific experience. The institutional framework for innovation has potentially been strengthened by the establishment of the Agency for Vocational Education and Training and Adult Education and the Agency for Mobility and EU Programmes, as well as by efforts to upgrade the role of the State Intellectual Property Office.

While substantial progress has been made in overall policy capacity building, particularly through the set-up of specialised agencies, there remains considerable room for improvement in the orientation, planning, implementation as well as in the monitoring and evaluation of innovation policy.

- *Policy orientation.* The overall orientation of innovation policy should be in line with the current stage of development and the specific challenges it poses. Non-R&D-driven forms of innovation, including services and marketing innovation, may be more relevant in an emerging innovation system. This will change over time as capacities are accumulated. Priority setting needs to become a routine practice. Striking an appropriate balance between pragmatism and ambition, and allowing this balance to evolve over time, will be crucial. Cross-sectoral co-ordination will be of utmost importance and will require co-ordination of and balance among stakeholders.

- *Planning, implementation, policy advice.* Improved planning is only possible when policy is informed by past experience and performance. This implies that actors (agencies) specialised in policy implementation need to have sufficient opportunity to accumulate the necessary experience. In this context, the continuity, scope and operational independence of intermediary organisations such as BICRO, CSF or ASHE are crucial to a successful Croatian innovation policy. This implies abandoning some past practices. While various new agencies and councils have been established in recent years, functional specialisation and range of action have remained limited. New policies, plans and strategies often lack sufficient resources to implement them. In some cases, the creation of auxiliary organisations (such as incubators, etc.) has not been accompanied by reform of the institutions they serve, notably higher education institutions (HEIs) and PRIs.
- *Steering in the public research system*. The main obstacles to the adoption and implementation by HEIs and PRIs of broader, longer-term strategies relate to: the presence of separate funding streams based on different rationales for salaries, consumables and investment, which results in a lack of budget flexibility; within HEIs, a largely fragmented governance system with a high degree of decentralisation and autonomy; in PRIs, a mode of governance that leads to suboptimal interaction with relevant environments, including the scientific and business communities. At the level of institutions, governance should foster a better alignment of national and institutional planning.
- *Funding of public research*. Overall, funding of public research and public support for innovation in the business sector seem too low to have a meaningful impact. Future funding policy needs to address the following challenges:
  - *Establishing strong and explicit relationships between project funding and institutional funding in the HEI and PRI sectors, supported by performance contracts*. PRIs' performance contracts should explicitly relate institutional funding to income from project-based funding (grants) and to income from research contracts and related services. This also applies to HEIs, taking due account of their educational functions. The main challenge is to reward both past performance and a coherent strategic vision for the future.
  - *Establishing strong and explicit relationships between SF funding and funding from national sources*. Linking SF funding and funding from national sources has a potentially high impact as it combines the funding with changes in major parts of the performing sector and the governance system. It will require new structures in the HEI and PRI system that link critical elements and support interaction. A major focus should be skills provision, including training young researchers in close relationship with the business sector. Another important focus is the funding of (regional) development agencies that provide hands-on services, with a focus on SMEs ("clusters"). Still another is institutional learning, including by agencies, as they implement the various programmes.
- *Monitoring and evaluation*. Formal monitoring arrangements are underdeveloped, feedback is poor, and evaluation at the level of programmes and support measures is not standard practice. The SF programmes and related projects will give an opportunity to establish a rigorous evaluation culture. This will enable learning as

a result of the accumulation and use of own capacities and of engagement with domestic and foreign experts that feed back into decision making. Another notable direction is linking effective *ex ante* evaluations to the negotiation of performance contracts. For instance, the Czech Republic used a combination of *ex ante* evaluation and negotiation of performance contracts to save EUR 200 million out of EUR 1.6 billion, which was then used to fund additional projects. Overall, the preparation and implementation of SF programmes and projects calls for the development of a range of policy intelligence functions (orientation, planning, monitoring, evaluation) that should be a starting point for developing and implementing a more advanced overall evaluation system.

Strategic tasks and guiding principles

The development of the Croatian innovation system is still at a relatively early stage. The role of innovation policy will vary as the system evolves. Innovation policy should therefore set its sights on goals that are both relevant to current stage of development and adequately anticipate the next.

The key strategic policy tasks will be to:

- *Strengthen political commitment, responsibility, continuity and co-ordination.* Political commitment is a fundamental precondition for meaningful innovation policy co-ordination. Over the past ten years, political commitment has been insufficient in terms both of budget share and reliability. Decisive steps will have to be taken to stabilise public funding for innovation and ensure continuity beyond the budgetary and electoral cycle. A clearer division of labour between the central government and independent agencies, coupled with stronger governance arrangements for inter-ministerial and inter-agency co-ordination, preferably with the involvement of the highest political level, will be central to successful implementation.

  Facilitate mobilisation of resources and the build-up of innovation capabilities in the business sector. Increasing the resources for innovation should be a primary aim of innovation policy. In particular, strengthening innovation capabilities in the business sector should be a priority. There is great potential for using EU instruments (SF, FP) to leverage business funding of innovation. At the same time, realistic goals should be set, as progress will take time. The policy approach should be in line with the business sector's current needs rather than directly transferred from advanced innovation systems. Inevitably, this will require a variety of more direct and better-funded support measures. The build-up of business innovation capabilities will also require policy initiatives that go beyond innovation policy, including strategic planning in industrial and education policy.

- *Enhance the contribution of universities and PRIs by ensuring effective governance.* Improvements in the governance, evaluation and accountability of organisations, individual research performers and policy instruments should go hand in hand with increasing resources. Performance-based budgeting has proved to be an effective approach.

Guiding principles

- *Leadership and commitment to leading to stability and predictability of framework conditions and resources.* This ensures that innovation actors in the business and the public research sectors are in a position to plan investments adequately. International experience demonstrates that this is essential for the success of innovation policy.
- *Effective governance arrangements and feedback.* Focus on effective strategic and operational functions, using evaluation and feedback mechanisms to inform successive rounds of decision making, based on a strong evidence base.
- *Effective co-ordination*. Improvements in framework conditions for innovation as well as dedicated policy measures for STI often cut across policy areas and require (horizontal and vertical) co-ordination. Co-ordination requires effective communication across organisations and institutional sectors as well as effective monitoring and evaluation of contributions. Broad stakeholder involvement in policy decisions and more interaction within the policy-making community will be needed.
- *A broad concept of innovation,* including non-R&D-driven types of innovation. This both allows and requires tighter, more systematic collaboration between generic innovation policy and sectoral policies, on the one hand, and use of regulation as a vehicle for innovation, on the other.
- *Setting the bar at the international level.* Placing the innovation system in an international perspective (e.g. through international peer review and the HEIs and firms' export ambitions) could lead to improved performance in the innovation system in terms of efficiency, quality and economic impact. Increased international openness and orientation can encourage competitiveness in firms and excellence in scientific research.
- *Performance orientation*. In order to raise the performance of the Croatian innovation system it is necessary to relate funding to long-term goals, targeted actors and related achievements. This includes the implementation of performance-based budgeting in HEIs and PRIs and contractual relationships between the government and its agencies, on the one hand, and a high degree of managerial autonomy, on the other hand.
- *Ambition, prioritisation and realism.* The country's ambitions should be tempered by a realistic assessment of existing capabilities and requirements for implementing change, including the time horizons involved. It is often difficult to change quickly, and the most important changes must be a priority. A long-term strategic outlook that evolves progressively but remains mindful of the system's current challenges will need to be adopted.

Recommendations

Improving framework conditions for innovation

Croatia enjoyed a stable macroeconomic environment during the years preceding the global financial and economic crisis, with solid growth, contained inflation and stable exchange rates. Economic growth was achieved in the face of adverse demographic trends, relatively high unemployment and low labour force participation. The crisis and

its aftermath had a negative impact on an already unfavourable trade balance and public finances have come under stress. Moderate gains in labour productivity were mostly due to capital deepening; the contribution of overall efficiency in the use of factors of production was minimal.

While Croatia is a relatively open economy, with trade and FDI increasing over the last decade, these remain below the levels of comparable economies. The competitive pressures faced by companies across sectors, which can provide a powerful incentive to innovate, are uneven. Although there is evidence that the degree of industrial concentration has decreased over the past decade, pockets of high concentration persist, especially in sectors in which the government had or maintains important stakes. Concentration has increased in some industries that have attracted the entry of multinational enterprises (such as computers and related services, manufacture of tobacco products and retail). The establishment of the Croatian Competition Agency and its recent extension of powers represent important steps in securing and maintaining a level field.

Businesses' access to finance for innovation is mixed. While a variety of arrangements meet a relatively wide array of needs, many smaller companies still find it hard to secure funding owing to strict technical regulations and the need for collateral. As in other countries, there is little capital available for risky investments. Overall, while the legal and regulatory environment has improved somewhat in recent years, important constraints remain, including a still burdensome bureaucracy and a less favourable tax regime than in the average OECD country. A lack of trust is an important issue, including in the effectiveness of legal institutions.

- *Establish and maintain a favourable macroeconomic environment* and fiscal sustainability, while fostering investment in science, technology and innovation.
- *Continue the process of reform*, shifting emphasis from the nominal requirements of compliance with the *acquis communautaire* to the measureable impact of regulatory changes in facilitating investment and the functioning of markets. The prevailing macroeconomic environment and the need to improve competitiveness call for continued reform even after accession to the EU.
- *Link the adoption of EU regulations with corresponding support measures* to facilitate their timely and effective adoption by the business sector and to trigger the adoption of a stream of associated or complementary organisational and process innovations. Such measures will require closer co-operation between relevant ministries and BICRO.
- *Identify and address any aspects of the framework conditions that reduce the attractiveness of R&D and innovation investments in Croatia,* including the administrative burden faced by companies, obstacles to SMEs' access to finance, and facilitate the funding of risky investments. In this respect, it may be useful to introduce an innovation dimension in the criteria of ex ante and ex post regulatory impact assessment.
- *Foster public-sector innovation, including through greater use of ICT in the delivery of public services,* with the set-up and modernisation of information platforms for STI policy, as well as process and organisational innovations.
- *Place emphasis in public-sector reform on transparency and on reducing the incidence, potential and perception of corruption.* Although Croatia has made

notable efforts recently, there are indications that corruption is an important constraint for smaller businesses.

- *Strengthen competition and ensure that a level playing field is maintained over time, thereby putting in place strong incentives to innovate.*

Strengthening the human resource base for innovation

The Croatian workforce is relatively well qualified but its skills profile may limit its innovation potential. Compared to the EU and countries with similar income per capita, Croatia has few students and graduates in mathematics, science and engineering, low share of tertiary educated workforce, low rate of employment among tertiary graduates and one of the lowest levels of on-the-job training and lifelong learning. Croatian companies report a lack of qualified personnel in the workforce as an important constraint on innovation. Lack of qualification often refers not only to formally acquired competences but also to past experience with innovation and its economic appropriation. A community of consultants or associated services to support businesses in innovation projects is not widely available.

Croatia is above the EU average in terms of the share of young population receiving secondary education. However, Croatian secondary students score behind comparable countries in mathematics and science in the OECD's PISA surveys, indicators which correlate with technological innovation performance across countries. Education in universities is insufficiently aligned with the needs of the labour market. This is evident in the structure of graduates by discipline (particularly the strong weight of the social sciences), and the fact that industry and local community organisations do not appear to be involved in curriculum setting.

Businesses often report a lack of so-called "soft" skills in management, marketing, entrepreneurship and intellectual property law. Traditional strengths in social sciences, law and humanities could be drawn on if the social relevance of education, training and research in universities and PRIs is reinforced. They could be mobilised to facilitate innovation in service and marketing innovation and to support sectoral innovation strategies, including in tourism. In addition, existing capacities in the social sciences, law and humanities could facilitate the training of human resources to improve companies' capacity to appropriate knowledge.

Multinational enterprises (MNEs) value locally trained researchers and appear willing to extend privately funded PhD opportunities. However, industry-oriented PhDs are not very popular with students, and industrial relevance is sometimes seen as a distraction from formal evaluation credentials, such as scientific publications. Changes may be needed in the academic incentive structure, with a detailed examination of non-academic career paths for researchers.

There are also indications of bottlenecks in the transfer of knowledge from abroad, as suggested by the low levels of inward and outward mobility of researchers and the low incidence of international co-publication relative to comparable countries.

Policy attention is also warranted to identify present and future skills needs of relevance to innovation in general and to the innovation capacities of the business sector in particular and to manage study programmes accordingly. The focus over the past decade on researchers, the scientific diaspora and other cutting-edge skills – important as these are – would need to be complemented by attention to a wider range of specialised, occupation-oriented skills. This should first be the subject of a comprehensive study;

next, formal mechanisms should be established to identify skills needs and to strengthen and expand the alignment of skills supply.

Available evidence point to the need to strengthen (non-academic) professional education at the tertiary and master's levels, areas that seem especially weak relative to comparable countries and are important for strengthening innovation capabilities in general and in the business sector in particular. The stronger presence of private education providers in the supply of this education in polytechnics constitutes a strong signal that there is a gap.

An important aspect of this effort will be the transfer of expertise, possibly by pairing with leading tertiary vocational education providers from abroad (e.g. Germany, United States, Ireland) in developing and delivering professional undergraduate programmes and academic master's programmes. Ireland's experience with using SF to develop its highly successful and respected institutes of technology may be a useful guide. In addition to improving the quality of vocational and master's programmes, an association with globally prestigious providers may help improve the attractiveness of vocational education to prospective students.

- *Encourage the study of science and technology* by stimulating interest in and take-up of relevant courses and offering places in the education system, along with measures to improve the attractiveness of associated career paths. Specifically, more consideration should be given to the training needs of researchers for the business sector.
- To eliminate skills mismatches based on systematic skill gap analyses, *put in place mechanisms to encourage interaction between industry and academia on decisions regarding curricula and assessment in higher education*.
- *Provide additional avenues for upgrading the skills of those already in the workforce and increase opportunities for and awareness of lifelong learning.*
- *Facilitate entrepreneurship through the development of relevant skills.* Mobilise existing capacities in the social sciences, law and humanities to improve companies' capacity to appropriate knowledge.

Improving the governance of the innovation system

Overall governance

Governance of innovation policy in Croatia is characterised by an absence of co-ordination, piecemeal programming and lack of continuity over time. The want of sustained political commitment has translated into haphazard strategic orientation and planning, shortfalls in implementation, and, sometimes, from the viewpoint of stakeholders, insufficiently credible policy initiatives. Long-term strategic orientation and programming are hampered by the volatility of R&D budgets; in recent years, these have been on a biennial cycle of double-digit growth, followed by sharp contractions of the same magnitude. Instability of this kind has negative impacts on human resources, investment and long-term research activity. Similarly, policy measures are not adequately prioritised and endowed with resources and do not achieve their full potential in terms of impact. International experience shows that much can be gained if top-level government focuses on providing an overall orientation and uses public resources to facilitate and leverage private investment in innovation in areas of strategic importance. Resource mobilisation will also hinge on changing perceptions: giving greater visibility to past

successes and emphasising their tangible economic benefits may help capture imaginations and strengthen political commitment to a long-term innovation strategy.

The public administration is currently characterised by strong compartmentalisation and uneven performance. While there has been some experience with programme design and experimentation with alternative instruments, programming remains piecemeal and is not yet part of a long-term strategy. Particular problems arise from incomplete "agencification" (some programmes and measures are managed by agencies, others by the ministries), an imbalance in policies, strategies and plans and their resources, ineffective governance of the largely fragmented HEI and PRI sectors, and rather weakly developed policy intelligence (monitoring, evaluation) in terms of reach and quality. However, there are clear signs of improvement in the gradual delegation of management of programmes to agencies and the example of ASHE, which appears to meet European standards and act as an anchor in the higher education system.

Responsibility for STI policy is shared by three ministries: the Ministry of Science, Education and Sports (MSES), the Ministry of Economy (MoE) and the Ministry of Entrepreneurship and Crafts (MoEC). MSES is the most prominent government body in STI matters; it is primarily responsible for programming, co-ordinating and monitoring science and education policies and has an important role in shaping innovation policy. For innovation policy in particular MSES shares its remit with MoE and MoEC. In anticipation of EU accession, the Ministry of Regional Development and EU Funds (MRDEUF) was established to integrate and co-ordinate the numerous EU policies and funding schemes.

The existing division of labour between the government level (in particular MSES, MoE and MoEC) and the agency level (in particular BICRO, HAMAG-INVEST and CSF) could be improved. While the central government has delegated a number of programmes and measures to operationally independent agencies, it keeps others in ministries. This halfway arrangement prohibits the creation of critical mass in terms of managerial capacity and intelligence at the agency level; with respect to the responsiveness of the policy mix, it lessens readiness to change, as people (and institutions) tend to protect "their" programmes and measures. Agencification should be accomplished by establishing meaningful and stable agency functions with the necessary operational independence and governance mechanisms. Pooling programme delivery creates better opportunities for building a larger portfolio of instruments and developing an internal specialisation and labour market.

The upcoming programming of the SF will create opportunities for introducing long-term strategies in a number of sectors. A challenge beyond the long-term orientation of the SF programmes will be tight linkage to relevant sectoral policies. Sectoral agencies (food, energy, etc.) can act as strategic partners for access to these sectors and become partners in achieving innovation policy goals.

As shown, Croatia possesses institutional actors and a record in innovation policy that can be built upon and developed to be ready for the next steps. Political commitment, leadership, realistic implementation plans, pursued vigorously and consistently over time, will be necessary.

- *Consider permanently raising innovation policy to the highest level of government*. This has been achieved in different ways in other countries, including the creation of a dedicated ministerial portfolio, the attribution of responsibility to the office of the prime minister, or the establishment of a top-level council, sometimes chaired

by the prime minister. Whatever the arrangement, it will deliver the desired results only if it is backed by strong commitment in practice.

- *Give high priority to the steady flow of sufficient funding for R&D and innovation*. This is a precondition of credibility, trust, long-term planning, and above all for a profound reform of the HEI and PRI sectors. EU membership and the new Structural Funds programming period (2014-20 plus two years extension) will create an historic opportunity that must not be missed. As there are many potential pitfalls, agenda setting, planning, institutional set-up and operational implementation are very important.
- *Establish a clearer division of responsibilities and consolidate overlapping competences of relevant ministries and the relevant, operationally independent agencies (such as BICRO and CSF)*. As a general principle, ministries should concentrate on policy making and strategic orientation and delegate execution to operationally independent agencies. The agencies should have strong and explicit relationships with the ministries, a reliable system of supervision, and operate in a situation that allows for systematic learning and improvement. Membership in international environments for learning and quality control is important. ASHE may act as a role model in a number of regards. BICRO and CSF should be extended and empowered to act as the single Croatian innovation agency and scientific research council, respectively. Adequate governance and management mechanisms must be implemented. Membership in professional organisations (TAFTIE, Science Europe) and regular external evaluations will contribute to quality assurance.
- *Give high priority to linking national support programmes with Structural Funds*. As SF allow for a high degree of flexibility while providing a stable, longer-term framework, they can be used to accomplish tasks that are critical fo*r the further development of the innovation system.* These include initiating and supporting the reform of the HEI and PRI sectors to strengthen both, and establishing a system of instruments and measures that support a broad concept of innovation (e.g. non-R&D-based innovation, innovation in services, implementation of standards and regulations as a vehicle for innovation, networking, consulting etc.). This would strengthen the tendency towards international evaluation, global relevance and international collaboration and can enhance the quality and international impact of knowledge output.

Policy mix and specific instruments

During the last decade Croatia has adopted and implemented a broad range of innovation policy instruments. For the business sector, the main instruments are clustered around BICRO and are strongly oriented towards support for technology-based start-ups, transfer centres, incubators and R&D centres, contract research with HEIs and PRIs, support for the proof-of-concept phase and for participation in EUREKA. While these instruments remain in place, consultancy for high-technology SMEs and subsidies for pre-commercial R&D have been terminated; provision of venture capital has never started. Overall, BICRO's activity is still strongly shaped by the concepts prevailing at the time of its establishment: research-based innovation, taking advantage of public-sector research, a preference for high-technology SMEs, etc. BICRO has not broadened its instruments to address challenges such as firms' absorptive capacities and a broader notion of innovation. Business support by BICRO seems to have resulted in a number of

successes (firm and employment creation, leveraging of private co-funding) despite tight resource constraints. HAMAG-INVEST is another agency that targets the business sector. It mainly provides general financial support and, more recently, consultancy services for SMEs. In recent years it increasingly uses regional development agencies or business centres as hubs for delivering its services. Innovation has been, at best, an implicit issue on HAMAG-INVEST's agenda; however, this is bound to change as a result of its forthcoming merger with BICRO. There do not seem to be any systematic attempts to co-ordinate the work of specialised agencies (energy, environment, food, etc.) with innovation policies or between these agencies and specialised PRIs, which could potentially create synergies between sectoral policies and general innovation policy.

The current tax incentives for R&D seem mostly to benefit medium-sized to larger firms, providing support for maintaining or increasing their R&D investment in Croatia. They provide much less support for smaller, less R&D-oriented firms and innovation more broadly. There may be a need to review tax incentives with a view to their opportunity cost and other potential impacts.

CSF manages a cluster of instruments addressing the higher education and the public research sectors. These instruments mainly tackle issues concerning HEIs and PRIs through grants (for research projects, training of doctoral students, brain gain, reform of higher education management, or internationalisation, including access to international research infrastructures). The number of funding schemes was reduced when CSF took over the research grant schemes from MSES.

The main issue regarding the policy mix and policy co-ordination is less one of fine-tuning of individual programmes and instruments and their co-ordination than of poor endowment. The overall funding provided to BICRO and even the funding managed through other schemes and tax incentives are exceptionally low by international standards. CSF has been far from having the resources necessary to have a profound impact on the scientific research community.

In the overall innovation policy mix, there has been a notable focus on technology transfer, incubators and academia-industry collaboration. This focus, including the implementation of various funding instruments and programmes, reflects in some respects the dominant international policy debate. The "binding constraint" in Croatia may well be a lack of actors with sufficient R&D and innovation capacities and institutional incentives to accumulate capacities (or to be rewarded with additional resources), rather than a lack of linkages or interaction between academia and business *per se* (desirable as they are). This would suggest the need to rebalance the policy mix to include instruments for overall capacity building, to bring about institutional reform that align incentives to this goal and reward performance and interventions aimed at increasing business capabilities and demand for innovation (and related services). Specifically, this would mean developing and enriching the range of funding and other support services that address innovation in the broad sense through capacity building, productivity enhancement, incremental innovation and upgrading. On the agency side, this requires an agency function that combines a portfolio of funding instruments with non-monetary support services such as consulting, coaching, information brokerage, and linking up with other policies. Competence building and stability and continuity in the agencies and their staff are key requirements for a long-term impact from funding.

- *Emphasise increasing the absorptive capacity of business enterprises, a major prerequisite for any kind of innovation.* Systematically link innovation policy measures with education and training (in particular vocational training and continuous learning) and with measures to foster the employment of highly skilled human resources.
- *Use the Structural Funds and national sources to foster capacity building and provide a step change in terms of the resources available for innovation* (human resources, infrastructures, support for business innovation, etc.).
- *Place greater emphasis on instruments that stimulate demand for innovation and innovation-related services*, including in the longer term. This implies some shifting from a predominantly supply-side, "science push" approach towards the demand side.
- In light of the pronounced decline in business expenditure on R&D, *review the relative success of all measures used so far (direct funding, tax incentives, etc.) to stimulate business R&D.*
- *Develop a better understanding of sectoral policies,* notably as regards PRIs with a sectoral specialisation (agriculture, health, energy, environment, etc.). Strategic alliances between agencies in charge of monitoring, supervising or implementing sectoral regulations and policies and specialised PRIs could provide an important opportunity. The adoption of European standards and regulations will be a major challenge – and can be used as an opportunity for innovation – over the next five to ten years.

Governance of universities and public research institutions

The current internal organisation of universities and PRIs presents obstacles to effective governance, and their funding arrangements are complex and fall short of international good practice. Moreover, the funding of universities and PRIs is fragmented. Salaries, investments and consumables are funded from different sources, based on different rationales. This is an obstacle for implementing coherent strategies and long-term planning. Moreover, because their faculties are very autonomous, the management and governance of most universities (including the largest, the University of Zagreb) are quite weak. Owing to the HEIs' and PRIs' funding patterns and inherently change-averse mode of governance, significant reforms have not been accomplished. Many of the measures and instruments introduced during the last decade have been incremental, leaving the underlying arrangements unchanged. Membership in the EU and the availability of SF resources will create opportunities to increase funding and improve the governance of public research.

The current state of fragmentation, especially in the largest, oldest and most significant universities, prevents the HEI sector from reaching its full potential and harbours risks. First, it tends to militate against "new combinations", in particular interdisciplinary approaches in education and in research. Second, as many regional (and societal) issues require a concerted interdisciplinary and multidisciplinary approach, fragmented institutional structures weaken institutions' ability to respond to regional concerns and thus to attract funding from industry. Third, the inherent limitations on the ability of the constituent units to co-ordinate efforts and programmes and to pool resources for the provision of common services leads either to redundancy or to uneven coverage (particularly when there are resource constraints) in support functions, such as

administrative, procurement, technical and student support services. An inefficient use of limited resources carries a higher opportunity cost in Croatia than in most EU countries, given that its development is at a crucial juncture. Fourth, functional fragmentation may discourage strategic planning on resources, the establishment of large research programmes, infrastructure investments, participation in major research initiatives, and more broadly, the achievement of "critical mass" in scale-critical contexts. Fifth, fragmentation is an obstacle to the development of a common mission, a sense of purpose and a clear identity. These are important for a university's ability to differentiate itself, increase its visibility, occupy a position in the national and international HEI landscape and consequently for its long-term success in an increasingly market-oriented sector. Finally, fragmentation complicates the improvement of governance through negotiated performance-based, future-oriented funding principles.

Comprehensive reform of the governance arrangements of the country's older universities seems overdue and will be essential if the universities are to fulfil their social and economic role fully. A major challenge for the government will be to negotiate a workable reform proposal with the old universities and their faculties and academies. A shared understanding of opportunities and, importantly, of the concerns that motivate the backlash against perceived "centralisation" will be essential to reach a widely accepted solution. Like all consensus-building exercises, success will hinge on a continuing dialogue and on the accumulation of trust among the various stakeholders.

Governance improvements will also require achieving a good balance in the division of responsibilities between the central government (MSES and agencies such as CSF) and the HEIs. As in other countries, the move to greater institutional autonomy has to go hand in hand with increased accountability. Typical governance instruments intended to increase accountability include monitoring of performance or outputs and the establishment of performance reporting, performance contracts or similar instruments. Such contracts increase accountability for performance without compromising the universities' intellectual independence. Such policy practices can be found in Australia, Canada, Ireland, New Zealand, the Netherlands, South Africa, the United Kingdom and the United States.

Croatia's PRI landscape is characterised by fragmentation (with the notable exception of the Rudjer Boskovic Institute). There are many organisations active in the humanities, social sciences, engineering, health and agriculture. A multiplicity of actors in a given area can be positive in that it can foster competition, diversity of approaches and independence in the provision of scientific results. However, in the absence of performance-based funding or of substantial competitive project-based funding there is little tendency to compete in terms of quality and relevance. Moreover, the fragmentation of capacities among several organisations may hinder collaboration and prevent scale-critical activities at national and international level. A move towards linking funding to performance by performance-based funding mechanisms would enable the PRIs to pursue their ambitious objectives with diversified sources of funding.

- *Strengthen universities by adapting funding arrangements according to international good practice, notably by implementing performance-based budgeting.* Performance-based budgeting should include:
  - budgetary autonomy in terms of financing personnel costs, as well as a comprehensive upgrading of their physical infrastructure and research equipment;

  - a concept of "performance" that takes due account of past achievements and plans for the future;
  - progress towards simplifying university management and consolidating governance in order to increase flexibility and responsiveness to changing demands for education, training and research.

- *Strengthen PRIs by implementing performance-based budgeting and related governance principles*. The main challenge here is to implement steering models – mainly by negotiating performance contracts – that will help strengthen public research by fostering: relationships with business firms and public institutions, mainly through more contract research and provision of related services (including training and consultancy); scientific productivity, not least through increased collaboration with the higher education sector; and international collaboration.
- *Use Structural Funds to strengthen universities and PRIs and support the reform process in terms of additional budgetary resources and improved governance.* Structural Funds provide an important opportunity to establish new research infrastructures with a well-defined research agenda, mission, target groups and governance. Ideally, these new structures should be placed in existing HEIs and PRIs with well-defined links to the wider system. Training of young researchers should have high priority.
- *Encourage individual universities to specialise in various types of links with industry*. While some universities may be better suited to cater to the needs of larger firms with their own R&D labs, others may be better able to provide services to SMEs.
- *More emphasis should be placed on measures to improve the relevance of graduates' skills,* such as the development of curricula, industrial placements and the co-funding of postgraduates. The provision of well-qualified graduates is, by far, universities' most significant impact on the innovative capabilities of Croatian firms. Training qualified personnel for research and innovation is also a very important function of PRIs.

Evaluation

Evidence on the efficiency and effectiveness of publicly funded innovation is mixed. Croatian scientists are more "productive" than their peers in comparable countries. However, Croatian scientific publications and patents receive fewer citations than those of comparable countries. Low international impact may indicate the weak relevance and quality of knowledge outputs. Making evaluation a standard practice and linking it to institutional funding will increase accountability, help to strengthen high-performing entities, and may help identify changes needed to improve performance.

In recent years, Croatia has made strides in the introduction of formal evaluation mechanisms, most notably with the establishment of the Agency for Science and Higher Education. ASHE is in charge of accreditation and quality assurance in HEIs and PRIs, as regards both education and research. Its commitment to international peer review, transparent procedures and willingness to learn from international best practices is encouraging. A tangible way of improving economic relevance is to involve industry representatives in evaluations of HEIs' education and research programmes.

When it comes to the evaluation of research and innovation programmes and support measures, however, it is fair to say that external evaluation mechanisms are still at an early stage of development. While some programmes have been formally evaluated, the practice is not systematic and the results of evaluations are not always made public. This limits stakeholder feedback and policy learning. It also represents a missed opportunity to improve the allocation of public resources. Lack of an independent actor with a programme evaluation remit prevents the accumulation of experience from a wide range of programmes.

Objectivity and independence are important, and greater use should be made of systematic measures, such as the relation between outputs and inputs, complemented by managed qualitative assessments involving panels of international evaluators. At the same time, evaluation practice needs to avoid excessive reliance on quantitative indicators.

- *Consider making the external evaluation of on-going and future programmes mandatory.* Evaluation results should be used as feedback in the policy cycle.
- *Put strong emphasis on the evaluation of institutions, their governance and management* in order to strengthen governance mechanisms and, eventually, performance.
- *Review existing evaluation arrangements to achieve a better balance in terms of the quantity and quality of research output* and more broadly the types of criteria applied.
- *Make use of the opportunities to improve the evaluation system and culture that the management of Structural Funds will provide*. The obligation to evaluate various kinds of proposals and to carry out mid-term and final evaluations can be instrumental in establishing a rigorous evaluation system that can spill over to other areas.
- *Consider employing "mixed teams" of national and international evaluators* as a way to transfer know-how on evaluation.
- *Consider creating a platform involving researchers, policy makers, and practitioners* charged with programme implementation to exchange experience with and results of evaluations.

Fostering innovation in the business sector

Croatian companies in general (and SMEs in particular) are less likely to engage in innovation than their counterparts in EU countries and, even when they do, they devote few resources to it. To some extent, the propensity of businesses to innovate systematically is constrained by characteristics of Croatia's industrial structure, such as firm size, sectoral distribution and the relatively low overall share of employment in knowledge-intensive sectors, while the share of employment in knowledge intensive market services is high. However, business-sector R&D spending is low by international standards even among countries with a similar industrial structure. The relative decline in the intensity of business-sector R&D (ratio of R&D expenditure to GDP) and the low level of business R&D expenditure (BERD) reveal a widening gap with many advanced and emerging economies. In addition, internationally comparable evidence on co-operation among companies on innovation places Croatia last among a group of similar countries. Government support to business in terms of direct R&D funding is

exceptionally small by international standards and the situation does not improve much when adding public support through tax incentives.

The two leading industries (telecommunications and pharmaceuticals) account for about a third of all business expenditure on R&D, while the rest is dispersed across various industries. (The structure of exports presents a similar picture.) "Technological productivity" as measured by the ratio of patents to BERD is low by international standards. Croatia's modest patenting record is not simply due to its small size but is also related to structural and institutional factors such as the lack of MNE headquarters, the prominence of public research in the research system (and its mode of governance), the intensity and quality of linkages between innovation system actors, and the appeal of intellectual property protection arrangements.

The combined presence of high scientific productivity and researcher cost efficiency (especially in comparison to older EU members) indicates that Croatia holds some attraction for business-funded R&D. Indeed, in terms of the R&D operations of MNEs, Croatia is comparable to other countries in the region, even if these are low by EU standards. Croatia may thus have some potential to attract further funding from abroad. This will depend, among other things, on the ability of Croatia's STI policy to nurture clusters of excellence and provide the necessary incentives (see below).

Support for business-sector innovation has centred on the interface between public research and the business sector with a view to greater collaboration between sectors and the commercialisation of public research. This focus is evident in the overall balance of instruments employed and their relative funding shares, i.e. the dominance of incubators and technology transfer, mainly from public research and higher education, to the private sector, with a focus on promising technological areas.

The STI policy debate has conceptualised the binding constraint as a *weak interface* between science and industry. The contrast between perceptions of a strong science base and the evident absence of strong economic impact may have contributed to the emergence of this view. However, Croatian performance in science lags that of comparable countries. Crucially, innovation activity and capacities in the business sector are weak in a number of dimensions. Therefore, the balance of available evidence – the quantity and quality of scientific output, the rather high share of applied research in HEIs and the weak commitments of businesses to R&D and other knowledge-intensive activities – overwhelmingly supports the view that the binding constraint is not at the interface but *at the core* of public-sector and business-sector innovation capacities. Of course policy in support of the interface between public and business research has led to desirable outcomes too; the argument made here is that the impact of these outcomes may be greater if policy attention is focused on unleashing the accumulation of innovation capabilities across the system.

Overall, support for business innovation is characterised by a strong emphasis, and perhaps over-emphasis, on R&D-based forms of innovation, and more specifically on the commercialisation of public research and support for high-technology start-ups. This science-push and frontier-focused policy approach has been useful for parts of the business sector. It has however been less attuned to the needs of the majority of business firms that are at the critical transition point between no innovation and new-to-the-firm innovation and to the innovating minority that lacks the resources and in-house capabilities (in engineering, design, marketing and information technology) needed to move to new-to-the-market and new-to-the-world innovation. This imbalance is due to the orientation of the public research system, to the presence of significant resource

constraints for boosting capacity building, to the fact that innovation policy has historically been linked to science and to the sometimes inadequate contextualisation of policy thinking and instruments transferred from abroad.

Comprehensive support for business innovation, especially for the long-term accumulation of in-house innovation capabilities in a greater number and variety of firms, will have to address businesses and their needs more directly, be better endowed, and make more extensive use of policy instruments. To give an indication of the challenge ahead, public support for business sector innovation will have to increase by at least an order of magnitude just to match the commitments of other new EU member states.

- *Increase government support for business innovation in general, while improving the policy mix and delivery of support.* Support should be widened to include non-R&D-based forms of innovation (such as organisational, marketing and services innovation) and to cover a wider range of innovation-related investments. Public support for knowledge-intensive employment (researchers, but also specialists in design, engineering, marketing and information technology), for training and education (e.g. enrolment on part-time courses at university for business staff) should be considered. Support for service innovation could be further strengthened through a sectoral focus, such as green tourism.
- *Adopt a nuanced approach that takes account of the different needs of various types of companies* (size, sector, market orientation) at various stage of their development (start-ups to mature firms). This has implications for the way support is organised and delivered (economies of scale and scope).
- *Evaluate the effectiveness of major programmes, including tax incentives for R&D,* to establish the benefits and costs of these instruments and compare them with policy alternatives. With respect to tax incentives, it would be important to seek ways to minimise risks arising from the cross-border tax planning activities of MNEs.
- *Make the innovation dimension part of all public support measures for industry, including sectoral support.* Seek synergies between support dispensed using existing instruments and the adoption of EU regulations. Consider a more creative use of funds for recurrent public procurement needs to support sectoral innovation.
- *Strengthen the ability of Croatian companies to appropriate and commercialise knowledge* from within and outside Croatia, e.g. by providing technical and material support for participation in international collaborative R&D initiatives (such as the EU Framework Programme and EUREKA).
- C*oncentrate efforts on attracting FDI in knowledge-intensive sectors.* Experience from Ireland indicates that this can bear fruit if an independent FDI-promoting agency has sufficient executive autonomy, and if there are targeted investments in skills, a comprehensive labour market and regulatory reform, integration in international markets, and the harnessing of diaspora networks.
- *Consider the introduction of measures to support inter-firm (or firm-firm) networks,* possibly with a sectoral and/or supply chain focus, to facilitate spillovers between firms capitalising on various modes of innovation.

Strengthening links in the innovation system

University-industry collaboration, as measured by public-private co-publications per million population, stands at about 50% of the EU27 average. More encouragingly, business-sector funding of higher education R&D is slightly above EU and OECD averages. MNE subsidiaries in particular appear to value the capabilities of Croatian universities and have expressed interest in co-financing more doctoral students. However, such opportunities are often perceived as incompatible with current evaluation criteria for scientists. The share of business in the financing of R&D in PRIs is low, at about 5%, or about half that of HEIs. Over the longer term, linkages may be negatively affected by a decline in the prominence of engineering, as evidenced by the evolution of its relative share in scientific publications over the last decade. Improvements in other parts of the innovation system, including in human resources, support to the business sector and general capacity building, can be expected to affect linkages and knowledge flows.

Aside from a small number of MNE subsidiaries with R&D departments, the few resources devoted to research and innovation in the majority of firms limit the potential for systematic R&D and the intensity and quality of R&D and innovation linkages. Countries in which the business sector shows weakly developed innovation capabilities and a low propensity to invest in R&D and innovation typically face the challenge of overcoming a "low-level equilibrium" with little effective demand for and supply of innovation-related services and research. In such a "locked-in" situation – observable in many countries – public research institutions and businesses do not gain experience through mutual learning and co-operation with each other. Research institutions tend to remain disconnected from the domestic economy; at best they are linked to research institutions and enterprises abroad (e.g. via European programmes). This situation is not conducive to creating the localised spillovers and positive feedback that are characteristic of economies that thrive on innovation. A major task is to devise policies that foster the required in-house capabilities and nurture this kind of dynamism.

On-going efforts to strengthen linkages and alignment with the needs of the business sector should continue. It would be important to adopt a wider definition of university-industry linkages than has been used to date, one that goes beyond joint research projects, technology transfer and spin-offs to include continuous consultation on the content of skills, the introduction of "sandwich courses" with longer (typically one year) work placements, joint workshops, industry involvement in doctoral schools, development of professional doctorates with distinct criteria for advancement and tailored HEI study programmes for those already in employment (part-time/summer courses). Innovative instruments to capitalise on the unique production and design knowledge of multinational enterprises by way of government-sponsored and HEI-led on-the-job-training schemes at the premises of multinational subsidiaries can also be explored.

- *Use the EU Structural Funds as an opportunity to establish robust, long-term collaborative research and innovation capacities*. Attention to industrial and other fields of application that serve the needs and goals of the parties involved is critical.
- *Maintain, and where possible increase, industry-oriented research at universities*. At the same time, examine possible options for the creation of complementary organisations (either independently, as part of existing PRIs or in the form of public-private partnerships) focusing on the provision of innovation services for a wider range of firms.

- *Facilitate university-industry collaboration not only on formal R&D but also in education, training and non-R&D-based innovation.* The possibility of government-sponsored schemes for on-the-job training at the premises of multinational subsidiaries can also be examined.
- *Consider using bottom-up, competitive calls* to solicit and identify promising ideas and configurations or consortia.
- *Encourage the training of researchers for the business sector* with appropriate changes in the incentives for students, including the introduction of professional doctoral programmes.
- In particular, *review evaluation mechanisms and criteria for scientists* (from training to senior posts) to encourage collaboration with industry. Evaluation criteria and methods should be appropriate to a situation in which a large of share of collaboration for innovation may involve small companies whose innovation activities do not usually lead to intellectual property rights or scientific publications.
- *Take concrete steps to strengthen the standing of disciplines that are relevant to industrial innovation* in the country's universities and public research institutes.

Fostering critical mass, excellence and relevance in public research

Croatia's HEIs and PRIs conduct research on a wide range of subjects. However, engineering, and to a lesser extent, agricultural and environmental sciences and chemistry, biochemistry and pharmacology have undergone a relative decline. In addition, their publications are characterised by a rather poor (though improving) citation impact and a small presence in the top 10%. Croatia compares unfavourably in these dimensions, including with new EU member states of similar income per capita. The quality deficit of Croatian science appears to be at least partly rooted in institutional features such as the governance of the public research system and the incentives provided by criteria for evaluating researchers' performance. The Croatian science system needs to raise its ambitions and progress beyond the "minimum" criteria for accreditation and other *ex post* quality assurance processes put in place by ASHE towards the active pursuit of excellence.

Due to the low levels of resources, a lack of continuity and a suboptimal institutional and governance structure, Croatia currently lacks the ability to steer the innovation system towards more large-scale and long-term research programmes that can lead to the creation of stable research communities. Factors that have prohibited advances in research are inflexible budgeting arrangements, highly fragmented organisation, both within HEIs and between PRIs, and the absence of substantial performance-related budgeting at institutional level.

Moreover, during the last decade, in addition to the unstable and overall low levels of resources, budgets for launching programmes have been relatively low and mainly allocated to projects at the periphery of the institutions (incubators, spin-offs, technology parks) rather than to more long-term and large-scale research programmes at the core. Accordingly, neither the government and its agencies nor the research system have gained sufficient experience in handling large, long-term investments in research, except for a few, mainly physical investments. Notably, there is no substantial experience with instruments of the kind that have been established in many countries during the last

decade, such as competence centres, doctoral schools or excellence programmes (typically with 50-150 researchers over a period of seven to twelve years). A research centre is generally a well-co-ordinated unit of a number of teams, in terms of its thematic profile and coverage, career opportunities, mobility and international exchange, and a proper balance of core activities and resources and incentives for probing new opportunities. "Critical mass" is therefore more a matter of governance, management and leadership than of mere numbers.

Competitive funding has generally been low in both absolute and relative terms and has been volatile, especially during the crisis. CSF in particular has played an insignificant role as a source of funding. Somewhat uncharacteristically for a science agency, CSF's mission has focused on maximising the economic impact of science. In countries with strong innovation systems, it is typical for science agencies to aim, above all, at fostering scientific rigour and a culture of constructive scepticism. This is generally achieved by fostering both competition at home and international collaboration. The role of CSF will be to help bring about a shift in the balance of HEI and PRI funding towards competitive funding and to support a system-wide drive to internationalise. The success of this effort, however, will also depend on factors beyond the CSF's mandate, such as meaningful reform of HEIs and PRIs and implementation of performance-based principles in the allocation of their institutional funding, correct functioning of advisory councils, and full exploitation of the opportunities created by EU membership, especially with respect to success in the FP and the European Research Council (ERC).

A gradual expansion of doctoral education, with the establishment of doctoral schools, would set the stage for a comprehensive, long-term upgrading of research capacities. In addition, the training of young researchers can be directly linked with and made dependent upon investment of Structural Funds in research infrastructures and competence centres. PhD students and post–doctoral researchers are the preferred candidates for collaborative projects funded from European programmes, in particular the follow-up to the FP, Horizon 2020. A strengthened CSF would be the natural candidate for launching the doctoral school programme.

The current balance of higher education capacities between the major urban centres and other parts of the country is in line with expressed policy commitments to lessen regional disparities. Provided good practices are adhered to in evaluation, there is no reason to suggest that geographic dispersion is incompatible with academic excellence. Regions need development agencies or equivalent functions provided by incubators, business centres, chambers of commerce, etc. However, given the scale of resources available and the importance of proximity to industrial centres for economically useful innovation, policy makers should avoid excessive dispersion of resources for technological and other innovation support infrastructure (incubators, technology parks, etc.). In the Croatian context it is unlikely that the disadvantages of a strong dispersion of resources would be outweighed by its impact on endogenous regional growth. From this perspective, some clustering of investments on technological capacities near industrial centres, ideally in locations with good international links, would appear necessary. An important function of regionally targeted measures would be to connect and integrate innovation actors from across the country to the national and European institutional framework. In many instances regional agencies would play the role of a "first-stop shop" (rather than of a "one-stop shop") by providing access to various resources and related agencies.

Against this backdrop, the following strategies and measures seem appropriate, recalling that the introduction of performance-based budgeting and greater autonomy in HEIs and PRIs are important pre-conditions for acting strategically, i.e. for taking a more focused, long-term outlook, across institutional borders.

- *Use the Structural Funds to facilitate capacity building* for skills and education, as well as research, innovation and commercialisation. Take decisive measures to strengthen administrative capacity for project planning and management.
- As a rule, *invest in research infrastructure* (including buildings) *only when they form part of coherent long-term research programmes* of wide appeal.
- *Pay special attention to establishing more application-oriented research facilities* that are jointly operated by HEIs, and PRIs and, wherever feasible, business enterprises. A jointly agreed research agenda, a clear understanding of access for users, and training of young researchers should be key elements. Negotiated performance contracts are a proven instrument for balancing different requirements and act as a supportive framework for management. In general, the main focus should be on the attributes of centres rather than on a given sector, as the latter approach may lead to the selection of inferior candidates.
- *Address the imbalance between competitive (or project-based) and institutional funding and recast the mission of CSF* to aim, above all, for scientific excellence. Its mission will only be meaningful if CSF is sufficiently empowered in terms of resources to engage in a wholesale expansion of competitive support to science while not neglecting support for its industry-oriented portfolio of measures.
- *Support Croatia's participation in and benefits derived from the FP* (Horizon 2020) and the European Research Council using awareness campaigns, mock screening of proposals and coaching.
- *Implement doctoral schools in more advanced academic contexts*. This has proven a quite powerful instrument for establishing long-term research programmes (up to 12 years), performed by PhD students and supervised by their professors and complemented by specialised training, industrial placements and international exchange programmes.
- *Avoid excessive dispersion of investments in technological capacities as more resources become available.* In addition to existing measures to foster localised economic impact, use resources across regions to better integrate regional actors into the national and European institutional fabric.

Maximising the benefits from the internationalisation of R&D and innovation

Integration in international scientific and innovation networks and technologically advanced production chains is fundamental to the quality and impact of R&D and innovation, especially for a small country. Croatia has – on various accounts – made progress in the internationalisation of its innovation system over the last decade. However, it remains less internationalised than one would expect given its size, geographic location, and links to the EU. The low levels of personnel mobility from and to Croatia are a key concern as cross-border mobility is an important channel of international knowledge transfer. While the R&D activities of subsidiaries of MNEs in Croatia are comparable to those in other countries in the region, overall FDI stocks and trade volumes are below those of comparable economies. Research in universities is still

not as internationalised as in comparable innovation systems, and this is true in terms both of funding streams and of international research collaboration.

In fields such as environment, water, energy or food, regulations, monitoring and reporting are increasingly international or European. Creating links in these sectors between agencies and research communities in the PRI and HEI sectors will provide opportunities for international collaboration, including participation in Horizon 2020, and particularly in the biggest sub-programme, societal challenges, which represents 40% of its total budget.

- *Support the internationalisation of activities of existing and new programmes and instruments for public and business R&D*. Policy learning in this area can be fostered by participation in the EU's Open Method of Co-ordination processes. Reform of HEIs and PRIs should provide incentives for increased internationalisation.
- *Actively support the internationalisation of Croatia's businesses* by offering a presence and brokerage services in selected innovation hotspots around the globe. While a dedicated Croatian presence may be necessary in selected places, policy makers may also explore the possibility of sharing existing facilities of other EU member states by contributing to their costs.
- *Foster internationalisation in the arrangements governing universities and PRIs and incentives for researchers*. Performance-based budgeting and related performance contracts can relate directly to increased internationalisation in terms of income generated from contracts and grants, exchange of staff, co-publications, partnerships, etc.
- *Relate the internationalisation of R&D and innovation of specialised PRIs to their respective agencies*.
- *Favour "brain circulation" over "brain drain"* by linking international mobility schemes to existing or projected long-term training and research and innovation programmes (rather than to stand-alone mobility schemes), so that mobility fulfils a specific purpose (e.g. training in a specialised skill, experience with specific methods). Provide adequate incentives for repatriation. On the first instance this may involve re-establishing discontinued initiatives by the CSF.
- *Consider developing an explicit internationalisation strategy for R&D and innovation*. Such a strategy would complement the internationalisation impulse offered by EU membership, with efforts to open up to third countries, especially those with which Croatia has traditional ties (neighbours in the region and major export markets) and whose rapidly developing economies offer opportunities for R&D collaboration and innovation.

Table 0.1. SWOT analysis

Strengths	Weaknesses
• Geographic location on the Adriatic coast and at the crossroads of central and southeastern Europe; historical links with several developed and emerging economies. • Good macroeconomic performance prior to the crisis. • Improvements in framework conditions for innovation (while significant scope remains), including in the institutional landscape of policy actors in STI matters. • A well-educated population, especially in terms of secondary education attainment, and strengths in social sciences, law and humanities. • Some strengths or pockets of excellence in public research (universities and PRIs) and examples of collaboration between academia and industry. • Increase in scientific output (scientific publications). • Export strengths in a range of industries and a (small) number of relatively strong industrial R&D performers. • A fledging community of technology-oriented start-ups. • Participation in European Framework Programmes. • Good regional coverage of HEIs.	• Structural weaknesses of the economy exposed by the crisis. • Weak recent macroeconomic performance; wide productivity gap vis-à-vis European and OECD averages. • Aspects of framework conditions for innovation, including access to finance, administrative and regulatory barriers to entrepreneurship, and a lack of trust. • A skills profile that is unfavourable to innovation in the business sector, including lack of entrepreneurship and management skills. • An innovation system that is not centred on the business sector. • Insufficient resources, internal capabilities and outcomes as regards business innovation. • Shortfalls in the organisational set-up and governance of universities and PRIs. • Lack of incentives to develop excellent science. • Insufficient adaptation of international policy practices and instruments to national settings. • Inadequate division of labour between the government and the agency level. • Lack of sustained, longer-term political commitment to innovation, volatility of R&D budgets.
Opportunities	**Threats**
• Greater use of EU Structural Funds, but also national funds (including by reorientation of existing subsidies to industry) to upgrade innovation capabilities across the system. • Making innovation a part of sectoral policies. • Nurturing the development of a dynamic business sector that thrives on innovation. • Increasing the contribution of public research to social and economic development through additional resources and improved organisation and governance. • Develop inter-firm networks, both in Croatia and with companies in the EU as way to accumulate in-house innovation capabilities in Croatian firms. • Use innovation policy and a strengthened investment agency (in conjunction with other interventions) to attract knowledge-intensive FDI.	• Inertia owing to unwillingness to change. • Weakness in implementing strategies and policies. • Failure to prepare for increased competitive pressure following EU accession and from emerging economies. • Inability to mobilise financial and human resources for innovation and thus to capitalise on innovation as a source of growth and competitiveness. • Inability to reform the HEI or PRI sector and bring about needed improvements in efficiency, relevance and rigour. • Failure to generate tangible economic impact from increased investments in science, technology and innovation. • Reinforcement of tendencies towards rent-seeking entrepreneurship in the face of increased resources, e.g. via Structural Funds, unless accompanied by strengthened governance and accountability.

Évaluation d'ensemble et recommandations

Introduction

La Croatie a parcouru un long chemin depuis son indépendance : à l'issue d'une phase de reconstruction et de transformation institutionnelle, elle est devenue une économie de marché qui entretient des relations étroites avec l'Europe et le reste du monde par le biais des échanges internationaux et des mouvements transfrontières d'investissements et de savoir. Porté par une croissance solide de son économie sur une longue période, le pays s'est rapproché du niveau de revenu moyen de l'Europe. Malgré l'ampleur des progrès à accomplir, son adhésion à l'Union européenne (UE) peut être perçue comme le point culminant de réformes visant, entre autres, à faciliter l'investissement, à renforcer la concurrence, à réduire la bureaucratie et à appliquer l'acquis communautaire.

Plus vivement qu'ailleurs, la crise financière et économique amorcée en 2008 a révélé au grand jour les faiblesses et vulnérabilités de l'économie croate passées inaperçues lorsque sa croissance était relativement robuste. Depuis, les preuves infirmant la solidité du modèle de croissance croate se sont accumulées, soulignant la nécessité d'aiguiller la croissance et le développement économiques du pays sur une voie plus pérenne. Stimuler l'innovation au sein de l'économie et de la société croates devrait être au cœur de toute stratégie axée sur une croissance durable et l'élévation du niveau de vie. L'expérience d'autres pays montre à quel point il importe d'améliorer les performances en matière d'innovation pour augmenter la productivité et, ainsi, renforcer la compétitivité internationale des différents secteurs de l'économie. L'innovation est primordiale pour les grandes entreprises, généralement aux prises avec la concurrence étrangère sur les marchés nationaux et mondiaux. Elle aide les petites et moyennes entreprises (PME) à moderniser leurs procédés de production et leurs pratiques de gestion ainsi qu'à se positionner sur des niches de produit leur permettant d'être compétitives et d'étendre leurs marchés. Un environnement et une infrastructure propices à l'innovation contribuent à renforcer l'attractivité d'un pays et favorisent les mutations structurelles au profit d'activités à plus forte valeur ajoutée. Dans le secteur public, l'innovation aide à fournir à bon prix des services de meilleure qualité aux citoyens.

La Croatie réunit déjà un certain nombre des conditions requises pour améliorer ses performances en matière d'innovation et se doter d'un système d'innovation porteur de croissance économique et de développement socioéconomique : le niveau relativement élevé de son capital humain (surtout au regard du taux de diplômés de l'enseignement secondaire, alors que le nombre de diplômés du supérieur est faible), de solides institutions scientifiques et une toute jeune communauté de start-ups innovantes. En revanche, il lui manque un système d'innovation bien établi autour d'un noyau dur d'entreprises très innovantes. En outre, la politique d'innovation menée dans le passé privilégiait l'innovation de pointe, tirée par les activités de recherche et développement (R-D), ainsi que les instruments de commercialisation de la science. Malgré les progrès accomplis en vue de développer et de relier entre elles les différentes composantes du système d'innovation, les retombées économiques se font encore attendre.

Les avantages économiques ne se matérialiseront qu'aux prix d'une amélioration concrète des conditions-cadres de l'innovation, dont fait partie l'environnement réglementaire, et d'une nouvelle valorisation des ressources humaines et des compétences. Elle dépendra aussi de l'action menée au niveau de toutes les composantes clés du système d'innovation croate et de l'établissement de liens entre ces éléments. Cette action consiste à favoriser l'innovation dans le secteur des entreprises grâce à la mise en place de l'infrastructure et des incitations requises pour renforcer la capacité des entreprises à mener des activités d'innovation (le plus souvent, il s'agit d'accumuler dans un premier temps les capacités de conception, d'ingénierie, de marketing et de technologie de l'information, pour seulement ensuite se consacrer à la R-D) principalement en interne et, dans la mesure du possible, en coopération avec d'autres entreprises et institutions de recherche ; à accroître la contribution des universités et des établissements publics de recherche au bon fonctionnement du système d'innovation, notamment par des mécanismes de pilotage et de financement ; et à améliorer la gouvernance générale de la politique de la science, de la technologie et de l'innovation (STI). Cependant, tous ces efforts ne donneront les résultats voulus que s'ils sont pensés et déployés avec efficience et de manière cohérente.

En adhérant à l'UE, la Croatie a élargi ses perspectives de développement économique et social. Il ne fait toutefois aucun doute que l'intégration totale soulèvera aussi des problèmes de taille auxquels tous les acteurs de l'économie et du système d'innovation, pris au sens large du terme, devront s'attaquer en amont. Ainsi, tout en bénéficiant d'un accès illimité aux marchés européens, les entreprises croates devront faire face à une concurrence plus âpre, notamment sur les marchés et les secteurs jusqu'alors peu exposés à la concurrence internationale. Plusieurs secteurs devraient en pâtir : de l'agro-alimentaire à l'ingénierie liée aux marchés publics. Avec l'évolution du régime du commerce extérieur, l'adhésion à l'UE pourrait aussi dresser des obstacles sur certains marchés traditionnels, y compris dans la région des Balkans occidentaux. Il y a fort à parier que la concurrence internationale s'exacerbera à mesure que plusieurs économies (nouvellement) émergentes poursuivront leur ascension et qu'une partie des échanges croates seront détournés de l'Europe du Sud-Est pour les marchés de l'UE plus concurrentiels.

Pour toutes ces raisons, il est essentiel de doper la compétitivité internationale des sociétés commerciales. À cette fin, la Croatie doit déployer des efforts vigoureux et plus soutenus que ceux menés jusqu'ici pour améliorer ses performances en matière d'innovation et, ainsi, se doter d'un puissant système d'innovation axé sur les entreprises et suffisamment performant. Son adhésion à l'UE lui procurera aussi des possibilités uniques, notamment celle de pouvoir accéder à d'immenses sources de financement de la science, de la technologie et de l'innovation, au premier rang desquelles figurent les Fonds structurels européens, et de participer à part entière aux programmes européens de recherche, de technologie et d'innovation. Enfin, en devenant membre de l'UE, la Croatie s'est engagée à adopter les normes et règlements communautaires, ce qui modifiera en profondeur l'environnement juridique et réglementaire qui détermine les conditions-cadres de l'innovation et peut créer des occasions de la stimuler.

Cependant, comme dans d'autres domaines, l'existence de nouvelles sources de financement et conditions ne se traduit pas nécessairement par une hausse proportionnelle des performances en matière de STI ni par une amélioration qualitative du système d'innovation. L'expérience internationale montre que les pays mal préparés peuvent avoir du mal à absorber les fonds supplémentaires et ne pas les utiliser de façon optimale. Il n'est pas aisé de trouver un emploi productif à une manne financière, car cela nécessite

une bonne préparation du point de vue de l'orientation stratégique et des institutions. Ainsi, vu la manière dont d'autres nouveaux membres de l'UE ont exploité les ressources des Fonds structurels en faveur de l'innovation, il semble important de bien planifier les projets et de se doter à l'avance des capacités de gestion requises, d'associer comme il convient les responsables de l'élaboration de la politique d'innovation et les organismes chargés de sa mise en œuvre, d'instaurer des dispositifs d'évaluation efficaces et d'encourager la concurrence de manière à améliorer la qualité des propositions d'investissement.

En résumé, la Croatie devra revoir complètement le degré de priorité qu'elle accorde à la R-D et à l'innovation sous toutes ses formes – ainsi que les ressources dédiées – pour gagner en compétitivité et avancer sur la voie d'une croissance davantage tirée par l'innovation. L'augmentation des ressources destinées à l'innovation doit s'accompagner de gains d'efficience dans la gestion des financements publics, ce qui suppose une meilleure gouvernance et le développement d'une culture de l'évaluation rigoureuse et transparente.

L'objet du présent examen est de recenser les grandes possibilités ainsi offertes aux acteurs du système d'innovation croate, mais aussi les principaux goulets d'étranglement qui en sont le corollaire, et de les conseiller sur la manière de procéder pour tirer profit de la situation. Le potentiel d'innovation est soumis à des contraintes étrangères à la politique STI (comme le cadre macroéconomique et autres conditions-cadres). En revanche, il ne s'agit pas de définir comment la politique STI peut rendre le système d'innovation croate plus efficient et, partant, renforcer la compétitivité du pays et ses résultats économiques en général. Compte tenu des particularités du contexte croate et de la riche expérience acquise par les pays de l'OCDE et leurs bonnes pratiques, un certain nombre de principes directeurs et de recommandations précises sont formulés à l'intention des pouvoirs publics.

Réalisations et défis : Les progrès accomplis en matière de renforcement des capacités n'ont toujours pas produit les résultats escomptés

Dans les années 90, l'économie croate a eu pour tendance lourde de rattraper le niveau de revenu moyen de l'UE, sauf pendant la période 1998-99. Durant la décennie qui a précédé la crise financière et économique mondiale, le produit intérieur brut (PIB) par habitant a été multiplié par deux : le revenu par habitant représentait 64 % de la moyenne de l'UE à parités de pouvoir d'achat (PPP) pour 2008 contre 50 % du revenu moyen de l'UE 27 calculé pour 2000. C'est la conséquence de l'ouverture aux échanges et investissements internationaux, de la libéralisation des secteurs dominés par les entreprises d'État et d'un certain nombre de réformes réglementaires, encore que la question de savoir s'il aurait été possible de mener la transition tout en conservant les capacités industrielles et les moyens d'innovation continue de faire débat. La libéralisation des marchés est allée de pair avec la mise en place d'organismes de réglementation indépendants. Ces dix dernières années ont également été marquées par le lancement progressif d'initiatives stratégiques en faveur de la science, de la technologie et de l'innovation, principalement inspirées par l'expérience des pays de l'UE. Leur effet positif transparaît dans la progression, quoique modeste, de certains indicateurs d'innovation : production scientifique, impact et internationalisation et, dans une moindre mesure, dépôts de brevets. Cependant, une grande partie de ces réalisations n'ont rien d'exceptionnel en comparaison avec celles d'autres anciennes économies en transition comparables en taille et en termes de revenu par habitant.

La crise financière et économique mondiale a porté un coup d'arrêt brutal au mouvement de convergence. Depuis que le PIB a chuté de près de 7 %, l'économie croate n'a toujours pas retrouvé le chemin d'une croissance durable et était retombée dans la récession en 2012. Le chômage est élevé et les conditions macroéconomiques actuelles n'incitent guère à l'optimisme. Même quand on tient compte de la période 2000-08, la croissance est plus lente qu'escompté et en retard sur les autres économies européennes émergentes. L'évolution récente de la situation infirme l'idée que le précédent modèle de croissance, largement alimenté par le crédit, permettra à terme à la Croatie d'afficher une croissance forte et durable. Il est établi que la hausse de son PIB tient principalement à l'accumulation de capital et beaucoup moins à la croissance de la productivité globale des facteurs (PGF), qui correspond aux gains d'efficience de production. La croissance de la productivité du travail est également lente au regard des critères internationaux, ce qui était déjà le cas avant la crise.

Améliorer les performances en matière d'innovation occupera une place de choix dans la stratégie dont la Croatie se dotera pour s'engager sur les rails d'une croissance forte et durable et de l'élévation du niveau de vie. Il est juste de dire que le système d'innovation croate n'est pas encore parvenu à maturité bien qu'il commence à en présenter des signes et à contenir des poches d'excellence. Son système d'innovation reste modeste en termes absolus et relatifs. Les dépenses brutes de R-D stagnant, la pénurie de financement qui en résulte nuit à l'emploi des chercheurs. Les budgets de R-D, tant publics que privés, ont particulièrement pâti de la crise. En fait, la Croatie s'est révélée être l'un des pays d'Europe les moins aptes à surmonter l'adversité dans ce domaine. Si l'on considère une période plus longue, l'intensité de R-D (dépenses brutes de R-D rapportées au PIB) a diminué ces dix dernières années, dans des proportions exceptionnelles par comparaison avec l'étranger, ce qui tranche nettement avec les progrès accomplis par de nombreux pays, en particulier les économies émergentes. Ce déclin de l'intensité de R-D est également révélateur d'une absence de mutation structurelle au profit des secteurs à forte intensité de savoir qui offrent des débouchés aux travailleurs hautement qualifiés.

Si les entreprises croates affichent une propension à mener des activités d'innovation qui correspond globalement à celle des pays dont le revenu par habitant est similaire à celui de la Croatie, les résultats de ces activités sont moindres en comparaison et compte tenu des ressources engagées. Les retombées de la production scientifique et technologique sont relativement faibles, au regard du nombre de brevets déposés et de citations d'articles. En revanche, les scientifiques croates affichent une productivité supérieure à la moyenne et une efficacité relative par rapport au coût, ce qui constitue les rares aspects positifs de ce système dont les potentialités sont loin d'être exploitées.

Vu la contribution plutôt modeste de la PGF à la croissance, l'économie croate tire pour le moment peu d'avantages de son système national d'innovation, encore à l'état d'ébauche : il se caractérise à la fois par d'importantes contraintes de moyens, une forte volatilité, de piètres antécédents en matière de gouvernance et des mécanismes de financement laissant à désirer, ainsi que par l'irrégularité des exercices de surveillance et d'évaluation. Aussi indispensable soit-il de prévoir des financements constants et adéquats pour consolider le système d'innovation, il ne suffira pas de remédier à la pénurie de ressources.

Principales forces et faiblesses du système d'innovation de la Croatie

L'histoire et la géographie croates ont conféré des atouts particuliers au pays et tracé la trajectoire de son développement. Globalement, et récemment encore, le cadre institutionnel ne favorisait pas l'innovation de marché. Les capacités du secteur des entreprises fondent au fil du temps et ce qui fait actuellement la force industrielle du pays date pour l'essentiel du vingtième siècle. La situation géographique de la Croatie et les perspectives offertes par son adhésion à l'UE sont certes prometteuses, mais elles n'en comportent pas moins des risques, dont manifestement certains n'ont pas été pleinement mesurés et traités à l'avance.

Principales forces

- *La population croate affiche un bon niveau d'instruction (secondaire).* La part de la population adulte ayant terminé le deuxième cycle du secondaire est supérieure à la moyenne de l'UE 27. L'instruction et l'érudition occupent depuis toujours une grande place dans le pays, où les sciences, le droit et les lettres sont à l'honneur. Une armée d'établissements d'enseignement supérieur répond aux besoins d'un vaste éventail de niches régionales et sectorielles. Tant les universités (celle de Zagreb se trouve dans le haut du classement mondial) que les établissements publics de recherche (en particulier l'Institut Rudjer Boskovic) offrent des poches d'excellence de recherche. Ces dernières années ont également été marquées par l'essor de l'activité de publication scientifique et une amélioration des retombées de la production scientifique. Certains signes montrent que les scientifiques croates sont plus productifs que ceux d'un grand nombre de pays comparables et qu'ils sont proportionnellement plus efficients.
- *Dans différents secteurs, les entreprises croates possèdent des atouts à l'exportation et comptent un petit nombre d'exécutants de R-D de premier plan.* Le bilan relativement satisfaisant des activités de R-D, principalement dans les secteurs des produits pharmaceutiques, du matériel électrique et électronique et des technologies de l'information et des communications (TIC), a éveillé l'intérêt des multinationales et entraîné la réorganisation de ces secteurs suite à des fusions et acquisitions. En contrepartie, l'investissement de création a été négligé, alors qu'il peut s'agir d'une source importante de renouveau industriel. Même ceux qui font figure de « grands » sont des acteurs modestes de la R-D sur la scène internationale.
- *Le tissu national des PME comporte une communauté de start-ups et d'entreprises pérennes tournées vers l'innovation,* dont certaines occupent des niches spécialisées, où elles ont acquises de grandes compétences et des atouts à l'exportation, en particulier sur le marché de l'Europe du Sud-Est.
- *La Croatie jouit d'un emplacement géographique privilégié*, le long de l'Adriatique, au carrefour de l'Europe centrale et du Sud-Est, et entretient des relations de longue date avec plusieurs pays de l'OCDE et économies émergentes. Ces avantages expliquent le niveau de l'investissement direct de l'étranger, dont une petite partie est destinée aux secteurs à forte intensité de savoir ou d'exécution de la R-D. Globalement, l'afflux est moindre que dans les pays comparables. Grâce à l'adhésion à l'UE, l'économie croate s'ouvrira davantage aux échanges et investissements internationaux et sera en mesure d'asseoir sa position dans les flux mondiaux des connaissances, à condition de saisir les occasions de le faire. De plus, la Croatie participera sur un pied d'égalité aux programmes européens de recherche, de développement et d'innovation.

Principales faiblesses

- *Ses résultats macroéconomiques sont médiocres depuis la crise financière et économique*, qui a exposé au grand jour des faiblesses structurelles jusqu'alors inaperçues. Le retard affiché par la Croatie en termes de revenu par habitant tient notamment à une productivité du travail inférieure aux moyennes européenne et OCDE. Il semble donc nécessaire de cibler les efforts sur les gains de productivité, essentiellement en améliorant, à divers égards, les performances des entreprises croates en matière d'innovation.

- *Les conditions-cadres de l'innovation sont mal adaptées du fait de réformes inachevées.* Bien des améliorations peuvent encore être apportées à la réglementation des marchés de produit, des investissements (simplification des procédures d'entrée et de sortie des entreprises) et des marchés du travail (taux d'activité et rotation des effectifs). Malgré certaines avancées, les formalités bureaucratiques restent pesantes : les procédures à suivre pour obtenir les autorisations et signer des contrats avec les entreprises de réseau sont longues et semées d'embûches. La tâche à accomplir pour adopter et appliquer la réglementation communautaire est considérable. La corruption demeure un obstacle de taille à l'innovation.

- *Le secteur des entreprises est pauvre en capacités d'innovation.* Par comparaison internationale, le niveau des dépenses de R-D des entreprises est exceptionnellement bas, même quand les différences de structure sectorielle sont prises en compte. Par rapport à des pays similaires, la Croatie est à la traîne en ce qui concerne les intrants de l'innovation ainsi que le niveau des ressources humaines et de l'infrastructure physique connexes. La faiblesse des niveaux d'innovation et des activités de recherche se traduit par de maigres moyens internes et une capacité d'absorption limitée, ce qui entrave considérablement la collaboration avec les universités et autres fournisseurs de connaissances. La Croatie compte pourtant des PME dynamiques qui savent tirer profit de la R-D et de l'innovation non liée à la R-D (innovation d'organisation et de commercialisation). Les entreprises de certains secteurs à forte intensité de savoir dépendent des marchés publics et devront probablement affronter une concurrence plus acharnée dans l'avenir. Les valeurs unitaires relatives des exportations (valeurs des exportations par unité de quantité, qui, dans certaines circonstances, peuvent être considérées comme indicatrices de la qualité du produit) donnent à penser que la compétitivité des exportations croates continue de reposer sur les coûts, plutôt que sur la qualité, qui est associée aux investissements dans le capital humain et l'innovation.

- *Le profil des qualifications n'est guère propice à l'innovation dans le secteur des entreprises*. La capacité d'innovation des entreprises dépend cruellement de compétences spécifiques dans la conception, l'ingénierie, le marketing et les technologies de l'information, entre autres domaines, ainsi que des demandes et activités d'innovation découlant de la présence de ces compétences dans les entreprises. D'après ce que l'on observe à l'étranger, ce sont surtout les entreprises elles-mêmes qui créent ces capacités dans le cadre de leurs activités. Pourtant, les entreprises implantées en Croatie sont en retard sur le reste du monde, voire de la région, pour ce qui est d'investir dans la formation structurée et d'y participer. La Croatie est également à la traîne au regard de la part des secteurs à forte intensité de savoir dans l'emploi total, du taux d'activité des diplômés de l'enseignement supérieur et de leur part dans l'emploi total, ainsi que de l'emploi des spécialistes des TIC. La dernière enquête communautaire sur

l'innovation (CIS 2008-10) et une autre, plus récente, de l'OCDE (réalisée en 2012) donnent à penser que le manque de personnel qualifié est un frein important à l'innovation dans les entreprises croates. Manifestement, le système éducatif ne permet pas d'y remédier : la Croatie est en retard sur les pays comparables en termes de participation à l'éducation des adultes. Des études antérieures ont également révélé une inadéquation des besoins des entreprises par rapport à l'offre fournie par le système éducatif. Cette inadéquation concerne les compétences d'entrepreneuriat, ainsi que différentes disciplines liées à la science, à l'ingénierie et aux mathématiques, et s'explique par le poids des diplômés croates du supérieur dans les sciences sociales et les humanités. Certains signes donnent à penser que les titulaires de diplômes professionnels de l'enseignement supérieur et secondaire sont probablement trop peu représentés. Les études comparatives de la qualité de l'enseignement des sciences et mathématiques placent la Croatie derrière les pays similaires et sous la moyenne de l'UE, ce qui est d'autant plus inquiétant que, d'après les données recueillies dans plusieurs pays, la qualité de l'enseignement des sciences et des mathématiques serait une variable explicative du dynamisme technologique à long terme.

- *Il existe des lacunes dans l'organisation et la gouvernance des universités et des établissements publics de recherche.* L'organisation actuelle des universités, qui fait de chaque faculté une entité juridique à part entière, empêche pour ainsi dire toute planification stratégique à l'échelle de l'institution et peut même compromettre le bon déroulement d'activités régulières comme la surveillance et l'évaluation. Les universités et établissements publics de recherche croates sont difficiles à diriger car les rênes sont détenues non pas par un « état-major » mais par des comités composés de cadres de rang inférieur et de représentants du corps professoral. Ce mode de gouvernance ou de gestion tend à favoriser la réciprocité des comportements et les dépendances structurelles et, ainsi, à empêcher les ajustements de l'organisation interne, des priorités et incitations pourtant indispensables pour rendre les universités puissante et en faire des lieux d'excellence. Par le passé, les autorités croates ont essayé de réformer l'enseignement supérieur, mais elles ont dû céder à la résistance. Les établissements publics de recherche sont eux aussi cloisonnés, mais plus sur le plan externe qu'interne. Ce cloisonnement a probablement empêché la réalisation de vastes projets sur le long terme et est confirmé par le faible niveau de l'investissement productif et la modeste expansion observés au cours de la décennie écoulée.

- *La Croatie ne parvient pas à s'adapter complètement aux pratiques internationales.* Ces vingt dernières années, la Croatie s'est dotée de nombreux programmes et instruments en faveur de la science, de la technologie et de l'innovation, généralement sous l'influence de l'évolution des systèmes d'innovation de pointe. Ces dix dernières années ont été marquées par la prédominance des dispositifs de transfert de technologies entre le monde universitaire et les entreprises : parcs technologiques et incubateurs, partenariats public-privé, etc. Bien que cela puisse être utile dans certains cas, il n'est pas toujours dans l'intérêt d'un système d'innovation émergent, comme celui de la Croatie, de trop privilégier les modes d'innovation et les transferts de technologie à forte intensité de R-D, surtout si rien n'est prévu pour encourager de manière systématique l'accumulation des capacités d'innovation, en particulier dans le secteur des entreprises.

- *Les tâches sont mal réparties entre l'administration et les organismes*. Si l'exécution d'un certain nombre de programmes et de mesures a été déléguée à différents organismes comme l'Agence croate pour l'innovation des entreprises (BICRO) et la Fondation croate pour la science (FCS), les autres relèvent toujours des ministères, ce qui n'est guère satisfaisant pour différentes raisons. Ce morcellement empêche le regroupement et la formation d'une masse critique de stabilité, de capacités managériales et de veille, tant au niveau des pouvoirs publics qu'à celui des organismes. Il fait aussi obstacle aux économies d'échelle et d'envergure. En outre, plus le nombre de programmes et de mesures est limité, moins l'évolution de leur éventail est souple, car les différentes composantes de l'administration ont tendance à défendre « leurs » programmes.
- *Le manque de confiance* est lourd de conséquences en ce qu'il empêche les inventeurs d'obtenir les fonds requis pour la commercialisation et l'administration centrale de déléguer les compétences. Il fait aussi obstacle à la collaboration entre les universités et les entreprises ainsi qu'à l'investissement dans l'innovation. Tout cela peut influencer les autorités lorsqu'ils choisissent et définissent les dispositifs de soutien à mettre en place. À cela s'ajoutent l'opacité des transactions publiques, la défaillance des procédures de surveillance et d'évaluation des mécanismes financés par l'État et le manque de retour d'expérience sur les programmes menés à bien. Le degré de confiance accordé au système dépendra inévitablement de son succès sur le long terme, mais le renforcement de la transparence, l'amélioration des procédures de surveillance et d'évaluation et la mise en place de dispositifs transversaux de renforcement communautaire entre les échelons ministériel et institutionnel constitueraient des pas dans la bonne direction.
- Enfin, *le manque d'engagement politique durable en faveur de l'innovation* constitue l'un des principaux obstacles. Dans la pratique, tous les pays qui ont su rattraper leur retard et devenir de grands acteurs de l'innovation (de la Corée à la Finlande) y sont parvenus grâce à une volonté politique ferme et inscrite dans la durée. Le manque d'engagement politique au plus haut niveau est à l'origine de plusieurs des problèmes dont pâtit le système d'innovation croate : prolifération des plans et mesures mal dotés, inefficacité des conseils, manque de continuité dans l'action publique et absence de perspectives stratégiques, insuffisance des ressources consacrées à la R-D et à l'innovation en général, volatilité budgétaire dans le domaine STI, grande capacité des intérêts catégoriels à résister au changement, inefficacité des dispositifs de gouvernance et difficulté à coordonner l'action publique et à donner effet aux changements requis dans les autres parties du système d'innovation. Cela creuse le « fossé de crédibilité » entre, d'une part, le potentiel de croissance et de développement économiques promis par l'innovation (à la lumière de la théorie et des exemples étrangers) et, d'autre part, les résultats que beaucoup dans le pays jugent réalisables. Il y a tout lieu de penser que le problème n'est pas sans lien avec le manque général de confiance précédemment évoqué.

Occasions à saisir et menaces

- *Le recours aux Fonds structurels de l'UE et l'utilisation accrue des fonds nationaux* permettent pour la première fois de moderniser les capacités d'innovation dans l'ensemble du système d'innovation croate. Faute de remontée de l'information sur les caractéristiques des systèmes d'innovation performants, il convient généralement de donner une première impulsion, sur une période suffisamment longue, pour amorcer un cercle vertueux. L'absorption des fonds structurels de l'UE et une nouvelle mobilisation des programmes-cadres pourraient certes œuvrer dans ce sens, mais les domaines d'intervention seraient le renforcement des capacités (dans le cas des Fonds structurels) et la R-D préconcurrentielle (dans le cas des programmes-cadres). Les fonds publics nationaux, en particulier dès lors qu'ils amplifient les effets de l'investissement privé dans la R-D, pourraient compléter le « coup de pouce » européen, par exemple en soutenant l'innovation proche du marché et la commercialisation. Un tel appui devrait être stratégique et reposer sur de rigoureux critères de qualité.
- *Favoriser le développement d'un secteur des entreprises dynamique stimulé par l'innovation.* L'accès inconditionnel aux marchés européens permettra l'expansion des exportations, y compris dans les secteurs à forte valeur ajoutée, à condition que le secteur des entreprises renforce ses capacités d'innovation de manière à avancer durablement sur la voie de la productivité, de l'amélioration de la qualité et, ainsi, de la compétitivité internationale. Les pouvoirs publics peuvent y concourir en prenant des mesures de nature à améliorer l'utilisation du réservoir national de main-d'œuvre et à développer l'ensemble des compétences utiles aux entreprises. Un moyen complémentaire d'y parvenir consiste à aménager les conditions-cadres de l'innovation ainsi que l'infrastructure institutionnelle et matérielle à l'appui d'un système d'innovation dynamique. Pour soutenir les sociétés innovantes et tournées vers les exportations, il convient peut-être aussi d'abaisser les coûts d'entrée et de transaction sur les marchés internationaux tout en agissant en faveur du cadre réglementaire et de l'infrastructure liée à l'information et à la logistique.
- *Renforcer la contribution de la recherche publique au développement social et économique*. La recherche publique croate (qui relève des universités et des établissements publics de recherche) pourrait contribuer davantage au développement socioéconomique du pays. Si ce n'est pas le cas actuellement, c'est certes pour des raisons financières, mais aussi à cause des pratiques établies en matière d'organisation, de gouvernance et de gestion, et des incitations et perceptions dominant dans le secteur de la recherche publique, qui sont contre-productives à maints égards. L'adoption de modèles de gouvernance fondés sur les performances et de modèles de gestion fondés sur les résultats pourrait conduire à un changement radical d'orientation. Les Fonds structurels de l'UE pourraient grandement faciliter la mise en œuvre de tels modèles compte tenu du montant de l'aide fournie et du fait que la durée de leur intervention confère une certaine stabilité, propice à l'apprentissage (institutionnel).
- *Favoriser l'innovation dans différentes branches (énergie, transports et agriculture, par exemple) à travers les politiques sectorielles.* D'une manière générale, les grappes d'entreprises et les établissements publics de recherche finalisée ciblent leurs efforts sur les besoins des secteurs. La Croatie a par ailleurs entrepris de constituer des organismes spécialisés et de renforcer ceux qui existaient

déjà (par exemple dans les domaines de l'eau, de l'énergie, de l'environnement et de l'alimentation), ces organisames ayant pour mission de superviser le secteur et de veiller à l'application de la règlementation. Leur collaboration peut fortement influencer l'exécution des travaux de recherche ainsi que la conception et la mise en place des services d'appui, de formation et de conseil.

Dans le même temps, le système d'innovation croate doit faire face à un certain nombre de *menaces* :

- *Le cadre macroéconomique international est volatil*, ce qui concerne aussi les voisins européens de la Croatie.
- *Le pays n'a pas su se préparer à l'escalade de la concurrence consécutive à l'adhésion à l'UE.* L'intensification de la concurrence internationale peut compromettre la viabilité des secteurs auparavant protégés ou moins exposés. Les entreprises croates concernées par l'Accord de libre-échange d'Europe centrale (ALEEC) auront certainement du mal à réussir la transition entre le marché régional et celui de l'UE. Il importe surtout d'éviter tout renforcement de la spécialisation dans les secteurs marqués par des termes de l'échange défavorables et par un potentiel limité de gains d'innovation et de productivité.
- *La hausse de l'investissement dans la science, la technologie et l'innovation n'a pas produit d'effets économiques concrets.* Faute de préparation et en l'absence d'une réforme appropriée des institutions, un afflux de ressources au profit de l'innovation (provenant essentiellement des Fonds structurels de l'UE, mais aussi d'autres sources) risque de ne pas faire croître en proportion les réalisations ou les incidences dignes d'intérêt pour l'économie croate.
- *La préférence pour les activités de recherche de rente est de plus en plus marquée*. Les enveloppes généreuses des Fonds structurels risquent d'accentuer le phénomène d'entrepreneuriat redistributif tourné vers la recherche de rente, dont l'objectif est de tirer le plus grand profit possible d'une manne financière au lieu d'accumuler des capacités de production et d'innovation. Ce risque sera exacerbé si la situation économique manque de dynamisme et qu'il est difficile de trouver des possibilités d'investissement rentables.

Améliorations à apporter à la politique d'innovation

En Croatie, la politique en faveur de l'innovation de marché est relativement récente. Elle a nécessité l'apparition d'acteurs clés, de processus encourageant l'innovation et d'institutions. Ont ainsi vu le jour plusieurs institutions ou organismes publics spécialisés, comme l'Agence croate pour l'innovation des entreprises (BICRO), la Fondation croate pour la science (CSF) et l'Agence pour la science et l'enseignement supérieur (ASES), qui sont chargés d'importantes fonctions au sein du système d'innovation : de la mise en œuvre à l'exécution des programmes de recherche publique en passant par le soutien à l'innovation des entreprises dans l'évaluation de la recherche et l'assurance qualité. Ces intermédiaires ont déjà eu recours à divers dispositifs d'aide et accumulé une expérience de terrain considérable. Il est possible que le cadre institutionnel de l'innovation ait été consolidé par la création de l'Agence d'enseignement et de formation professionnels et d'éducation des adultes et de l'Agence pour la mobilité et les Programmes de l'UE, ainsi que par les efforts déployés pour renforcer le rôle du Bureau d'État de la protection de la propriété intellectuelle.

Bien que des progrès non négligeables aient été accomplis dans le renforcement général des capacités publiques, en particulier grâce à la création d'organismes spécialisés, il reste encore beaucoup d'améliorations à apporter du point de vue de l'orientation, de la planification, de la mise en œuvre, de la surveillance et de l'évaluation de la politique d'innovation.

- *Orientation de l'action publique.* L'orientation générale de la politique d'innovation devrait coïncider avec le stade de développement atteint et les problèmes particuliers qui l'accompagnent. Les formes d'innovation non tirées par la R-D, comme l'innovation de services et l'innovation de commercialisation, peuvent être plus intéressantes pour un système d'innovation émergent, mais cela changera au fil du temps, à mesure que de nouvelles capacités seront accumulées. Définir les priorités doit devenir une pratique habituelle. Bien concilier pragmatisme et ambition, et permettre à cet équilibre d'évoluer dans le temps, sera crucial. Une coordination transversale sera primordiale et exigera un bon équilibre entre les parties prenantes.

- *Planification, exécution et aide à la formulation de la politique.* La planification ne peut être améliorée que s'il est tenu compte de l'expérience et des résultats passés, ce qui suppose que les acteurs (organismes) chargés de l'exécution de la politique soient en mesure de recueillir les données nécessaires. Il est donc crucial, pour le succès de la politique d'innovation croate, que les organisations intermédiaires comme BICRO, FCS ou ASES poursuivent leurs activités en toute indépendance. Pour cela, certaines pratiques du passé doivent être abandonnées. Bien que divers organismes et conseils aient vu le jour ces dernières années, leur degré de spécialisation et champ d'action restent limités. Dans bien des cas, les politiques, plans et stratégies nouvellement adoptés ne sont pas assortis des ressources nécessaires à leur bonne mise en œuvre et il est arrivé que des organisations auxiliaires (comme des incubateurs, etc.) soient créées sans que les institutions dont elles relèvent, principalement des établissements d'enseignement supérieur et des établissements publics de recherche, ne fassent l'objet d'une réforme.

- *Pilotage du système de recherche publique.* Les établissements d'enseignement supérieur et les établissements publics de recherche ont du mal à adopter et à exécuter des stratégies de grande envergure portant sur des horizons lointains pour les raisons suivantes : il existe des flux de financement parallèles fondés sur différents systèmes de salaires, produits consommables et d'investissement, à l'origine d'une certaine rigidité budgétaire ; les établissements d'enseignement supérieur sont administrés suivant un système très cloisonné, caractérisé par un niveau élevé de décentralisation et d'autonomie ; le mode de gouvernance des établissements publics de recherche empêche une bonne interaction avec la communauté scientifique et le milieu des affaires. Au niveau institutionnel, la gouvernance devrait favoriser l'harmonisation de la planification nationale et institutionnelle.

- *Financement de la recherche publique*. Globalement, le niveau des fonds alloués à la recherche publique et de l'aide publique à l'innovation des entreprises paraît bien trop faible pour avoir une incidence notable. La politique de financement devra à l'avenir satisfaire aux impératifs suivants :

- *Tisser des liens clairs et solides entre le financement de projets et le financement institutionnel des établissements d'enseignement supérieur et les établissements publics de recherche, sur la base de contrats d'objectifs*. Dans le cas des établissements publics de recherche, ces contrats d'objectifs devraient relier de façon explicite le financement institutionnel aux revenus tirés du financement sur projet (subventions) et des contrats de recherche ou autres services connexes. Cela vaut aussi pour les établissements d'enseignement supérieur compte tenu de leurs fonctions éducatives. La tâche la plus difficile consiste à récompenser à la fois les performances passées et une ambition stratégique cohérente pour l'avenir.

- *Tisser des liens clairs et solides entre les ressources fournies par les Fonds structurels et les dotations nationales*. Cet impératif est lourd de conséquences en ce qu'il s'agit d'associer le financement à l'évolution d'éléments majeurs du secteur d'exécution et du système de gouvernance. Cela suppose également de revoir la structure des établissements d'enseignement supérieur et des établissements publics de recherche de manière à lier les éléments d'importance cruciale et à favoriser le dialogue. L'accent doit être placé sur l'acquisition des compétences, notamment la formation des jeunes chercheurs en relation étroite avec le secteur des entreprises. La priorité doit aussi être donnée au financement des organismes (régionaux) de développement qui proposent des services sur le terrain, principalement aux PME (« grappes d'entreprises »), ainsi qu'à l'apprentissage institutionnel, notamment au sein des organismes chargés de mener à bien les différents programmes.

- *Surveillance et évaluation*. Les modalités officielles de la surveillance ne sont pas assez étoffées, il y a peu de retours d'expérience et évaluer l'exécution des programmes et des mesures d'appui n'est pas une pratique établie. Les programmes financés par les Fonds structurels et les projets connexes permettront d'instaurer une culture de l'évaluation caractérisée par une grande rigueur. Ce sera l'occasion de faire le bilan de l'accumulation et utilisation des capacités ainsi que de la collaboration avec des experts locaux et étrangers, afin que les enseignements ainsi tirés puissent ensuite être mis à profit dans la prise de décisions. Une autre solution notable consiste à associer les évaluations *ex ante* à la négociation des contrats d'objectifs. En procédant de la sorte, la République tchèque a dégagé une économie de 200 millions EUR, sur 1.6 milliard EUR, au profit du financement de nouveaux projets. Globalement, l'élaboration et l'exécution des programmes et projets financés par les Fonds structurels supposent l'établissement de différentes fonctions de veille politique (orientation, planification, surveillance, évaluation) qui devraient servir de point de départ à la mise en place d'un système plus poussé d'évaluation générale.

Tâches stratégiques et principes directeurs

Le système d'innovation croate n'en est encore qu'à un stade de développement relativement précoce. Comme la politique d'innovation voit son rôle varier au fil de l'évolution du système, elle doit s'attacher à poursuivre des objectifs qui à la fois conviennent au stade actuel de développement et anticipent correctement le stade suivant.

Les principales tâches stratégiques des pouvoirs publics consisteront à :

- *Renforcer la volonté politique, la responsabilité, la continuité et la coordination.* La volonté politique est un préalable essentiel à une coordination avisée de la politique d'innovation. Ces 10 dernières années, cette volonté a été insuffisante en termes tant de part du budget que de constance. Des mesures résolues devront être prises pour stabiliser le financement public de l'innovation et en assurer la pérennité par-delà le cycle budgétaire et électoral. Une division plus claire du travail entre l'échelon central et les agences indépendantes, conjuguée à des dispositions de gouvernance plus fermes en matière de coordination entre les ministères et les agences, avec de préférence un engagement politique au plus haut niveau, sera cruciale pour réussir la mise en œuvre.
- *Faciliter la mobilisation des ressources et le renforcement de capacités d'innovation dans le secteur des entreprises.* L'augmentation des ressources consacrées à l'innovation devrait être un objectif central de la politique d'innovation. Priorité doit en particulier être donnée au renforcement des capacités d'innovation dans le secteur des entreprises. L'emploi d'instruments de l'UE (FS, PC) recèle un grand potentiel de démultiplication du financement de l'innovation par les entreprises. Il convient parallèlement de fixer des objectifs réalistes, car les progrès mettront du temps à se manifester. La démarche des pouvoirs publics doit être en phase avec les besoins actuels du secteur des entreprises, et non pas résulter d'un transfert direct à partir de systèmes d'innovation sophistiqués. Cette optique nécessitera inévitablement une palette de mesures de soutien plus directes et mieux financées. Le renforcement des capacités d'innovation des entreprises supposera par ailleurs des initiatives de la puissance publique dépassant la seule politique d'innovation, dont notamment une planification stratégique de la politique industrielle et éducative.
- *Accroître la contribution des universités et des établissements publics de recherche par une gouvernance efficace.* Des améliorations de la gouvernance, de l'évaluation et de la responsabilisation des organisations, des chercheurs individuels et des instruments d'action devraient aller de pair avec l'augmentation des ressources. La budgétisation axée sur les résultats a fait la preuve de son efficacité.

Principes directeurs

- *Une impulsion politique et un engagement propices à des conditions-cadres et des ressources stables et prévisibles.* Les acteurs de l'innovation dans les entreprises et dans le secteur de la recherche publique sont ainsi en mesure de planifier les investissements de manière appropriée. L'expérience accumulée sur la scène internationale montre que cet aspect est essentiel pour la réussite de la politique d'innovation.
- *Un dispositif de gouvernance et de retour d'information efficace*. L'accent est mis sur des fonctions stratégiques et opérationnelles efficaces, grâce à des mécanismes d'évaluation et de retour d'information permettant de fonder des cycles décisionnels successifs sur un socle factuel solide.
- *Une coordination efficace*. Il est fréquent que les améliorations des conditions-cadres de l'innovation et que les mesures de nature spécifiquement STI soient transversales, et nécessitent de ce fait une coordination (horizontale et verticale). Pour cela, il faut une bonne communication entre organisations et secteurs

institutionnels, ainsi qu'un suivi et une évaluation efficaces des contributions. Il faudra en outre veiller à impliquer largement les parties prenantes dans les décisions publiques et à multiplier les interactions entre les décideurs.

- *Une vision large de l'innovation* ne se limitant pas aux produits de la R-D. Cette vision à la fois autorise et nécessite une collaboration plus étroite et systématique entre d'un côté la politique d'innovation générique et les politiques sectorielles, et de l'autre l'utilisation de la réglementation pour susciter l'innovation.
- *Une ambition de niveau international.* Le fait de donner au système d'innovation une perspective internationale (par exemple au moyen d'examens par les pairs internationaux et *via* les ambitions exportatrices des établissements d'enseignement supérieur et des entreprises) pourrait améliorer les performances du système d'innovation en termes d'efficience, de qualité et d'impact économique. Un surcroît d'internationalisation peut stimuler la compétitivité des entreprises et l'excellence de la recherche scientifique.
- *Un ciblage des résultats*. L'amélioration des performances du système d'innovation croate suppose de lier les financements aux objectifs à long terme, aux acteurs visés et aux résultats connexes. Il faut notamment à ce titre mettre en œuvre une budgétisation axée sur les résultats dans les établissements d'enseignement supérieur et les établissements publics de recherche, et instaurer d'une part des relations contractuelles entre le pouvoir central et ses agences, et d'autre part une forte autonomie managériale.
- *Ambition, hiérarchisation et réalisme.* Les ambitions du pays doivent être tempérées par une évaluation réaliste, y compris en termes d'horizon temporel, des capacités existantes et des besoins que suscite le changement. Souvent, il est difficile de changer vite, et les changements les plus importants doivent être prioritaires. Il conviendra donc d'opter pour une démarche stratégique de longue haleine qui évolue peu à peu sans perdre la notion des contraintes actuelles du système.

Recommandations

Améliorer les conditions-cadres de l'innovation

Pendant les années qui ont précédé la crise financière et économique mondiale, la Croatie a joui d'un environnement macroéconomique stable marqué par une croissance solide, une inflation contenue et des taux de change peu fluctuants. Le pays a pu connaître une telle croissance économique malgré des évolutions démographiques défavorables, un chômage relativement élevé et un faible taux d'activité. La crise et ses prolongements ont eu un impact négatif sur une balance commerciale déjà dégradée, et les finances publiques se sont tendues. Les modestes gains de productivité du travail ont été pour l'essentiel imputables à une intensification capitalistique ; la contribution de l'efficience globale à l'utilisation des facteurs de production est restée minimale.

La Croatie est une économie relativement ouverte qui a vu ses échanges et ses IDE progresser cette dernière décennie, mais sans parvenir au niveau d'économies comparables. Les pressions concurrentielles subies par les entreprises d'un secteur à l'autre – pressions qui peuvent fortement inciter à innover – sont inégales. La concentration industrielle semble certes avoir reculé en 10 ans, mais on note des poches persistantes de concentration élevée, en particulier dans des secteurs où la puissance

publique détenait ou conserve des intérêts importants. La concentration a augmenté dans certains secteurs qui ont attiré des entreprises multinationales (notamment informatique et services connexes, fabrication de produits à base de tabac, commerce de détail). La création de l'autorité croate de la concurrence et la récente extension de ses pouvoirs sont des pas importants sur la voie de l'équité des conditions de marché et de sa préservation.

Les entreprises ont un accès inégal au financement de l'innovation. Si différents dispositifs répondent à une palette de besoins relativement large, de nombreuses entreprises de petite taille, en raison de réglementations techniques sévères et de l'obligation de fournir des sûretés, rencontrent encore des difficultés pour obtenir des fonds. Comme dans d'autres pays, les capitaux susceptibles de s'investir à risque sont limités. Globalement, même si l'environnement juridique et réglementaire s'est quelque peu amélioré ces dernières années, d'importantes contraintes perdurent, dont une bureaucratie encore pesante et une fiscalité moins favorable que celle d'un pays « moyen » de la zone OCDE. Le manque de confiance, y compris dans l'efficacité des institutions juridiques, est un problème de taille.

- *Instaurer et préserver un environnement macroéconomique favorable* et des finances publiques viables, tout en stimulant les investissements dans la science, la technologie et l'innovation.
- *Continuer le processus de réforme*, en accordant moins d'importance aux exigences nominales de conformité à l'acquis communautaire, pour privilégier l'impact mesurable des évolutions de la réglementation sur la facilitation des investissements et le fonctionnement des marchés. L'environnement macro-économique qui prévaut et le besoin d'améliorer la compétitivité imposent de poursuivre les réformes même après l'adhésion à l'UE.
- *Associer des mesures de soutien à l'adoption des règlements communautaires* afin de faciliter une adhésion rapide et efficace du secteur des entreprises et de déclencher une vague d'innovations d'organisation et de procédé associées ou complémentaires. De telles mesures nécessitent une coopération plus étroite entre les ministères concernés et BICRO.
- *Détecter et traiter toute condition-cadre diminuant l'attrait de la Croatie pour les investisseurs bailleurs de fonds de R-D et d'innovation*, y compris la charge administrative assumée par les entreprises et les obstacles entravant l'accès des PME aux financements ; et faciliter le financement des investissements à risque. À cet égard, il peut s'avérer utile d'intégrer un axe « innovation » aux critères d'évaluation de l'impact de la réglementation ex ante et ex post.
- *Stimuler l'innovation dans le secteur public, y compris grâce à une utilisation accrue des TIC pour la fourniture des services publics,* avec la création et la modernisation de plateformes d'information sur la politique STI, ainsi que des innovations de procédé et d'organisation.
- *Mettre l'accent des réformes du secteur public sur la transparence et la réduction de la prévalence de la corruption, ainsi que du potentiel et du sentiment de corruption.* Malgré les récents efforts notables de la Croatie, la corruption semble toujours constituer une contrainte importante pour les petites entreprises.
- *Renforcer la concurrence et veiller au maintien durable de conditions de concurrence équitables, de manière à instaurer de fortes incitations à innover.*

Renforcer le réservoir de ressources humaines en faveur de l'innovation

Si le niveau de qualification de la population active croate est relativement élevé, son profil limite peut-être les possibilités d'innovation. Par rapport à l'UE et aux pays comparables du point de vue du revenu par habitant, la Croatie compte peu d'étudiants et de diplômés en mathématiques, sciences et ingénierie, la part de sa population active ayant suivi un enseignement supérieur est faible, de même que le taux d'emploi des diplômés du supérieur, et le pays se trouve au bas du classement s'agissant de la formation en cours d'emploi et tout au long de la vie. Les entreprises croates font état d'une pénurie de personnel qualifié, qui constitue un obstacle de taille à l'innovation. Ce problème concerne non seulement l'acquisition officielle de qualifications, mais aussi l'accumulation d'une expérience en matière d'innovation et d'appropriation économique. Il n'existe pas de communauté de consultants ou d'offre de services à grande échelle pour accompagner les entreprises dans les projets d'innovation.

La part des jeunes Croates en études secondaires est supérieure à la moyenne de l'UE. En revanche, ils affichent de moins bons résultats que leurs homologues de pays comparables dans les études PISA de l'OCDE pour ce qui est des mathématiques et des sciences, disciplines liées au bilan national en matière d'innovation technologique. L'enseignement universitaire est trop inadapté aux besoins du marché de l'emploi. En témoignent la distribution des diplômés par discipline (marquée par le poids écrasant des sciences sociales) et le fait que les entreprises et les associations locales ne sont manifestement pas associées à l'élaboration des programmes.

Les entreprises font souvent état d'une pénurie de compétences dites « personnelles » dans les domaines du management, du marketing, de l'entrepreneuriat et du droit de la propriété intellectuelle. Il serait possible de tirer profit des points forts traditionnellement affichés en social sciences, en droit et en sciences humaines en faisant une plus grande place au social dans l'enseignement, la formation et la recherche. Ces mêmes atouts pourraient faciliter l'innovation de service et de commercialisation et étayer les stratégies d'innovation sectorielles, notamment dans le tourisme. En outre, les capacités existantes en sciences sociales, en droit et en sciences humaines pourraient faciliter la formation destinée à renforcer la faculté des entreprises à s'approprier le savoir.

Les entreprises multinationales prisent les chercheurs formés au niveau local et semblent disposées à financer des doctorats. Pourtant, les doctorats qui les concernent ne sont guère populaires auprès des étudiants, l'utilité d'un projet pour le monde de l'entreprise étant parfois considérée comme secondaire par rapport aux dispositifs officiels d'évaluation comme les publications scientifiques. Il pourrait être nécessaire d'apporter des changements à la structure d'incitation académique et d'examiner minutieusement les carrières suivies par les chercheurs en dehors du milieu universitaire.

On observe par ailleurs des signes d'engorgement dans le transfert de connaissances depuis l'étranger, avec, par exemple, la faible mobilité des chercheurs et la part modeste de travaux publiés en co-autorat international par rapport aux pays comparables.

Il conviendrait aussi que les pouvoirs publics recensent les compétences qui sont et seront utiles pour l'innovation en général et, plus particulièrement, pour la faculté d'innover du secteur des entreprises, tout en administrant les programmes d'étude requis à cet effet. Aussi importante soit-elle, l'attention accordée, ces dix dernières années, aux chercheurs, à la diaspora scientifique et aux autres compétences d'avant-garde devrait être étendue à un éventail plus large de compétences professionnelles spécialisées. Pour ce faire, il faudrait commencer par réaliser une étude approfondie de la question pour

ensuite instaurer les mécanismes d'inventaire des compétences requises avant de consolider et d'élargir l'harmonisation de l'offre de talents.

D'après les informations disponibles, il est nécessaire de renforcer l'enseignement professionnel (non universitaire) aux niveaux du supérieur et du master, où la Croatie semble accuser un grand retard par rapport aux pays comparables alors que cela est important pour affermir la capacité d'innovation à l'échelle du pays et au niveau de ses entreprises. La forte présence de prestataires privés de services d'enseignement polytechnique est révélatrice d'un vide à combler.

Le transfert des compétences techniques occupera une grande place dans ces efforts, éventuellement à travers l'établissement de liens de coopération avec de grands organismes de formation professionnelle à l'étranger (par exemple, en Allemagne, aux États-Unis et en Irlande) en vue de mettre au point et d'exécuter des programmes de pré-licence professionnelle et de master universitaire. Le cas de l'Irlande, où des instituts de technologie de grande renommée et au taux de réussite élevé ont vu le jour grâce aux Fonds structurels, pourrait servir d'exemple. En plus d'améliorer la qualité des programmes de formation professionnelle et de master, il pourrait être judicieux de s'associer à des organismes réputés dans le monde pour redorer l'image de l'enseignement professionnel auprès des étudiants potentiels.

- *Promouvoir l'étude des sciences et technologies* en suscitant l'intérêt pour ces disciplines et en offrant des places dans les programmes connexes, tout en prenant des mesures visant à améliorer l'attrait des carrières possibles dans ces domaines. Plus précisément, il faudrait s'intéresser de plus près aux besoins de formation des chercheurs qui concernent le secteur des entreprises.
- *Mettre en place des mécanismes favorisant l'interaction entre l'entreprise et l'université s'agissant de la définition des programmes et de l'évaluation dans l'enseignement supérieur,* de manière à remédier à l'inadéquation des compétences mise en évidence par une analyse systématique des déficits de qualifications.
- *Offrir à la population active des moyens supplémentaires de valoriser ses compétences et étendre et faire connaître les possibilités de formation tout au long de la vie.*
- *Faciliter l'entrepreneuriat en développant les compétences dignes d'intérêt.* Mobiliser les capacités existantes en sciences sociales, en droit et en sciences humaines pour renforcer la faculté des entreprises à s'approprier le savoir.

Améliorer la gouvernance du système d'innovation

Gouvernance d'ensemble

La gouvernance de la politique d'innovation croate se caractérise par un manque de coordination, une programmation au coup par coup et l'absence de continuité dans le temps. Le manque d'engagement politique durable a conduit à une orientation et à une planification stratégique anarchiques, à des déficits de réalisation et parfois, du point de vue des parties prenantes, des initiatives des pouvoirs publics insuffisamment crédibles. L'orientation et la programmation stratégiques à long terme ont pâti de la volatilité des budgets de R-D ; au cours des années récentes, ceux-ci ont connu un cycle biennal de croissance à double chiffre, suivi de brutales contractions d'une ampleur tout aussi

importante. Ce type d'instabilité a des incidences négatives sur les ressources humaines, l'investissement et l'activité de recherche à long terme. De la même manière, les mesures ne sont pas suffisamment hiérarchisées et dotées de ressources et n'expriment pas leur plein potentiel en termes d'impact. L'expérience internationale montre qu'il y a beaucoup à gagner quand les échelons supérieurs de l'exécutif se concentrent sur la définition d'une orientation générale et utilisent les ressources publiques pour faciliter et démultiplier l'investissement privé dans l'innovation dans des domaines d'importance stratégique. La mobilisation des ressources dépendra également d'une évolution des perceptions : le fait de donner davantage de visibilité aux succès passés et de souligner leurs retombées économiques tangibles pourrait contribuer à marquer les esprits et à renforcer l'engagement politique en faveur d'une stratégique d'innovation à long terme.

L'administration publique se distingue actuellement par une forte compartimentalisation et des résultats inégaux. Si parfois des instruments alternatifs ont pu être utilisés pour la conception et l'expérimentation de programmes, la programmation manque de cohérence et ne s'inscrit pas encore dans une stratégie à long terme. Des problèmes se posent en particulier du fait d'une « agencification » incomplète (certains programmes et certaines mesures sont gérés par des agences, d'autres par les ministères), d'un déséquilibre dans les politiques, stratégies et plans ainsi que dans leurs ressources, d'une gouvernance inefficace des secteurs très morcelés des établissements d'enseignement supérieur et des établissements publics de recherche et d'une analyse insuffisamment développée de l'action publique (suivi, évaluation) en termes de portée et de qualité. Il existe toutefois des signes clairs d'amélioration, avec la délégation progressive à des agences de la gestion de certains programmes et avec l'exemple de l'ASES, qui semble répondre aux critères européens et sert de point d'ancrage dans le système de l'enseignement supérieur.

La responsabilité de la politique STI est partagée entre trois ministères : le ministère des Sciences, de l'Éducation et des Sports, le ministère de l'Économie et le ministère de l'Entrepreneuriat et de l'Artisanat. Le ministère des Sciences, de l'Éducation et des Sports est l'organisme spécialement chargé des questions STI ; il a la responsabilité principale de la programmation, de la coordination et du suivi des politiques scientifiques et pédagogiques et il joue un rôle important dans la formulation de la politique d'innovation. S'agissant spécifiquement de la politique d'innovation, il partage ses attributions avec le ministère de l'Économie et le ministère de l'Entrepreneuriat et de l'Artisanat. En préparation à l'adhésion à l'UE, un ministère du Développement régional et des Fonds communautaires a été créé pour intégrer et coordonner les multiples politiques et dispositifs de financement de l'UE.

La division actuelle du travail entre la structure gouvernementale (notamment le ministère des Sciences, de l'Éducation et des Sports, celui de l'Économie et celui de l'Entrepreneuriat et de l'Artisanat) et les agences (BICRO, HAMAG-INVEST et FCS notamment) pourrait être améliorée. Bien que l'administration centrale ait délégué un certain nombre de programmes et de mesures à des agences indépendantes au plan opérationnel, d'autres relèvent toujours des ministères. Cette demi-mesure interdit la création d'une masse critique en termes de capacité de gestion et d'information au niveau des agences ; en ce qui concerne la réactivité de l'articulation de la politique publique, elle nuit à la préparation au changement dans la mesure où les individus (et les institutions) tendent à protéger « leurs » programmes et mesures. L'agencification devrait être menée à bien en créant des fonctions d'agence cohérentes et stables assorties de l'indépendance opérationnelle et des mécanismes de gouvernance nécessaires. La

mutualisation dans l'exécution des programmes facilite la constitution d'une plus vaste panoplie d'instruments et l'instauration d'un marché interne du travail spécialisé.

Avec la programmation prochaine des Fonds structurels, des stratégies à long terme pourraient être introduites dans un certain nombre de secteurs. L'enjeu, au-delà de l'orientation à long terme des programmes des Fonds structurels, sera de veiller à ce que ceux-ci soient étroitement articulés avec les politiques sectorielles correspondantes. Les agences sectorielles (alimentation, énergie, etc.) peuvent devenir des partenaires stratégiques pour l'accès à ces secteurs et jouer également le rôle de partenaires dans la réalisation des objectifs de la politique d'innovation.

Comme on l'a vu, la Croatie possède des acteurs institutionnels et un bilan en matière de politique d'innovation sur lesquels elle peut s'appuyer et qu'elle peut développer pour se préparer aux étapes à venir. Il faudra pour cela un engagement politique, un esprit d'initiative et des plans de mise en œuvre réalistes poursuivis de façon énergique et systématique dans le temps.

- *Se préoccuper de porter en permanence la politique de l'innovation jusqu'aux plus hauts niveaux de l'administration*. Divers moyens ont été utilisés à cet effet par les autres pays, notamment la création d'un portefeuille ministériel spécialisé, l'attribution de responsabilités au Cabinet du Premier Ministre ou la création d'un Conseil de haut niveau, parfois présidé par le Premier Ministre. Quel que soit le dispositif retenu, celui-ci ne produira les résultats souhaités que s'il est concrètement épaulé par un solide engagement politique.
- *Donner une priorité élevée à un flux régulier de financements adéquats de la R-D et de l'innovation*. Il s'agit d'un préalable à la crédibilité, à la confiance, à la planification à long terme et surtout à une réforme profonde des secteurs des établissements d'enseignement supérieur et des établissements publics de recherche. L'adhésion à l'UE et la nouvelle période de programmation de Fonds structurels (2014-20, plus prolongement de deux années) créeront une opportunité historique qui ne doit pas être manquée. Comme les écueils potentiels sont nombreux, la définition des programmes d'action, la planification, le dispositif institutionnel et la mise en œuvre opérationnelle sont très importants.
- *Établir une division claire des responsabilités et fusionner les compétences qui font double-emploi entre les ministères compétents et les agences indépendantes sur le plan opérationnel concernées (comme la BICRO et la FCS).* En règle générale, les ministères devraient se concentrer sur la formulation de la politique et l'orientation stratégique et déléguer l'exécution aux agences indépendantes sur le plan opérationnel. Les agences devraient entretenir des relations solides et explicites avec les ministères, faire l'objet d'un système fiable de supervision et opérer dans un contexte permettant un apprentissage et une amélioration systématiques. La participation à des environnements internationaux pour l'apprentissage et le contrôle de qualité est importante. L'ASES peut jouer un rôle modèle à plusieurs égards. La BICRO et la FCS devraient être élargies et dotées des pouvoirs nécessaires pour assumer pleinement le rôle respectif d'Agence croate pour l'innovation et de Conseil pour la recherche scientifique. Des mécanismes adéquats de gouvernance et de gestion devraient être mis en place. La participation à des organisations internationales (TAFTIE, Science Europe) et des évaluations externes régulières contribueront à l'assurance-qualité.

- *Donner une priorité élevée à l'articulation des programmes de soutien nationaux avec les Fonds structurels.* Les Fonds structurels offrant un degré élevé de flexibilité, tout en fixant un cadre stable à long terme, ils peuvent être utilisés pour accomplir des tâches essentielles pour *la poursuite du développement du système d'innovation*. Il s'agit notamment d'engager et de soutenir la réforme des secteurs des établissements d'enseignement supérieur et des établissements publics de recherche afin de renforcer les uns et les autres, et d'établir un système d'instruments et des mesures au service d'une conception large de l'innovation (par exemple innovation non basée sur la R-D, innovation dans les services, mise en œuvre de normes et de réglementations comme vecteurs de l'innovation, travail en réseau, conseils, etc.). Cela renforcerait la tendance vers l'évaluation internationale, la pertinence mondiale et la collaboration internationale et pourrait améliorer la qualité et l'impact international de la production de savoirs.

Articulation de la politique et instruments spécifiques

Au cours de la décennie écoulée, la Croatie a adopté et mis en œuvre un large éventail d'instruments de politique d'innovation. S'agissant des entreprises, les principaux instruments sont réunis au sein de la BICRO et ils sont fortement orientés vers le soutien des entreprises nouvelles à vocation technologique, les centres de transfert, les incubateurs et les centres de R-D, la recherche sous contrat avec des établissements d'enseignement supérieur et des établissements publics de recherche, l'aide aux projets de validation de concept et la participation à EUREKA. Bien que ces instruments demeurent en place, les services de conseil à l'intention des PME de haute technologie et les aides à la R-D pré-commerciale ont été arrêtés ; la fourniture de capital-risque n'a jamais débuté. Au total, l'activité de la BICRO demeure toujours fortement conditionnée par les concepts en vigueur à l'époque de sa création : innovation basée sur la recherche, exploitation de la recherche du secteur public, préférence pour les PME de haute technologie, etc. La BICRO n'a pas élargi ses instruments pour relever des enjeux tels que la capacité d'assimilation des entreprises et une vision plus large de l'innovation. Le soutien de la BICRO aux entreprises semble avoir produit un certain nombre de succès (création d'entreprises et d'emplois, mobilisation de co-financements privés) malgré de fortes contraintes sur les ressources. HAMAG-INVEST est une autre agence ciblant le secteur des entreprises. Elle fournit principalement un soutien financier général et, plus récemment, des services de conseil aux PME. Depuis quelques années, elle s'appuie de plus en plus sur les agences de développement régional ou les centres d'affaires pour centraliser son offre de services. L'innovation reste, au mieux, un aspect secondaire du programme d'action d'HAMAG-INVEST, mais cela devrait changer avec sa fusion prochaine avec la BICRO. Il ne semble pas exister de tentatives systématiques pour coordonner les travaux des agences spécialisées (énergie, environnement, alimentation, etc.) avec les politiques d'innovation ou entre ces agences et les instituts publics de recherche spécialisés, ce qui pourrait être une source de synergies entre les politiques sectorielles et la politique générale pour l'innovation.

Les incitations fiscales actuelles à la R-D semblent bénéficier avant tout aux grandes entreprises ou à celles de taille moyenne, le soutien fourni visant à ce qu'elles maintiennent ou augmentent leurs investissements dans la R-D en Croatie. Le soutien est beaucoup plus limité à l'égard des petites entreprises moins tournées vers la R-D et de l'innovation de façon plus générale. Il conviendrait peut-être de revoir les incitations fiscales sous l'angle de leurs coûts d'opportunité et de leurs autres impacts potentiels.

La FCS gère une panoplie d'instruments en direction des secteurs de l'enseignement supérieur et de la recherche publique. Principalement axés sur les problèmes rencontrés par les établissements d'enseignement supérieur et les établissements publics de recherche, ils prennent généralement la forme de subventions (pour les projets de recherche, la formation des doctorants, l'attraction de talents étrangers, la réforme de la gestion de l'enseignement supérieur ou l'internalisation, notamment l'accès aux infrastructures de recherche internationales). Le nombre des dispositifs de financement a été réduit quand la CFS a repris au ministère des Sciences, de l'Éducation et des Sports ses mécanismes de subventions pour la recherche.

La principale question concernant l'articulation et la coordination des politiques tient moins à un réglage fin des différents programmes et instruments et à leur coordination qu'au fait que ceux-ci sont insuffisamment dotés. La dotation globale de la BICRO et même le financement géré via les autres dispositifs et incitations fiscales sont exceptionnellement bas au regard des normes internationales. La FCS est loin de disposer des ressources nécessaires pour avoir un impact profond sur la communauté de la recherche scientifique.

En ce qui concerne l'articulation générale de la politique d'innovation, celle-ci se concentre surtout sur le transfert de technologies, les incubateurs et la collaboration universités-industries. Cette orientation, notamment la mise en œuvre de divers instruments et programmes de financement, reflète à certains égards le débat international dominant sur l'action publique. La contrainte majeure de la Croatie pourrait bien être l'absence d'acteurs dotés de capacités de R-D et d'innovation suffisantes et d'incitations institutionnelles à l'accumulation de capacités (ou à bénéficier en retour de ressources additionnelles), plutôt que l'absence de passerelles ou d'interactions entre l'université et l'entreprise proprement dites (pour désirables qu'elles soient). Cela tendrait à indiquer le besoin de rééquilibrer l'articulation de la politique pour y inclure des instruments en faveur d'un renforcement général des capacités, d'introduire une réforme institutionnelle qui oriente les incitations dans ce sens et récompense les résultats et d'engager des interventions qui renforcent les capacités des entreprises et la demande d'innovation (et de services connexes). Cela signifiera en particulier de développer et d'enrichir l'éventail des services de financement et autres services de soutien qui prennent en compte l'innovation au sens large, via un renforcement des capacités, l'amélioration de la productivité, l'innovation progressive et la montée en niveau. Pour les agences, cela nécessite une fonction d'agence associant un portefeuille d'instruments de financement et des services de soutien non monétaires tels que conseils, mentorat, courtage d'information et articulation avec les autres politiques. Le renforcement des compétences ainsi que la stabilité et la continuité dans les agences et parmi leur personnel sont des exigences essentielles pour un impact durable des financements.

- *Insister sur l'accroissement de la capacité d'assimilation des entreprises, préalable essentiel à toute forme d'innovation.* Articuler systématiquement les mesures de politique d'innovation avec l'enseignement et la formation (notamment la formation professionnelle et la formation continue) et avec les mesures visant à promouvoir l'emploi de ressources humaines hautement qualifiées.
- *Utiliser les Fonds structurels et les sources nationales pour promouvoir le renforcement des capacités et introduire un changement radical dans les ressources disponibles pour l'innovation* (ressources humaines, infrastructures, soutien à l'innovation en entreprise, etc.).

- *Privilégier davantage les instruments qui stimulent la demande d'innovation et de services liés à l'innovation,* notamment à long terme. Cela implique une certaine réorientation en direction de la demande d'une approche actuellement « poussée par la science » et dominée par l'offre.
- *Réexaminer,* compte tenu de la baisse prononcée des dépenses de R-D des entreprises, *le succès relatif de l'ensemble des mesures utilisées jusqu'à présent (financement direct, incitations fiscales, etc.) pour stimuler la R-D des entreprises.*
- *Acquérir une meilleure compréhension des politiques structurelles,* notamment s'agissant des établissements publics de recherche à vocation sectorielle (agriculture, santé, énergie, environnement, etc.). Des alliances stratégiques entre les agences chargées de la surveillance, de la supervision ou de la mise en œuvre des réglementations et politiques sectorielles et les établissements publics de recherche spécialisés pourraient offrir des perspectives intéressantes. L'adoption des normes et réglementations européennes représentera un défi majeur – et pourrait être mise au service de l'innovation – au cours des cinq à dix prochaines années.

Gouvernance des universités et des établissements publics de recherche

L'organisation interne actuelle des universités et des établissements publics de recherche présente des obstacles pour une gouvernance efficace, et leurs mécanismes de financement sont complexes et ne sont pas au niveau des bonnes pratiques internationales. De plus, le financement des universités et des établissements publics de recherche est morcelé. Les salaires, les investissements et les dépenses courantes sont financés par des sources différentes, selon des logiques différentes. Cela est un obstacle à l'introduction de stratégies cohérentes et d'une planification à long terme. De plus, comme leurs facultés sont très autonomes, la gestion et la gouvernance de la plupart des universités (dont la plus importante, l'Université de Zagreb) sont peu développées. Du fait des modes de financement des établissements d'enseignement supérieur et des établissements publics de recherche et d'une forme de gouvernance intrinsèquement hostile au changement, il n'y a pas eu de réforme significative. Nombre de mesures et instruments introduits au cours de la dernière décennie agissaient à la marge, sans que les mécanismes sous-jacents soient modifiés. L'adhésion à l'UE et la disponibilité des ressources des Fonds structurels créeront des opportunités pour accroître le financement et améliorer la gouvernance de la recherche publique.

Le manque actuel de cohésion, notamment dans les universités les plus grandes, les plus anciennes et les plus significatives, empêche le secteur de l'enseignement supérieur de concrétiser tout son potentiel et représente une source de risques. Tout d'abord il tend à empêcher les « associations novatrices », notamment les approches interdisciplinaires dans l'enseignement et dans la recherche. Deuxièmement, comme de nombreuses problématiques régionales (et sociétales) appellent une approche interdisciplinaire et multidisciplinaire concertée, le morcellement des structures institutionnelles affaiblit la capacité des institutions à répondre aux préoccupations régionales et donc à attirer des financements de la part de l'industrie. Troisièmement, des limitations intrinsèques de la capacité des unités de base à coordonner les efforts et les programmes et à mettre en commun les ressources pour la fourniture de services communs conduit soit à des redondances soit à une couverture incomplète (notamment lorsqu'il existe des contraintes de ressources) dans des fonctions de soutien comme les services administratifs, les services d'achat, les services techniques et l'aide aux étudiants. Une utilisation inefficiente de

ressources limitées entraine en Croatie un coût d'opportunité plus élevé que dans la plupart des pays de l'UE, car le pays est à un stade crucial de son développement. Quatrièmement, le morcellement des fonctions peut décourager la planification stratégique des ressources, la mise en place de grands programmes de recherche, l'investissement dans les infrastructures, la participation à de grandes initiatives de recherche et, de façon plus générale, la mobilisation d'une « masse critique » dans des contextes pour lesquels la taille est essentielle. Cinquièmement, le manque de cohésion est un obstacle à l'avènement d'un sentiment de mission partagée, d'un sens des responsabilités et d'une identité claire. Tous ces éléments sont importants pour la capacité d'une université à se différencier, à améliorer sa visibilité, à occuper une position dans le paysage national et international de l'enseignement supérieur et, par conséquent, pour son succès à long terme dans un secteur de plus en plus tourné vers le marché. Enfin, le manque de cohésion complique l'amélioration de la gouvernance au moyen de principes de financement négociés, basés sur les résultats et tournés vers l'avenir.

Une réforme générale des dispositifs de gouvernance des universités les plus anciennes du pays semble s'imposer depuis longtemps et sera essentielle pour que les universités jouent pleinement leur rôle économique et social. Un défi majeur pour le gouvernement sera de négocier un projet de réforme réaliste avec les universités anciennes et leurs facultés et académies. Une compréhension commune des opportunités et surtout des préoccupations derrière la réaction de rejet vis-à-vis d'une évolution ressentie comme une « centralisation » sera indispensable pour parvenir à une solution acceptée par le plus grand nombre. Comme pour toutes les recherches de consensus, le succès exigera de maintenir en permanence le dialogue et de bâtir pas à pas la confiance entre les diverses parties prenantes.

L'amélioration de la gouvernance nécessitera également de trouver un bon équilibre dans la division des responsabilités entre l'administration centrale (Ministère des Sciences, de l'Éducation et des Sports et agences comme la FCS) et les établissements d'enseignement supérieur. Comme dans les autres pays, l'évolution vers une plus grande autonomie des institutions doit aller de pair avec davantage de responsabilisation. Les instruments de gouvernance les plus courants pour renforcer la responsabilisation sont notamment le suivi des résultats ou des produits, et la mise en place d'un système de notification des performances, les contrats de performance ou des instruments analogues. Ces contrats améliorent la responsabilisation vis-à-vis des résultats obtenus, sans remettre en question l'indépendance intellectuelle des universités. De telles pratiques s'observent en Afrique du Sud, en Australie, au Canada, aux États-Unis, en Irlande, en Nouvelle-Zélande, aux Pays-Bas et au Royaume-Uni.

S'agissant des établissements publics de recherche, le contexte croate est également hétérogène (à l'exception notable de l'Institut Rudjer Boskovic). De nombreuses organisations sont actives dans les sciences humaines, les sciences sociales, les sciences de l'ingénieur, la santé et l'agriculture. Une pluralité d'acteurs dans un domaine donné peut être positive dans la mesure où elle peut favoriser la concurrence, la diversité des approches et l'indépendance dans la fourniture de résultats scientifiques. Mais faute d'un financement basé sur les résultats ou d'un financement substantiel avec mise en concurrence des projets, la tendance à rivaliser sur les plans de la qualité et de la pertinence est limitée. De plus, le morcellement des capacités entre plusieurs organisations peut entraver la collaboration et empêcher des activités pour lesquelles la taille est essentielle aux niveaux national et international. Le fait de conditionner le financement aux résultats via des mécanismes basés sur les performances permettrait aux établisse-

ments publics de recherche de poursuivre des objectifs ambitieux avec des sources de financement diversifiées.

- *Renforcer les universités en adaptant leurs mécanismes de financement aux bonnes pratiques internationales, notamment par l'introduction d'une budgétisation basée sur les résultats.* Cette budgétisation basée sur les résultats devrait reposer sur :
  - une autonomie budgétaire dans le financement des dépenses de personnel, de même que sur une mise à niveau générale de leur infrastructure physique et de leurs équipements de recherche ;
  - une notion de « résultats » qui prenne dûment en compte les succès passés et les plans pour l'avenir ;
  - une évolution vers une gestion simplifiée des universités et l'unification de la gouvernance, de manière à accroître la flexibilité et la capacité de réponse face à l'évolution des demandes en matière d'enseignement, de formation et de recherche.
- *Renforcer les établissements publics de recherche en introduisant des principes de budgétisation par résultats et des principes de gouvernance connexes.* Le principal défi en la matière est de mettre en œuvre des modèles de pilotage – principalement par la négociation de contrats de performance – qui aideront à renforcer la recherche publique en encourageant : les liens avec les entreprises privées et les établissements publics, principalement par le développement de la recherche sous contrat et de la fourniture de services connexes (notamment formation et conseils) ; la productivité scientifique, tout particulièrement par une collaboration plus étroite avec le secteur de l'enseignement supérieur, et la collaboration internationale.
- *Utiliser les Fonds structurels pour renforcer les universités et les établissements publics de recherche et soutenir le processus de réforme par des ressources budgétaires additionnelles et une amélioration de la gouvernance.* Les Fonds structurels offrent une possibilité importante de création de nouvelles infrastructures de recherche avec un programme de recherche, des missions, des groupes cibles et une gouvernance bien définis. Dans l'idéal, ces nouvelles structures devraient être implantées dans des établissements d'enseignement supérieur et des établissements publics de recherche existants, avec des liens bien définis avec l'ensemble du système. Une priorité élevée devrait être donnée à la formation de jeunes chercheurs.
- *Encourager les différentes universités à se spécialiser dans divers types de liens avec l'industrie.* Si certaines entreprises peuvent être mieux placées pour répondre aux besoins de grandes entreprises disposant de leurs propres laboratoires de R-D, d'autres peuvent être mieux à même de fournir des services aux PME.
- *Privilégier davantage les mesures visant à doter les diplômés de qualifications plus pertinentes,* comme le développement des programmes d'enseignement, les stages en entreprise et le co-financement des titulaires de doctorat. C'est dans la formation de diplômés bien qualifiés que réside de loin l'impact le plus significatif des universités sur la capacité d'innovation des entreprises croates. La formation de personnel qualifié pour la recherche et l'innovation est aussi une fonction importante des établissements publics de recherche.

Évaluation

Les éléments disponibles sur l'efficience et l'efficacité de l'innovation financée par des fonds publics sont contrastés. Les scientifiques croates sont plus « productifs » que leurs homologues de pays comparables. Toutefois, les publications scientifiques et brevets croates font l'objet de moins de citations que ceux des pays comparables. Ce faible impact international pourrait exprimer une pertinence et une qualité médiocres des productions intellectuelles. Le fait de faire de l'évaluation une pratique courante et de la coupler avec le financement institutionnel contribuera à la responsabilisation, aidera à renforcer les entités hautement performantes et pourrait faciliter l'identification des changements nécessaires pour améliorer les performances.

Au cours des années récentes, la Croatie a beaucoup progressé dans l'introduction de mécanismes d'évaluation formelle, notamment avec la création de l'Agence pour les sciences et l'enseignement supérieur. L'ASES est en charge de l'accréditation et de l'assurance-qualité dans les établissements d'enseignement supérieur et les établissements publics de recherche en ce qui concerne à la fois l'enseignement et la recherche. Son engagement à l'égard de l'évaluation internationale par les pairs, la transparence de ses procédures et sa volonté d'apprendre au contact des meilleures pratiques internationales sont encourageants. Un moyen tangible d'améliorer sa pertinence économique est d'associer des représentants de l'industrie aux évaluations des programmes d'enseignement et de recherche des établissements d'enseignement supérieur.

S'agissant toutefois de l'évaluation des programmes et des mesures de soutien pour la recherche et l'innovation, on peut dire que les mécanismes d'évaluation externe n'en sont qu'à leur tout premier stade de développement. Si certains programmes ont été formellement évalués, la pratique n'est pas systématique et les résultats des évaluations ne sont pas toujours rendus publics. Cela limite le retour d'information pour les parties prenantes et la reproductibilité des politiques publiques. C'est également une opportunité manquée d'améliorer l'allocation des ressources publiques. L'absence d'un acteur indépendant doté d'un mandat pour l'évaluation des programmes empêche l'accumulation d'expériences issues d'un large éventail de programmes.

L'objectivité et l'indépendance sont importantes et il conviendrait d'utiliser plus largement des mesures systématiques, comme la relation entre les ressources investies et les résultats, complétées par des évaluations qualitatives encadrées, faisant intervenir des panels d'évaluateurs internationaux. Dans le même temps, il importe dans la pratique de l'évaluation d'éviter de trop dépendre des indicateurs quantitatifs.

- *Envisager de rendre obligatoire l'évaluation externe des programmes en cours et futurs.* Les résultats des évaluations devraient être réintroduits dans le cycle de l'action publique.
- *Donner une forte priorité à l'évaluation des institutions, de leur gouvernance et de leur gestion* afin de renforcer les mécanismes de gouvernance et, à terme, les résultats.
- *Revoir les dispositifs d'évaluation existants afin de trouver un meilleur équilibre en termes de quantité et de qualité des produits de la recherche* et, plus généralement, en ce qui concerne les types de critère appliqués.
- *Tirer parti des possibilités d'amélioration du système et de la culture d'évaluation que permettra la gestion des Fonds structurels.* L'obligation d'évaluer divers types de propositions et de procéder à des évaluations à mi-parcours et en fin de projet

peut être déterminante dans la mise en place d'un système d'évaluation rigoureux susceptible d'avoir des retombées dans d'autres domaines.

- *Envisager d'avoir recours à des « équipes mixtes » d'évaluateurs nationaux et internationaux* pour le transfert de savoir-faire sur l'évaluation.
- *Envisager de créer une plateforme associant chercheurs, décideurs publics et praticiens* chargés de la mise en œuvre des programmes pour des échanges d'expérience sur la conduite et les résultats des évaluations.

Promouvoir l'innovation dans le secteur des entreprises

Les entreprises croates en général (et les PME en particulier) sont moins susceptibles de faire de l'innovation que leurs homologues des pays de l'UE, et même lorsqu'elles la pratiquent, elles y consacrent moins de ressources. Dans une certaine mesure, la propension des entreprises à innover de façon systématique est limitée par les spécificités de la structure industrielle de la Croatie, telles que la taille des entreprises, la répartition par secteur et la part globale relativement faible de l'emploi dans les secteurs à forte intensité de connaissance, alors que la part de l'emploi dans les services marchands à forte intensité de connaissance est forte. Toutefois, les dépenses de R-D du secteur des entreprises sont faibles au regard des normes internationales, même comparées à celles des pays ayant une structure industrielle analogue. Le déclin relatif de l'intensité de R-D du secteur des entreprises (dépenses de R-D rapportées au PIB) et le faible niveau de dépenses de R-D de ce secteur (DIRDE) révèlent un écart qui se creuse avec un grand nombre d'économies avancées et émergentes. De plus, des données internationalement comparables sur la coopération entre entreprises dans le domaine de l'innovation placent la Croatie au dernier rang d'un groupe de pays similaires. Les aides publiques aux entreprises sous la forme de financement direct de la R-D sont exceptionnellement faibles au regard des normes internationales, et la situation n'est guère meilleure si l'on prend en compte le soutien public via les incitations fiscales.

Les deux industries dominantes (télécommunications et produits pharmaceutiques) assurent environ un tiers de l'ensemble des dépenses de R-D des entreprises, le reste étant réparti entre diverses branches. (La structure des exportations présente une configuration analogue). La « productivité technologique », mesurée par le taux de brevets rapporté à la DIRDE, est faible par rapport aux normes internationales. Les modestes résultats de la Croatie en matière de dépôts de brevets ne s'expliquent pas uniquement par son statut de petit pays, et des facteurs structurels et institutionnels entrent aussi en jeu comme l'absence de sièges d'entreprises multinationales, la prédominance de la recherche publique dans le système de recherche (et son mode de gouvernance), l'intensité et la qualité des liens entre les acteurs du système d'innovation et l'attractivité des dispositifs de protection de la propriété intellectuelle.

La présence combinée d'une productivité scientifique élevée et de chercheurs d'un bon rapport coût-efficacité (notamment par comparaison avec des membres plus anciens de l'UE) indique que la Croatie présente toujours un certain attrait pour la R-D financée par les entreprises. De fait, pour les activités de R-D des multinationales, la Croatie est comparable à d'autres pays de la région, même si ceux-ci se situent en-deçà des normes de l'UE. La Croatie pourrait donc disposer d'un certain potentiel pour attirer de nouveaux financements de l'étranger. Cela dépendra, entre autres choses, de la capacité de la politique STI croate à favoriser l'émergence de pôles de compétence et à offrir les incitations nécessaires (voir plus loin).

Le soutien à l'innovation en entreprise a privilégié l'interface entre la recherche publique et le secteur des entreprises, pour favoriser une collaboration plus étroite entre les secteurs et la commercialisation de la recherche publique. Cette orientation est évidente dans le dosage général des instruments employés et leurs parts relatives dans le financement, à savoir la place dominante donnée aux incubateurs et au transfert de technologie, principalement en provenance de la recherche publique et de l'enseignement supérieur, en direction du secteur privé, en privilégiant les domaines technologiques prometteurs.

Le débat sur la politique STI a conceptualisé la contrainte forte d'une *faible interface* entre la science et l'industrie. Le contraste entre les perceptions d'une solide base scientifique et l'absence évidente de fort impact économique peut avoir contribué à l'émergence d'un tel point de vue. Cependant, les résultats de la Croatie dans le domaine scientifique sont à la traîne, comparés à ceux de pays comparables. Un aspect crucial est que l'activité d'innovation et les capacités en entreprises sont faibles sur un certain nombre de plans. De ce fait, si l'on fait le bilan des éléments disponibles - quantité et qualité de la production scientifique, proportion relativement élevée de recherche appliquée dans les établissements d'enseignement supérieur et faibles engagements des entreprises en faveur de la R-D et autres activités à forte intensité de connaissance – celui-ci conforte résolument l'idée que la contrainte ne se situe pas à l'interface mais *au cœur* des capacités d'innovation du secteur public et du secteur des entreprises. Bien entendu, la politique en faveur de l'interface entre la recherche publique et la recherche en entreprise a aussi produit des résultats positifs ; mais il s'agit de souligner ici que l'impact de ces résultats pourrait être plus important si les pouvoirs publics s'attachaient à libérer l'accumulation de capacités d'innovation à l'échelle de tout le système.

De façon générale, le soutien à l'innovation en entreprise se caractérise par une importance majeure, et peut-être excessive, donnée aux formes d'innovation basées sur la R-D et, plus particulièrement, à la commercialisation de la recherche publique et au soutien des entreprises nouvelles de haute technologie. Cette approche tirée par la science et centrée sur des domaines-frontières a été utile pour certains segments du secteur des entreprises. Elle s'est toutefois révélée moins adaptée aux besoins de la majorité des entreprises qui se situent dans une position de transition critique entre ne pas faire d'innovation et se lancer pour la première fois dans une activité d'innovation en entreprise et à ceux de la minorité innovante qui n'a pas les ressources et capacités internes (en matière d'ingénierie, de conception, de commercialisation et de technologie de l'information) nécessaires pour s'engager dans l'innovation de produits nouveaux à l'échelle internationale. Ce déséquilibre est dû à l'orientation du système de recherche publique, à la présence de contraintes significatives sur les ressources pour dynamiser le renforcement des capacités, au fait que la politique d'innovation est depuis longtemps liée à la science et à une contextualisation parfois inadaptée de la réflexion politique et des instruments importés de l'étranger.

Pour un soutien général à l'innovation en entreprise, notamment l'accumulation durable de moyens d'innovation interne dans un plus grand nombre et une plus grande diversité d'entreprises, il faudra s'adresser plus directement aux entreprises et à leurs besoins, affecter davantage de ressources et utiliser plus largement les instruments d'action. Pour donner une idée du défi qu'il faudra relever, le soutien public à l'innovation en entreprise devra augmenter d'au moins un ordre de grandeur ne serait-ce que pour simplement atteindre le niveau des engagements des autres nouveaux États membres de l'UE.

- *Accroître le soutien public à l'innovation en entreprise en général, tout en améliorant l'articulation de la politique et la fourniture des aides.* Le soutien devrait être élargi pour prendre en compte les formes d'innovation non basées sur la R-D (comme les innovations organisationnelles, de commercialisation et de services) et couvrir un plus large éventail d'investissements liés l'innovation. Une aide publique à l'emploi à forte intensité de connaissance (chercheurs, mais également spécialistes en études techniques, ingénierie, commercialisation et technologies de l'information) à la formation et à l'enseignement (par exemple cours à temps partiel en université à l'intention du personnel des entreprises) pourrait être envisagée. Le soutien à l'innovation dans les services pourrait être encore renforcé par une orientation sectorielle plus ciblée, tourisme vert par exemple.
- *Adopter une approche nuancée tenant compte des différents besoins des diverses catégories d'entreprises* (taille, secteur, orientation vers le marché) à divers stades de leur développement (depuis les entreprises nouvelles jusqu'aux entreprises matures). Cela a des implications sur la façon dont le soutien est organisé et fourni (économies d'échelle et de gamme).
- *Évaluer l'efficacité des grands programmes, notamment les incitations fiscales à la R-D,* afin de déterminer les avantages et les coûts de ces instruments et de les comparer avec d'autres moyens d'action. En ce qui concerne les incitations fiscales, il conviendrait de rechercher des moyens de limiter les risques découlant des activités d'optimisation fiscale transfrontière des multinationales.
- *Intégrer la dimension de l'innovation dans l'ensemble des mesures de soutien public à l'intention de l'industrie, notamment les aides sectorielles.* Rechercher les synergies entre les aides dispensées via les instruments existants et l'adoption des réglementations de l'UE. Envisager une utilisation plus créative des fonds pour les besoins récurrents en matière de marchés publics de manière à soutenir l'innovation sectorielle.
- *Renforcer la capacité des entreprises croates à s'approprier et commercialiser le savoir* issu tant de l'intérieur que de l'extérieur de la Croatie, par exemple en fournissant un soutien technique et matériel pour la participation à des initiatives internationales de R-D en collaboration (ou comme le Programme-Cadre de l'UE et EUREKA).
- C*oncentrer les efforts pour attirer l'IDE dans les secteurs à forte intensité de connaissance.* L'expérience de l'Irlande montre que des résultats peuvent être obtenus en s'appuyant sur un organisme indépendant d'encouragement de l'IDE disposant d'une autonomie d'action suffisante, sur des investissements ciblés dans les qualifications, sur une réforme globale du marché du travail et de la réglementation, sur l'intégration avec les marchés internationaux et sur la mobilisation des réseaux de la diaspora.
- *Envisager l'introduction de mesures de soutien des réseaux inter-entreprises (ou d'entreprise à entreprise),* éventuellement ciblées sur des secteurs et/ou chaines d'approvisionnement spécifiques, pour faciliter les retombées entre entreprises capitalisant sur divers modes d'innovation.

Renforcer les liens dans le système d'innovation

La collaboration université-industrie, mesurée par le nombre de co-publications public-privé par million d'habitants, se situe à environ la moitié de la moyenne de l'UE27. Plus encourageant toutefois est le fait que le financement par les entreprises de la R-D dans l'enseignement supérieur est légèrement au-dessus des moyennes de l'UE et de l'OCDE. Les filiales de multinationales, notamment, semblent apprécier les capacités des universités croates et ont exprimé leur intérêt pour le cofinancement d'un plus grand nombre d'étudiants en doctorat. Toutefois, ces possibilités sont souvent perçues comme incompatibles avec les critères actuels d'évaluation des chercheurs. La part des entreprises dans le financement de la R-D dans les établissements publics de recherche est faible, de l'ordre de 5 %, soit la moitié de ce qu'elle est dans les établissements d'enseignement supérieur. À plus long terme, les liens pourraient être négativement affectés par un effritement de la position dominante des sciences de l'ingénieur, comme en témoigne l'évolution de leur part relative dans les publications scientifiques au cours de la décennie écoulée. Les améliorations dans d'autres secteurs du système d'innovation, notamment dans les ressources humaines, le soutien au secteur des entreprises et le renforcement général des capacités devraient affecter les liens et les flux de connaissance.

Indépendamment d'un petit nombre de filiales de multinationales disposant de services de R-D, les rares ressources consacrées à la recherche et à l'innovation dans la majorité des entreprises limitent le potentiel de R-D systématique et l'intensité et la qualité des liens entre la R-D et l'innovation. Les pays dans lesquels le secteur des entreprises se caractérise par des capacités d'innovation faiblement développées et une faible propension à investir dans la R-D et l'innovation sont en général confrontés au défi d'avoir à dépasser un « équilibre de bas niveau » illustré par une demande effective et une offre faibles de services liés à l'innovation et la recherche. Dans une telle situation de blocage - observable dans de nombreux pays - les établissements publics de recherche et les entreprises ne retirent pas d'acquis de l'apprentissage mutuel et de la coopération les uns avec les autres. Les établissements de recherche restent en général déconnectés de l'économie nationale ; au mieux, ils ont des liens avec des établissements de recherche et des entreprises de l'étranger (par exemple via les programmes européens). Cette situation n'est pas propice à la création d'effets de retombées localisés et de boucles de rétroaction positives caractéristiques d'économies qui se développent grâce à l'innovation. Une tâche majeure est de concevoir des politiques qui encouragent le développement des capacités internes requises et favorisent ce type de dynamisme.

Les efforts en cours pour renforcer les liens et l'adéquation avec les besoins du secteur des entreprises devraient être poursuivis. Il importerait d'adopter pour les liens université-industrie une définition plus générale que celle qui a été utilisée jusqu'à présent, et qui aille au-delà des projets de recherche conjoints, du transferts de technologie et de l'essaimage pour englober les consultations permanentes sur le contenu des qualifications, l'introduction de « formation en alternance » avec des stages en entreprise de plus longue durée (en général un an), des ateliers conjoints, l'implication de l'industrie dans les écoles doctorales, l'élaboration de doctorats professionnels relevant de critères distincts pour l'avancement et des programmes d'étude personnalisés en établissements d'enseignement supérieur pour les personnes occupant déjà un emploi (cours à temps partiel ou d'été). On peut également imaginer d'explorer l'utilisation d'instruments innovants pour capitaliser sur les connaissances particulières des entreprises multinationales en matière de production et de conception, au moyen de programmes de formation en cours d'emploi pilotés par des établissements d'enseignement supérieur et financés par le gouvernement dans les locaux de filiales de multinationales.

- *Saisir l'opportunité offerte par les Fonds structurels de l'UE pour créer des capacités robustes et durables de recherche et d'innovation en collaboration.* L'attention à des domaines d'applications industrielles et autres qui répondent aux besoins et aux objectifs des parties intéressées est capitale.
- *Maintenir, et chaque fois que possible accroître, la recherche tournée vers l'industrie dans les universités*. Dans le même temps, examiner les options envisageables pour la création d'organisations complémentaires (soit à titre indépendant, soit dans le cadre d'établissements publics de recherche existants soit sous la forme d'un partenariat public-privé) centrées sur la fourniture de services d'innovation pour un plus large éventail d'entreprises.
- *Faciliter la collaboration université-industrie non seulement dans la R-D formelle mais aussi dans l'enseignement, la formation et l'innovation non basée sur la R-D.* La possibilité de dispositifs financés par les pouvoirs publics pour une formation en cours d'emploi dans les locaux des filiales de multinationales peut également être examinée.
- *Envisager le recours à des appels à propositions avec mise en concurrence* afin de susciter et d'identifier des idées et des configurations ou consortiums prometteurs.
- *Encourager la formation de chercheurs pour le secteur des entreprises* en introduisant des changements appropriés dans les incitations proposées aux étudiants, notamment l'introduction de programmes de doctorats professionnels.
- En particulier, *revoir les mécanismes et critères d'évaluation des scientifiques* (depuis la formation jusqu'aux postes élevés) afin d'encourager la collaboration avec l'industrie. Les critères et méthodes d'évaluation devraient être adaptés pour répondre à une situation dans laquelle une grande part de la collaboration pour l'innovation pourrait concerner de petites entreprises dont les activités d'innovation ne débouchent généralement pas sur des droits de propriété intellectuelle ou des publications scientifiques.
- *Prendre des mesures concrètes pour renforcer la place de disciplines importantes pour l'innovation industrielle* dans les universités et instituts publics de recherche du pays.

Promouvoir la création d'une masse critique, l'excellence et la pertinence dans la recherche publique

En Croatie, les établissements d'enseignement supérieur et les établissements publics de recherche travaillent sur un large éventail de sujets. Toutefois, les sciences de l'ingénieur, et dans une moindre mesure l'agriculture et les sciences de l'environnement, de même que la chimie, la biochimie et la pharmacologie, ont connu un recul relatif. De plus, les publications dans ces disciplines ont un impact en termes de citations relativement médiocre (bien que celui-ci s'améliore) et une présence limitée dans le Top 10 %. La Croatie se classe médiocrement au regard de ces critères, notamment vis-à-vis des nouveaux États membres de l'UE ayant un revenu par habitant analogue. Le déficit de qualité de la science croate semble au moins en partie avoir son origine dans des caractéristiques institutionnelles comme la gouvernance des systèmes de recherche publique et les incitations associées aux critères utilisés pour l'évaluation des chercheurs. Le système scientifique croate doit viser plus haut et ne pas se contenter de critères

« minimaux » pour l'accréditation et les autres processus d'assurance-qualité ex post mis en place par l'ASES, mais s'orienter vers une recherche active de l'excellence.

En raison des faibles niveaux de ses ressources, d'un manque de continuité et d'une structure institutionnelle et de gouvernance qui n'est pas optimale, la Croatie n'a actuellement pas les moyens d'orienter son système d'innovation vers des programmes de recherche à plus grande échelle et à long terme pouvant déboucher sur la création de collectifs de recherche stables. Parmi les facteurs qui ont empêché les progrès de la recherche on peut mentionner les dispositifs rigides de budgétisation, une organisation très morcelée, tant à l'intérieur des établissements d'enseignement supérieur qu'entre les établissements publics de recherche et l'absence d'une véritable budgétisation basée sur les résultats au niveau institutionnel.

De plus, au cours de la décennie écoulée, indépendamment de l'instabilité et du faible niveau global des ressources, les budgets pour le lancement des programmes ont été relativement faibles et ils ont principalement été affectés à des projets périphériques à la mission des institutions (incubateurs, essaimage, parcs technologiques) plutôt qu'à des programmes à plus long terme et à plus grande échelle au cœur de leurs missions. En conséquence, ni le gouvernement et ses agences ni le système de recherche n'ont acquis d'expérience suffisante de la gestion de grands investissements à long terme dans la recherche, si ce n'est pour un nombre limité d'investissements avant tout matériels. Il est à noter en particulier l'absence d'expérience significative d'instruments du type de ceux mis en place dans de nombreux pays au cours de la décennie écoulée, comme les centres de compétence, les écoles doctorales ou les programmes d'excellence (en général rassemblant 50 à 150 chercheurs sur une période de sept à douze ans). Un centre de recherche est généralement une unité bien coordonnée d'un certain nombre d'équipes, en termes de profil et de couverture thématiques, de possibilités de carrière, de mobilité et d'échanges internationaux, avec un bon dosage d'activités centrales et d'incitations et de ressources pour l'exploration de nouvelles opportunités. La « masse critique » est donc plus une question de gouvernance, de gestion et de pilotage, que de simples chiffres.

Le financement soumis à concurrence a généralement été faible en termes tant absolus que relatifs, notamment pendant la crise. La FCS, en particulier, n'a contribué que de façon insignifiante au financement. Fait quelque peu inhabituel pour une agence scientifique, la mission de la FCS a surtout visé à maximiser l'impact économique de la science. Dans les pays dotés de robustes systèmes d'innovation, il est caractéristique des agences scientifiques de s'attacher, avant tout, à promouvoir la rigueur scientifique et une culture de scepticisme constructif. Celles-ci y parviennent en général en favorisant à la fois la concurrence en interne et la collaboration au plan international. Le rôle de la FCS sera de redonner dans le financement des établissements d'enseignement supérieur et des établissements publics de recherche une priorité au financement soumis à concurrence et d'encourager une action d'internationalisation à l'échelle de tout le système. Le succès de cet effort, toutefois, dépendra aussi de facteurs n'entrant pas dans le mandat de la FCS, par exemple une réforme significative des établissements d'enseignement supérieur et établissements publics de recherche et l'application de principes reposant sur les résultats pour l'allocation de leur financement institutionnel, un fonctionnement adéquat des conseils consultatifs et une exploitation maximale des possibilités créées par l'adhésion à l'UE, notamment la participation au Programme-cadre et au Conseil européen de la recherche (CER).

Une expansion progressive de l'enseignement au niveau du doctorat, avec la création d'écoles doctorales, préparerait le terrain pour une amélioration d'ensemble durable des capacités de recherche. De plus, la formation de jeunes chercheurs peut être directement liée et conditionnée à l'investissement des Fonds structurels dans des infrastructures de recherche et centres de compétence. Les étudiants en doctorat et les chercheurs post-doctoraux sont les candidats de choix pour les projets en collaboration financés par les programmes européens, notamment le prolongement du Programme-cadre, Horizon 2020. Une FCS renforcée serait le candidat naturel pour le lancement du programme d'écoles doctorales.

La répartition actuelle des capacités d'enseignement supérieur entre les grands centres urbains et les autres régions du pays est conforme aux engagements exprimés par les responsables de réduire les disparités régionales. Pour autant que l'évaluation s'appuie sur de bonnes pratiques, il n'y a aucune raison de laisser entendre que la dispersion géographique est incompatible avec l'excellence universitaire. Les régions ont besoin d'agences de développement ou de fonctions équivalentes assurées par les incubateurs, centres d'affaires, chambres de commerce, etc. Toutefois, étant donné l'échelle des ressources disponibles et l'importance de la proximité des centres industriels pour une innovation utile sur le plan économique, les décideurs devraient éviter de trop disperser les ressources pour l'infrastructure technologique et autres infrastructures de soutien à l'innovation (incubateurs, parcs technologiques, etc.). Dans le contexte croate, il est peu probable que les inconvénients d'une forte dispersion des ressources soient contrebalancés par leur impact sur la croissance régionale endogène. De ce point de vue, un certain regroupement des investissements dans les capacités technologiques à proximité des centres industriels, dans l'idéal sur des sites ayant de bonnes liaisons internationales, semblerait nécessaire. Une fonction importante des mesures ciblées sur le plan régional serait de lier et intégrer les acteurs de l'innovation de l'ensemble du territoire au cadre institutionnel national et européen. Très souvent, les agences régionales joueraient le rôle de « guichet de première ligne » (plutôt que de « guichet unique ») donnant accès à diverses ressources et agences compétentes.

Dans ce contexte, les stratégies et mesures suivantes semblent appropriées, étant entendu que l'introduction d'une budgétisation basée sur les résultats et d'une plus grande autonomie des établissements d'enseignement supérieur et des établissements publics de recherche sont des préalables importants à une action stratégique, c'est-à-dire une approche mieux focalisée et à long terme qui dépasse les frontières institutionnelles.

- *Utiliser les Fonds structurels pour faciliter le renforcement des capacités* en matière de qualifications et d'éducation, ainsi que de recherche, d'innovation et de commercialisation. Prendre des mesures décisives pour renforcer les capacités administratives de planification et de gestion des projets.
- Par principe, *n'investir dans l'infrastructure de recherche* (y compris bâtiments) *que lorsque cela s'inscrit dans des programmes de recherche à long terme cohérents suscitant un large attrait.*
- *Porter une attention particulière à la mise en place de moyens de recherche davantage tournés vers les applications*, exploités conjointement par des établissements d'enseignement supérieur et des établissements publics de recherche ainsi que, là où c'est possible, des entreprises privées. Un programme de recherche défini en concertation, une claire compréhension des conditions d'accès pour les utilisateurs et la formation des jeunes chercheurs devraient en être des éléments clés. Des contrats de résultat négociés sont un instrument

éprouvé pour concilier différents impératifs et encadrer la gestion. De façon générale, l'accent principal devrait être mis sur les points forts des centres, plutôt que sur tel ou tel secteur, car le risque dans ce dernier cas est de choisir de moins bons candidats.

- *S'attaquer au déséquilibre entre le financement par appel à la concurrence (ou par projet) et le financement institutionnel et redéfinir la mission de la FCS* pour viser avant tout l'excellence scientifique. Sa mission n'aura un sens que si la FCS est dotée de ressources suffisantes pour s'engager dans une expansion générale de son aide à la science avec appel à la concurrence, sans négliger le financement de sa panoplie de mesures en direction de l'industrie.
- *Soutenir la participation de la Croatie au Programme-Cadre* (Horizon 2020) et au Conseil européen pour la recherche ainsi que les retombées qu'elle en retire, au moyen de campagnes de sensibilisation, d'une présélection des propositions et de parrainages.
- *Mettre en place des écoles doctorales dans des cadres universitaires plus avancés.* Ces écoles se sont révélées un instrument assez puissant pour la mise en place de programmes de recherche à long terme (jusqu'à douze ans) exécutés par les étudiants en doctorat supervisés par leurs professeurs et complétés par des programmes spécialisés de formation, de stages en entreprise et d'échanges internationaux.
- Éviter une dispersion excessive des investissements dans les capacités technologiques à mesure que des ressources supplémentaires deviennent disponibles. Outre les mesures existantes visant un impact économique localisé, utiliser les ressources dans l'ensemble des régions afin de mieux intégrer les acteurs régionaux dans le tissu institutionnel national et européen.

Maximiser les retombées de l'internationalisation de la R-D et de l'innovation

L'intégration dans les réseaux scientifiques et d'innovation internationaux et les chaines de production technologiquement avancées est fondamentale pour la qualité et l'impact de la R-D et de l'innovation, notamment pour un petit pays. La Croatie a, sur divers plans, progressé dans l'internationalisation de son système d'innovation au cours de la décennie écoulée. Toutefois, elle demeure moins internationalisée qu'on pourrait l'attendre de par sa taille, sa situation géographique et ses liens avec l'UE. Les faibles mouvements de personnel en provenance et à destination de la Croatie sont particulièrement préoccupants dans la mesure où la mobilité transfrontière est un canal important de transfert international de connaissances. Si les activités de R-D des filiales des multinationales en Croatie sont comparables avec ce qu'elles sont dans d'autres pays de la région, les stocks d'IDE et les volumes d'échange sont globalement inférieurs à ceux des économies comparables. La recherche dans les universités n'est pas encore aussi internationalisée que dans les systèmes d'innovation comparables, et cela se vérifie en termes aussi bien de flux de financement que de collaboration internationale pour la recherche.

Dans des domaines comme l'environnement, l'eau, l'énergie ou l'alimentation, les réglementations, le suivi et l'information prennent un caractère de plus en plus international ou européen. La création de passerelles dans ces secteurs entre les agences et les collectifs de recherche dans les établissements publics de recherche et les établissements d'enseignement supérieur ouvrira des possibilités de collaboration internationale,

notamment de participation à Horizon 2020, et plus particulièrement son plus important sous-programme, sur les défis sociétaux, qui mobilise 40 % de son budget total.

- *Soutenir l'internationalisation des activités des programmes et instruments existants et nouveaux pour la R-D publique et en entreprise.* La reproductibilité des politiques publiques dans ce domaine peut être favorisée par la participation aux processus de la méthode ouverte de coordination (MOC) de l'UE. La réforme des établissements d'enseignement supérieur et les établissements publics de recherche devraient offrir des incitations à une plus grande internationalisation.
- *Soutenir activement l'internationalisation des entreprises croates* en assurant une présence et des services de courtage dans un certain nombre de foyers d'innovation autour du globe. Si une présence croate spécifique peut dans certains lieux être nécessaire, les décideurs publics pourraient aussi explorer la possibilité de partager des moyens existants avec d'autres États membres de l'UE, en contribuant à leurs coûts.
- *Promouvoir l'internationalisation dans les mécanismes régissant les universités et les établissements publics de recherche ainsi que dans les incitations aux chercheurs.* La budgétisation basée sur les résultats et les contrats de résultats qui s'y rattachent peuvent être liés directement à une plus grande internationalisation en termes de revenus générés par les contrats et les subventions, d'échanges de personnel, de co-publications, de partenariats, etc.
- *Coordonner l'internationalisation de la R-D et de l'innovation* des établissements publics de recherche spécialisés avec les agences de leur secteur.
- *Favoriser la « circulation des cerveaux », pour pallier « l'exode des cerveaux »*, en couplant les dispositifs de mobilité internationale aux programmes existants ou projetés de formation et de recherche à long terme et d'innovation (de préférence à des dispositifs de mobilité autonomes), afin que la mobilité remplisse un but spécifique (par exemple formation pour l'acquisition de compétences spécialisées, expérience de méthodes spécifiques). Proposer des incitations adéquates au rapatriement. En première instance, cela peut impliquer la réinstauration d'initiatives auxquelles la FCS avait mis fin.
- *Envisager l'élaboration d'une stratégie explicite d'internationalisation pour la R-D et l'innovation*. Une telle stratégie complèterait l'élan en faveur de l'internationalisation imprimé par l'adhésion à l'UE, avec des efforts d'ouverture en direction de pays tiers, notamment ceux avec lesquels la Croatie entretient des liens traditionnels (pays voisins de la région et grands marchés à l'exportation) et d'économies en développement rapide qui offrent des possibilités de collaboration pour la R-D et l'innovation.

Tableau 0.1. Analyse SWOT

Forces	Faiblesses
• Emplacement géographique, le long de l'Adriatique et au carrefour de l'Europe centrale et du Sud-Est ; liens historiques avec plusieurs économies développées et émergentes. • Bons résultats macroéconomiques avant la crise. • Amélioration des conditions-cadres de l'innovation (même si la marge reste grande), notamment du paysage institutionnel dans lequel évoluent les acteurs de l'action publique STI. • Population instruite, en particulier au niveau secondaire, et dynamisme dans les sciences sociales, le droit et les lettres. • Atouts et poches d'excellence de la recherche publique (universités et établissements publics de recherche) et exemples de collaboration entre universités et entreprises. • Hausse de la production scientifique (publication d'articles dans des revues scientifiques). • Atouts à l'exportation dans différents secteurs et (petit) nombre d'entreprises relativement importantes dans l'exécution de R-D. • Apparition d'une communauté de start-ups à vocation technologique. • Participation aux programmes-cadres européens. • Bonne répartition régionale des établissements d'enseignement supérieur.	• Existence de faiblesses structurelles de l'économie révélées par la crise. • Faiblesse des récents résultats macroéconomiques ; grand retard de productivité pour rapport aux moyennes de l'UE et de l'OCDE. • Lacunes des conditions-cadres de l'innovation : obstacles financiers, administratifs et réglementaires à l'entrepreneuriat, et manque de confiance. • Profil des qualifications défavorable à l'innovation dans le secteur des entreprises, notamment pénurie de compétences entrepreneuriales et managériales. • Système d'innovation non tourné vers le secteur des entreprises. • Insuffisance des ressources, capacités internes et résultats liés à l'innovation des entreprises. • Lacunes des modes d'organisation et de gouvernance des universités et établissements publics de recherche. • Manque d'incitation à développer l'excellence scientifique. • Cadre national mal adapté aux pratiques et instruments d'envergure internationale. • Répartition des tâches inadéquate entre l'administration et les organismes. • Manque d'engagement politique durable en faveur de l'innovation, volatilité des budgets de R-D.
Occasions à saisir	**Menaces**
• Recours accru aux Fonds structurels de l'UE, mais aussi aux dotations nationales (notamment à travers une réorganisation des subventions existantes) pour moderniser les capacités d'innovation dans l'ensemble du système. • Intégrer l'innovation dans les politiques sectorielles. • Favoriser le développement d'un secteur des entreprises dynamique stimulé par l'innovation. • Renforcer la contribution de la recherche publique au développement social et économique en affectant des ressources supplémentaires et en améliorant l'organisation et la gouvernance. • Développer les réseaux inter-entreprises, en Croatie et dans l'UE, pour permettre aux entreprises croates d'accumuler en interne des capacités d'innovation. • S'appuyer sur la politique d'innovation et un organisme d'investissement consolidé (conjointement avec d'autres interventions) pour attirer l'IDE à forte intensité de savoir.	• Inertie due à une réticence au changement. • Application limitée des stratégies et mesures. • Mauvaise préparation à l'intensification de la pression concurrentielle liée à l'adhésion de l'UE et émanant des économies émergentes. • Incapacité à mobiliser les ressources financières et humaines au service de l'innovation et, partant, à exploiter le potentiel de croissance et de compétitivité offert par l'innovation. • Incapacité à réformer les établissements d'enseignement supérieur et les établissements publics de recherche en vue les rendre plus efficients, pertinents et rigoureux. • Impuissance à obtenir des retombées économiques concrètes de la hausse des investissements dans la science, la technologie et l'innovation. • Sous l'effet de l'afflux des ressources (provenant notamment des Fonds structurels), exacerbation du phénomène d'entrepreneuriat tourné vers la recherche de rente, à moins d'un renforcement de la gouvernance et de l'obligation redditionnelle.

Chapter 1

Economic performance and framework conditions for innovation

This chapter gives a short overview of Croatia's macroeconomic performance and highlights important features of its economic development, including its integration in European markets and the world economy, and its openness to international trade and foreign direct investment. It sketches some salient features and patterns of structural change in production and trade, including the emergence of services and the relative decline in the comparative advantage of key exporting sectors. It also looks at the current state of important framework conditions for innovation. It concludes with a discussion of the potential role of innovation in Croatia's economic development in the longer term.

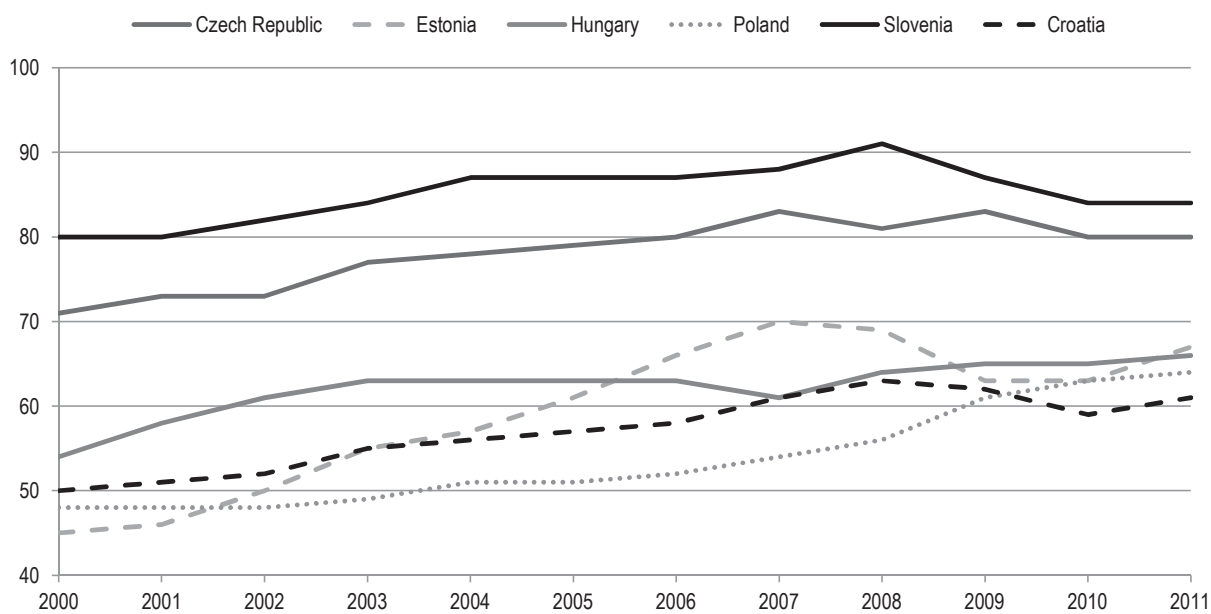
Its gradual integration and accession to the European Union have shaped Croatia's economic development, with a profound impact on the institutional framework and policy making, not least in the area of science, technology and innovation. Overall, Croatia performed quite well before the crisis and has a leading position among western Balkan countries. The picture is more mixed when other former transition countries, particularly the new EU members, are taken as comparators. However, the global financial and economic crisis that began to spill over to Croatia in 2009 led to a sharp downturn and has exposed the vulnerability of parts of its economy. Moreover, for various reasons Croatia, like neighbouring Slovenia, has found it harder than some other countries to embark on a dynamic path of recovery and has suffered some loss of competitiveness.

1.1. Macroeconomic performance and productivity growth

In the two decades since independence Croatia has made a successful transition to a stable market economy and achieved notable progress on institutional reform. Its achievements are reflected in a good pre-crisis record of economic growth, a sustained increase in per capita incomes, and indicators of social development that are among the highest in the region. Croatia's accession to the European Union (EU) in July 2013 constitutes concrete recognition of the country's political, economic and social development.

In the decade preceding the financial and economic crisis, from 1998 to 2008, Croatia's growth averaged 3.6% a year (Eurostat, 2013). From 2000 to 2008, Croatian income rose from 50% to 63% of EU27 GDP per capita in purchasing power standard (PPS) euros (Figure 1.1). At the time of its accession Croatia was the wealthiest of the non-EU member states in south-eastern Europe. However, income per capita remains considerably below the EU27 average[1] and Croatia is among the EU's least prosperous members, ahead only of Latvia, Romania and Bulgaria. Moreover, the financial and economic crisis has challenged many of its achievements.

Figure 1.1. GDP per capita convergence with the EU27 (=100), Croatia and comparator countries, 2000-11



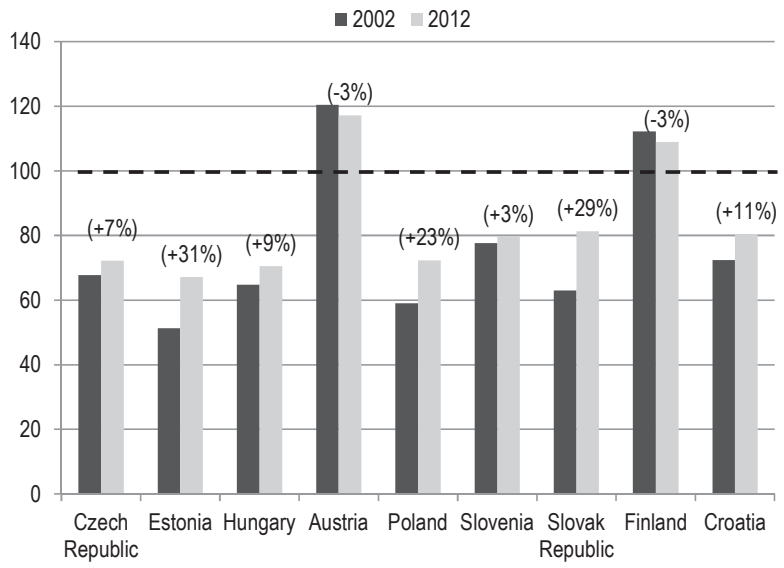
Source: Eurostat (2013), Statistics Database, accessed June 2013.

At an annual average of 4.3%, Croatia grew faster than older EU members during 2000-08. By 2007 Croatia had reached the GDP per capita level of Hungary. It is worth bearing in mind that growth was mostly of the convergence ("catch-up") type, opportunities for which are progressively exhausted as average income approaches that of the EU. Moreover, the IMF (2012, pp. 3-4) finds that Croatia's growth was lower than would be expected on the basis of the country's potential for convergence.

The evolution of productivity is central to an explanation of Croatia's weaker-than-expected growth performance. Labour productivity, measured as GDP per person employed, improved between 2002 and 2012 in Croatia from about 72% to 80% of the EU27 average (Figure 1.2). Croatia's level was high relative to the other transition countries under comparison, though Croatia's low labour force participation and the high degree of informality in the labour market complicate international comparisons (EC, 2008; EC, 2013). All of the central and eastern European countries considered experienced labour productivity improvements. Progress was particularly marked in Estonia, the Slovak Republic and Poland. In fact, over this ten-year period, Croatia improved productivity by 11%, compared to 31% for Estonia, 29% for the Slovak Republic and 23% for Poland, albeit these countries started from a lower level. By 2012 Croatia's labour productivity was at about the same level as Slovenia's (80%) but considerably lower than that of Austria (117%) and Finland (109%).

Figure 1.2. Labour productivity per person employed, Croatia and comparator countries, 2002 and 2012

Percentile change over a decade earlier in brackets, EU27 = 100



Source: Eurostat (2013), Statistics Database, accessed June 2013.

Various studies of Croatia's recent growth have concluded that it can be attributed mostly to capital accumulation (Moore and Vamvakidis, 2007; World Bank, 2009; IMF, 2012). Capital accumulation was driven partly by investment to restore and upgrade the country's physical infrastructure and partly by foreign direct investment (FDI). FDI was concentrated in consumption-related and inward-oriented sectors (such as the financial sector and construction), which had only a small impact on productivity (IMF, 2012, p. 13). Total factor productivity (TFP) – formally the amount of output that cannot be

explained by the amount of input – reflects the combined efficiency of productive inputs, such as the amount of productive investment and the size and quality of the workforce, and is of particular relevance to innovation. Improvements in TFP are driven to some extent by the process of absorption, adaptation and generation of knowledge that is a part of the broad concept of innovation.

The considerable growth in Croatia's TFP in the latter part of the 1990s as a result of structural reforms slowed over time. In fact, a breakdown of the sources of economic growth over 2000-11 reveals that growth was slowed primarily due to a decline in TFP. Croatia's inability to generate TFP gains over the decade preceding the financial crisis is at odds with the experience of neighbouring Slovenia in particular (OECD, 2012). The productivity shortfall is also related to the incomplete process of reform and to aspects of the competitive environment. A World Bank study (2009, p. 18) finds that firms with higher productivity do not necessarily command a higher share of total output. It may be due to the combined effect of the domestic market's incomplete exposure to international competition, the persistence of single-supplier markets in state-supported sectors, the moderate increases in concentration in a few other sectors, the inward orientation of much of the business sector, and the bias of Croatian exports towards relatively uncompetitive markets in south-eastern Europe (to be discussed below).

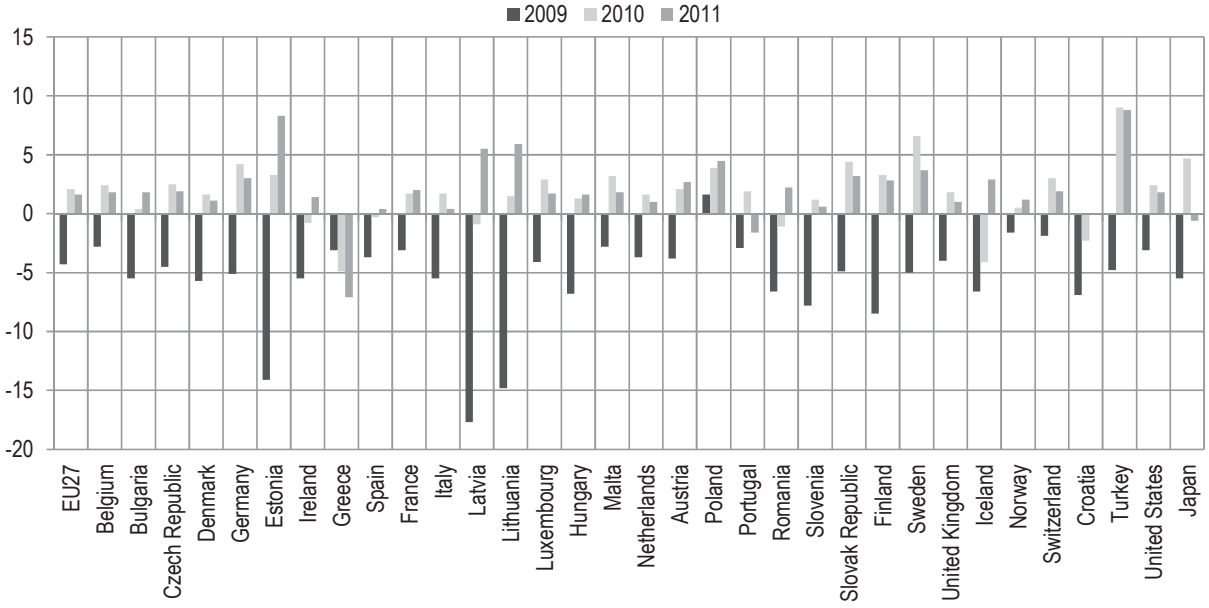
Table 1.1. Contributions of capital, labour and total factor productivity to real GDP growth in Croatia

	2000-08	2009-11	2000-11
Real GDP growth	4.3	-2.8	2.5
Contributions of:			
• Capital	2.6	1.5	2.3
• Labour	0.5	-1.4	0.0
• TFP	1.2	-2.9	0.2

Source: International Monetary Fund (2012), "Republic of Croatia: Selected Issues", IMF Country Report No. 12/303, 12 November, p. 5.

The crisis interrupted the convergence process in 2009 and the Croatian economy has not since returned to growth (Figure 1.3). Croatia was hit harder during the global crisis than most other countries in Central and Eastern Europe (IMF, 2012, p. 4) with the exception of the small open economies of Estonia, Latvia and Lithuania. Some drivers of Croatia's erstwhile growth, such as post-war reconstruction, FDI flows to the financial sector and a subsequent extension of credit, reflected exceptional circumstances that are unlikely to recur. However, EU membership will soon provide alternative lines of funding for investment. Provided these are absorbed efficiently and effectively and coupled with increased international openness and a possibly fuller use of human resources, an additional transitory boost to growth can be expected over the coming years. Ultimately, however, and as is the case for its EU peers, Croatia's path to sustainable long-term growth will increasingly depend upon its ability to innovate.

Figure 1.3. GDP growth, 2009, 2010 and 2011



Source: Eurostat (2013), Statistics Database, accessed June 2013.

Table 1.2. Gross value added in Croatia across NACE sectors, 2005-12

Index 2005=100

	2006	2007	2008	2009	2010	2011	2012
Agriculture, forestry and fishing	108.5	104.5	110.3	107.3	100.2	95.5	89.6
Industry (except construction)	104.0	109.5	109.7	98.6	96.5	95.6	90.9
Manufacturing	103.4	111.1	111.7	98.8	95.7	95.3	90.3
Construction	106.6	110.7	118.7	105.7	89.0	80.9	71.7
Wholesale and retail trade, transport, accommodation and food service activities	105.9	113.7	115.0	101.9	98.9	99.8	97.4
Information and communication	106.4	112.9	116.3	113.0	111.6	110.7	109.0
Financial and insurance activities	104.3	111.7	117.1	118.5	121.9	123.2	120.5
Real estate activities	107.2	111.3	113.0	113.5	114.7	116.0	115.6
Professional, scientific and technical activities; administrative and support service activities	105.7	117.0	121.5	109.7	106.9	110.5	111.6
Public administration, defence, education, human health and social work activities	100.7	101.4	103.6	103.9	104.3	106.0	106.8
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	102.7	107.8	111.2	106.5	103.6	103.6	103.8
Total - All NACE activities	104.9	110.0	112.7	105.6	102.9	102.7	100.0

Source: Eurostat (2013), Statistics Database, accessed June 2013.

The short-term prospects remain negative. Reductions in employment have occurred across all sectors and are especially pronounced in the construction sector (CBS, 2012a). The negative outlook is confirmed in terms of value added and investment not only for construction, but also for trade and non-financial services. By contrast, industry (including manufacturing) has shown tentative signs of recovery in terms of investment (CBS, 2012a), but has seen continuing decline in terms of value added, with the most pronounced fall in 2012 (Table 1.2). The financial sector, real estate and trade also showed signs of recovery in value added in 2011, but the gains were reversed in 2012 (Table 1.2). Overall, Croatian GDP contracted by close to 2% in 2012. A decline in disposable income and fiscal consolidation subdued aggregate demand, and the Croatian economy experienced another year of declining employment and investment (Vidovic, 2013). The European Commission forecasts a further contraction of 1% in 2013 and a return to weak growth in 2014 (EC, 2013). The unemployment trend is worrying; it stood at over 15% in 2012, and youth unemployment was especially pronounced at 40%.

In many respects the length and extent of the current downturn reflect some of Croatia's long-standing weaknesses, such as the inefficiency of product and factor markets and a limited ability to mobilise sources of economic growth other than capital accumulation, notably human capital, entrepreneurship and innovation. The World Bank (2009) identifies a lack of market dynamism – exemplified by weak firm entry and exit in sheltered sectors – as a major drawback to productivity. Achieving more dynamic markets will likely require further adjustments to the regulatory framework and a more judicious use of state support. A series of related interventions will be necessary, including reform to tackle low labour force participation, strengthen human capital and align skills with market needs, as well as to support entrepreneurship and innovation.

Joining the EU presents opportunities for improvements with a lasting impact on Croatia's long-term growth prospects. First, it should open the Croatian economy much more to international trade and investment. International trade will facilitate efficiency gains through specialisation and competition and increase international transfers of economically useful knowledge (Keller, 2004). FDI will provide an additional boost to growth via capital accumulation and knowledge spillovers. Such spillovers, however, will be largely conditional on improvements in the absorptive capacity of domestic firms. Second, EU membership will be accompanied by the obligation to comply with many regulations and standards, with the emphasis shifting from legal adoption to practical implementation. The potential efficiency gains from the adoption of regulations and standards are considerable (EC, 2012a). Third, several funding opportunities that will become available to Croatia will be relevant not only for capital-intensive investments, but also for entrepreneurship education, R&D and innovation. Importantly, European funding is often accompanied by obligations and opportunities for increased interaction with policy peers from other EU member states. This can facilitate meaningful policy learning and lead to more effective policy delivery.

A number of trends suggest that Croatian competitiveness has declined in recent years. First, the Croatian currency appreciated by more than 10% from 1999 to 2009 (Orszaghova et al., 2013, p. 16). Second, unit labour costs[2] rose for most of the past decade before reaching a peak in 2009 (Orszaghova et al., 2013, Chart 3). Unit labour costs have since declined somewhat and are at levels comparable to those of EU candidate countries in the region. Similar trends in currency appreciation and unit labour costs are common among EU candidates in south-eastern Europe over this period. However, unlike both EU candidate countries and the post-2004 EU member states, Croatia's share of world exports declined after 2003, a trend that accelerated in 2009-11

(Orszaghova et al., 2013, pp. 15-16). Moreover, a study of the sources of Croatia's export competitiveness finds that, unlike Slovenia, where medium-high- and high-technology-intensive manufacturing has shifted from price- to quality-driven competitiveness, Croatian manufacturing continues to be driven by price competitiveness (Stojcic et al., 2012, p. 82).

Sound macroeconomic conditions would facilitate the long-term investments needed for innovation but will not suffice on their own. Harnessing the opportunities of international trade and investment, motivating labour market participation, removing barriers to entrepreneurship, ensuring functional markets, improving the confidence of investors and diversifying to higher value-added economic activities will be central to the long-term dynamism of the Croatian economy.

1.2. International trade and foreign direct investment

International trade and cross-border investment can be significant drivers of economic growth and development, particularly for small countries as they benefit from increases in the size of markets. Competing in global markets encourages national specialisation and can result in solid productivity improvements. Trade, and imports in particular, are major channels for the diffusion of knowledge embodied in goods. Links to global production chains, through FDI and by domestic firm international trade in intermediate goods, provide additional opportunities for knowledge transfer and national capability accumulation (Keller, 2004). Exports, particularly in sectors of growing global demand, are crucial to sustainable increases in national income. In an open economy, the ability to diversify the national production structure in line with changing patterns of global demand is essential.

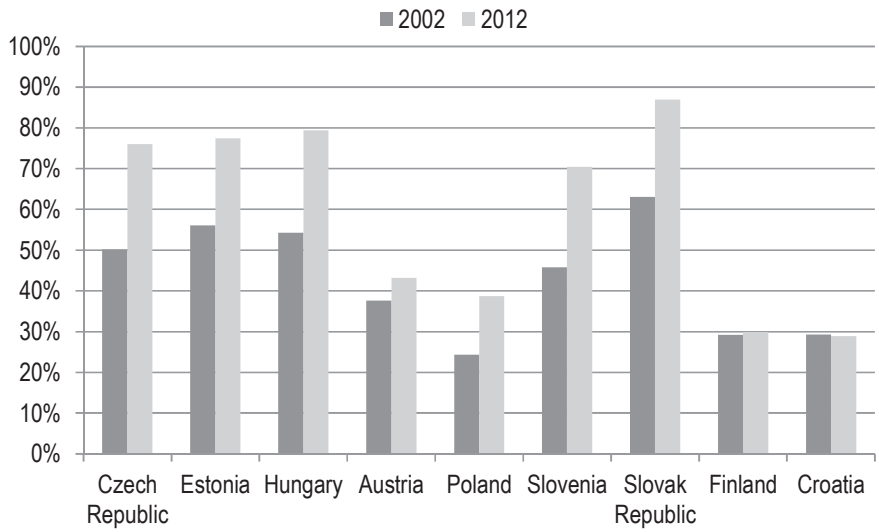
International trade

Croatia participates in international trade less than comparable countries. Its small increases in trade integration over the past decade were reversed in 2009. International trade openness (the ratio of the average of imports and exports to GDP) stood at just under 30% in 2012 as in 2002 (Figure 1.4). By contrast, all recent EU members saw considerable increases over the period. Modelling exercises that take into account factors such as the country's size suggest that even before the crisis Croatia was considerably less integrated than comparable countries (World Bank, 2009, p. 19). For example, neighbouring Slovenia was considerably more open to trade in 2002 (an openness ratio of 46%); following EU accession its trade openness has increased to 70%. Croatia's experience during the crisis differs from that of EU candidate countries in south-eastern Europe and may be related to the low regional diversification and geographic concentration of Croatia's exports (Orszaghova et al., 2013).

The EU is Croatia's single largest export market, collectively accounting for 58% of Croatian exports (Figure 1.5). Geographic proximity and historical links also mean that the export orientation of the Croatian business sector is geared towards south-eastern Europe, especially the member countries of the Central European Free Trade Agreement (CEFTA, whose current parties include Albania, Bosnia and Herzegovina, FYR Macedonia, Moldova, Montenegro, Serbia and Kosovo*[3] (20%), and to a lesser extent to countries such as Russia (3%) and Turkey (1%). Croatia joined CEFTA in 2003 but its participation will end with EU accession. The ensuing diversion of trade presents opportunities as well as challenges. With respect to opportunities, demand for innovative products and services is likely to be stronger in EU markets than in CEFTA. Simulations

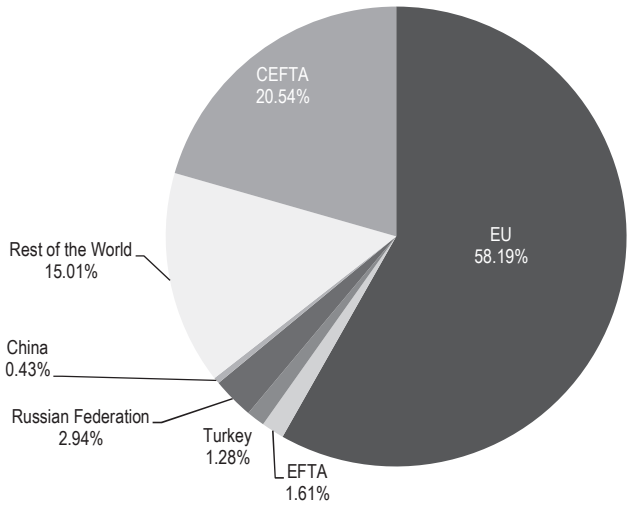
of the likely effects of joining the EU suggest modest short-run reductions in output (0.4% of GDP) owing to the partial loss of traditional markets. However, this is likely to be offset by an increase in trade with the EU in the long run (Holzner, 2013, pp. 14-15). Whether Croatian exporters will indeed manage to reach a sufficient level of sophistication to compensate for the loss of traditional markets will depend on their ability to innovate and diversify.

Figure 1.4. Trade openness, selected countries, 2002 and 2012



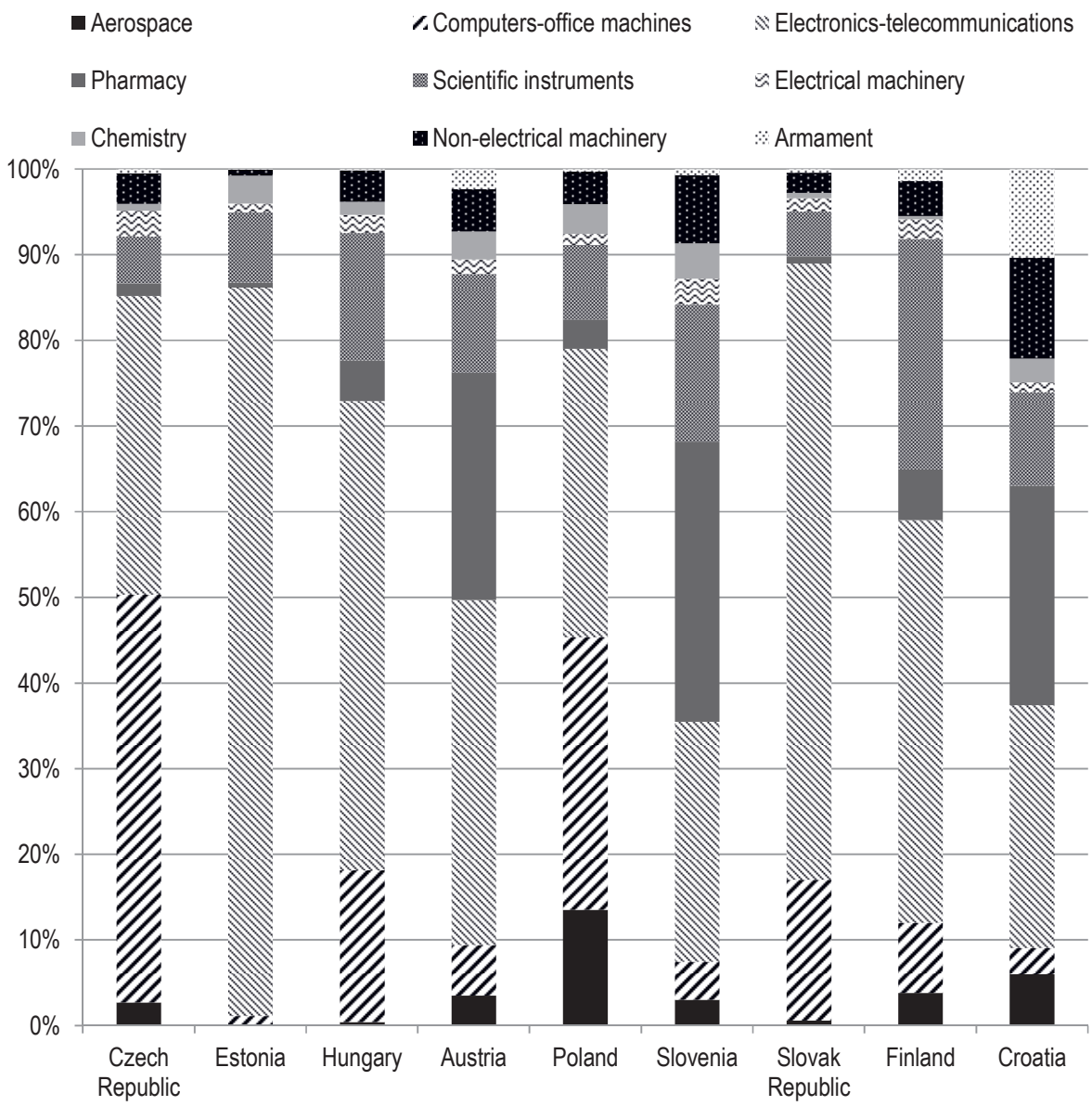
Source: Eurostat (2013), Statistics Database, accessed June 2013.

Figure 1.5. Croatian exports by principal destination



Source: CEFTA (2012). "CEFTA Trade Statistics 2012 Half Year Update", www.cefta.int/sites/default/files/Cefta_trade_1h2012.pdf, accessed 7 March 2013.

Figure 1.6. High-technology exports by high-technology product groups, selected countries, 2012



Source: Eurostat Statistics Database, accessed June 2013.

The composition of Croatia's exports is very diverse (see Table 1.6). The top five export product categories in 2010 accounted for just over 27% of all exports. The categories were: cruise ships, etc.; petroleum oils, refined; electrical transformers; floating or submersible drilling platforms; and medicaments, packaged.

A relatively low 7.4% (see comparison in Figure 1.11) of total exports was accounted for by manufacturing sectors classified as high-technology on the basis of their tendency to perform R&D (Eurostat, 2013). The distribution across sectors was relatively even, with the share of the top sector (electronics-telecommunications, 28%) substantially lower than the average of the top sector in the comparator group (52%) (Figure 1.6).

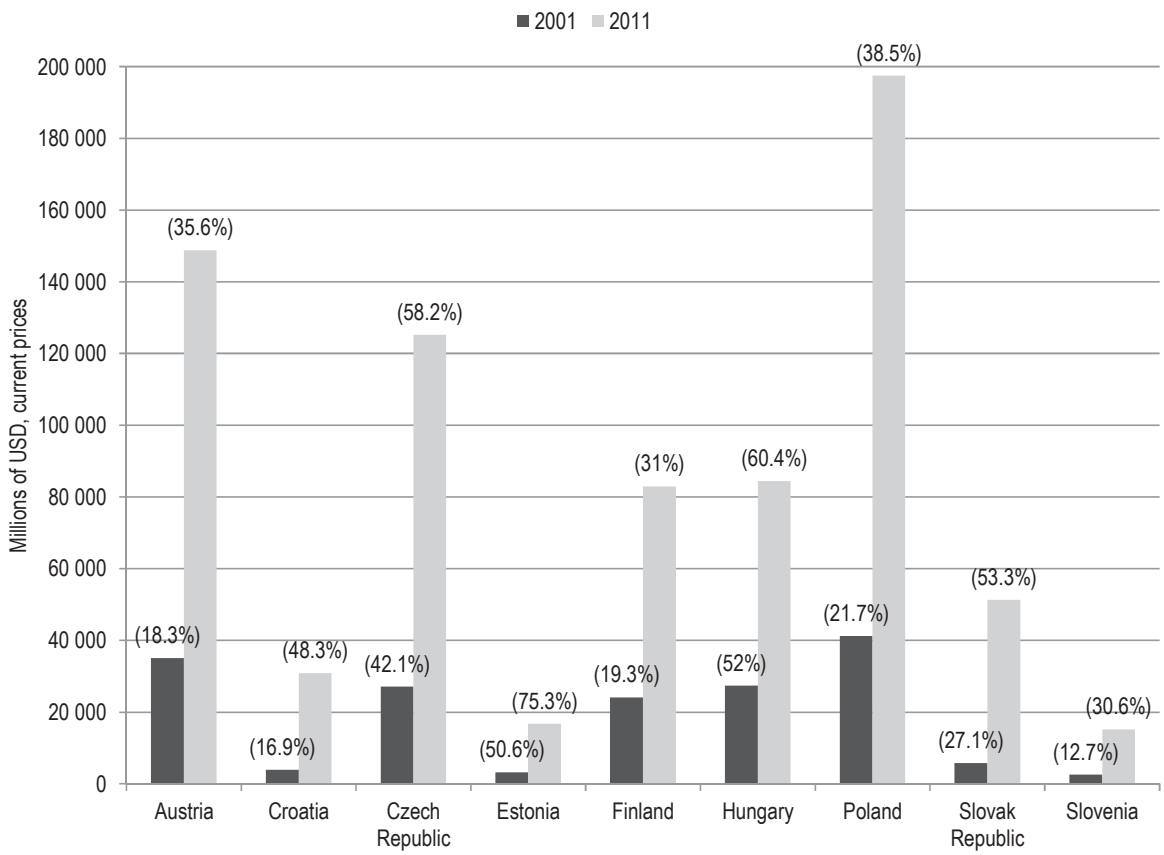
Pharmaceuticals had the second-largest share (26%), followed by non-electrical machinery (12%) and arms (12%). Slovenia is the country that most resembles Croatia in terms of the distribution of high-technology exports.

Foreign direct investment

FDI is another important dimension of a country's international economic integration. Inward FDI reflects the activities of foreign multinationals, including the acquisition of stakes in domestic firms. FDI can be an important channel for technology transfer and can spur innovation activities of local firms either directly, e.g. by integration into global production chains and the transfer of knowledge through co-operation and labour mobility, or indirectly, for instance as a by-product of increased competition. A considerable amount of empirical evidence on the incidence of spillovers to the host economy from FDI is now available (Bijsterbosch and Kolasa, 2009; Crespo and Fontoura, 2007; Damijan et al., 2008; Hanousek et al., 2010). Outward FDI may help link the economy to international technology production networks and can play a complementary role in international knowledge transfer.

Figure 1.7. Inward FDI stocks, selected countries, 2001 and 2011

Millions of USD, current prices, percentage of GDP in brackets

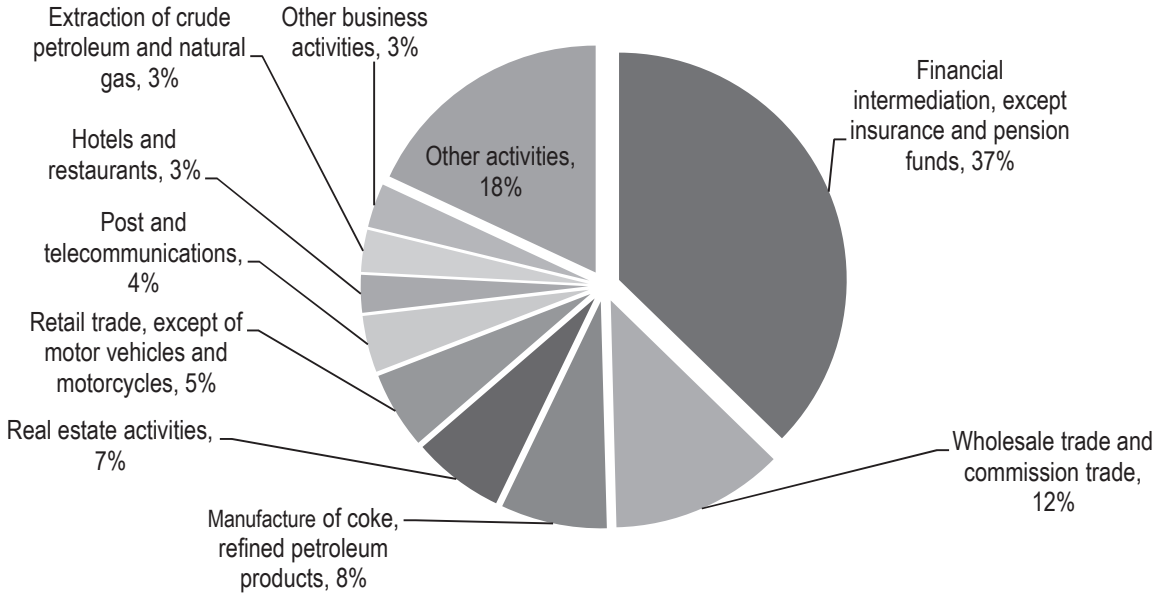


Source: UNCTAD.

Over the last decade inward FDI stocks increased considerably in Croatia and comparator countries in absolute terms and relative to GDP. Croatia, together with Slovenia, had the largest increase in inward stocks relative to GDP between 2001 and 2011. As a percentage of GDP in 2011, FDI stocks were more significant in Croatia than in many EU countries, including Austria, Finland, Poland and Slovenia (Figure 1.7). While the ratio of inward FDI stocks to GDP in Croatia (48%) was considerably above the overall share of all transition economies (19%), it was significantly below that of some new EU members such as Estonia (75%), Hungary (60%), the Czech Republic (58%), and the Slovak Republic (53%) (UNCTAD, 2012). The fact that wages in Croatia are high relative to productivity levels (Orszaghova et al, 2013, p. 16) may be part of the reason why inward FDI stocks in Croatia are lower than comparable countries.

Historically, FDI flows to Croatia have come for the most part from Austria, the Netherlands and Germany, which collectively accounted for over 50% of FDI stocks up to 2008. In the years since independence, FDI inflows have been motivated primarily by the opportunities presented by privatisation and market access. In countries such as the Czech Republic, Hungary and the Slovak Republic, FDI implied a substantial shift in production and export structures and facilitated integration in European production networks (see OECD, 2008, Box 2.1, p. 101). However, in Croatia FDI was concentrated in non-tradable sectors such as financial intermediation, which unlike manufacturing, present little opportunity for knowledge spillovers (World Bank, 2009). Moreover, little investment was directed to newly established companies. (Hunya and Skudar, 2007). In some respects the situation in Croatia is similar to that of neighbouring Slovenia, where a large part of inward FDI also flowed to financial intermediation (OECD, 2012).

Figure 1.8. FDI inflows to Croatia by activities, 2000-10



Source: Croatian National Bank.

The distribution of inward FDI across sectors has had two phases: manufacturing accounted for more than 70% of total FDI between 1990 and 1998, while in the past decade, FDI was mostly oriented towards services (e.g. banking, trade, real estate services and telecommunications). In common with other countries in south-eastern Europe, the Croatian banking sector is characterised by high foreign penetration (over 90% of bank assets) (Bartlett and Prica, 2011). Figure 1.8 presents the sectoral distribution of inward FDI for 2000-10. Finance (37%) and trade (17%) accounted for the bulk of FDI inflows to Croatia, followed by the combined shares of extractive industries and utilities (15%), owing to the acquisition of important stakes in formerly state-owned companies. Hotels and restaurants and real estate activities accounted for about a tenth of FDI inflows.

Annual inward FDI flows slowed considerably following the global financial crisis (by about 50% in 2008-09) and declined further in subsequent years. They currently stand at about a quarter of their pre-crisis magnitude (Croatian National Bank, 2013). Unlike other eastern European countries, Croatia does not appear to have enjoyed a surge of investment in the years preceding EU accession.

The bulk of inward investment during 2010-12 is linked to real estate, finance and tourism (recreational, cultural and sporting activities), even if the inflows, to finance in particular, are considerably smaller than previously (Croatian National Bank, 2013). Sectors linked to real estate and tourism not only receive significant investments in current terms, the investments are also very high when compared with the history of FDI in these sectors. In contrast, there have been significant FDI reversals – both in current and historical terms – in the chemicals industry, extraction of crude petroleum and natural gas, and construction.

The past decade has seen a worldwide surge in FDI in research and development (R&D) (OECD, 2011). In Croatia, a number of recent policy initiatives may help facilitate international investment in R&D, including tax incentives and other support foreseen in the Act on Investment Promotion and Development of the Investment Climate and the establishment of the Agency for Investment and Competitiveness (EC, 2013).

1.3. Structural change: Production and international trade

Production

The evolution of the Croatian business sector over the past decade can be briefly summarised as the persistence (despite some relative decline) of industrial strengths in manufacturing and the parallel rise of the services sector.

Economic activity in Croatia is now dominated by service industries, with the overall share of services accounting for about 55% of employment and 54% of value added (Table 1.3). Industry (mining, manufacturing and utilities) accounts for just over 30% of employment and 36% of value added. Within industry, manufacturing is the leading industrial activity with 26% of employment and 23% of value added. According to the latest CBS data (2012b), there was a sharp contraction in 2011 in the construction sector (in turnover, value added, gross investments and number of persons employed), and to a lesser extent in trade and services, while industry (including mining and quarrying, manufacturing and utilities) was more resilient. The dominance of services underscores the need to take an approach to innovation that goes beyond R&D, as services typically innovate in particular ways (organisational, marketing innovation) and tend to spend less on R&D than manufacturing. Nevertheless, the presence of a still sizeable manufacturing sector is broadly indicative of the continuing relevance of traditional forms of innovation policy, such as support for technical/engineering education, the encouragement of formal R&D activities and a focus on product and process innovation.

Table 1.3. Basic structural business indicators in Croatia, 2010

Sector	Number of enterprises	Number of persons employed	Turnover	Value added at factor cost	Labour productivity (thousand HRK per person employed)
B – Mining and quarrying	0.2%	1.5%	4.8%	6.0%	571.4
C – Manufacturing	14.4%	26.1%	22.0%	23.1%	128.3
D - Electricity, gas, steam and air conditioning supply	0.1%	1.5%	4.7%	4.9%	462.1
E – Water supply; sewerage, waste management and remediation activities	0.4%	1.9%	1.1%	2.1%	160.4
F – Construction	14.9%	12.7%	9.0%	10.3%	117.7
G – Wholesale and retail trade; repair of motor vehicles and motorcycles	27.6%	23.3%	37.7%	19.1%	119.4
H – Transportation and storage	6.6%	7.2%	4.8%	8.0%	161.5
I – Accommodation and food service activities	11.8%	8.7%	3.0%	4.9%	81.5
J – Information and communication	3.5%	3.7%	5.5%	8.8%	346
L – Real estate activities	3.3%	1.0%	0.8%	1.7%	249.8
M – Professional, scientific and technical activities	12.1%	7.7%	4.6%	8.5%	161.8
N – Administrative and support service activities	3.8%	4.2%	1.8%	2.5%	85.8

Note: CBS's NKD 2007 sectoral classification.

Source: Croatian Bureau of Statistics (2012), *Statistical Yearbook of the Republic of Croatia 2012*, CBS, Zagreb, Table 13-3, p. 221.

Structural change is both a result and a driver of innovation. The broad tendencies in the evolution of Croatia's industrial structure can be indicative of the demand for certain types of skills (e.g. scientific, technical, professional, managerial), for capital investments (e.g. physical infrastructure, knowledge-based capital) and for various types of innovation (product, process, organisational, services, marketing).

Table 1.4 presents structural change in Croatia and the comparator group in terms of value added across industrial sectors. Over the last decade the trend in the comparator group was towards a greater share of value added in manufacturing. Croatia was the only country in which it decreased, whereas it increased in the Slovak Republic and the Czech Republic by 14% and 11%, respectively. In Croatia value added in the services sector increased significantly, in contrast with other countries in the comparator group, with the exception of Finland, which enjoyed minor increases. In Slovenia it remained stable.

Table 1.4. Structural change: Proportions of gross value added by sector, selected countries, 2001 and 2011

	Austria		Croatia		Czech Republic		Estonia		Finland	
	2001	*2011*	*2001*	*2011*	*2001*	*2011*	*2001*	*2011*	*2001*	*2011*
Agriculture, hunting, forestry, fishing (ISIC A-B)	2%	2%	6%	5%	2%	2%	5%	4%	3%	3%
Mining, manufacturing, utilities (ISIC C-E)	23%	24%	22%	20%	27%	35%	21%	23%	24%	24%
Manufacturing (ISIC D)	19%	21%	18%	16%	21%	32%	16%	18%	21%	21%
Construction (ISIC F)	7%	6%	6%	6%	7%	6%	7%	8%	6%	7%
Wholesale, retail trade, restaurants and hotels (ISIC G-H)	19%	18%	14%	16%	15%	15%	15%	12%	13%	14%
Transport, storage and communication (ISIC I)	7%	7%	10%	11%	11%	10%	13%	14%	10%	10%
Other activities (ISIC J-P)	42%	44%	42%	41%	37%	32%	39%	40%	44%	42%

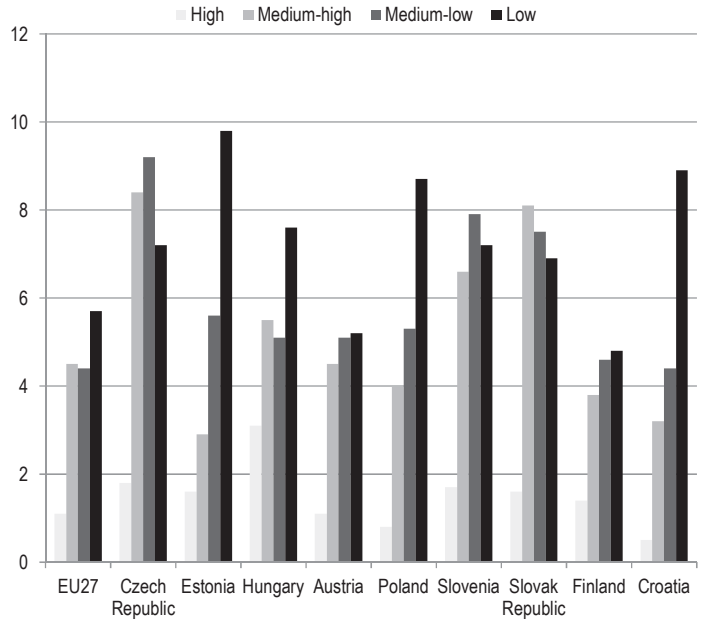
	Hungary		Poland		Slovak Republic		Slovenia	
	2001	*2011*	*2001*	*2011*	*2001*	*2011*	*2001*	*2011*
Agriculture, hunting, forestry, fishing (ISIC A-B)	4%	5%	5%	3%	4%	2%	3%	3%
Mining, manufacturing, utilities (ISIC C-E)	25%	28%	22%	29%	23%	39%	26%	27%
Manufacturing (ISIC D)	20%	24%	15%	24%	18%	32%	22%	22%
Construction (ISIC F)	6%	4%	7%	8%	7%	8%	7%	5%
Wholesale, retail trade, restaurants and hotels (ISIC G-H)	13%	13%	22%	21%	16%	13%	14%	14%
Transport, storage and communication (ISIC I)	8%	9%	7%	8%	13%	6%	9%	11%
Other activities (ISIC J-P)	44%	42%	36%	31%	38%	31%	41%	41%

Source: OECD, based on United Nations Statistics Division.

The propensity of Croatian firms to use highly skilled labour, engage in R&D and in other innovative activities can be gleaned from the distribution of economic activity according to technological intensity.[4] Most manufacturing employment in Croatia is in low and medium-low technology, and the country's overall distribution is more similar to that of Poland and Estonia than to that of Slovenia or the Czech Republic (Figure 1.9). In relative terms, Croatia had the lowest share of high-technology manufacturing employment[5] in the comparator group (less than 1%) and above only Estonia in terms of the share of employment in medium-high technology sectors. Croatia's shares in medium-low- and low-technology employment were higher, the former at about the EU27 average and the latter second-largest after Estonia. In terms of the share of employment in knowledge-intensive services, Croatia presents a more positive picture (Figure 1.10). While its share of employment in knowledge-intensive high technology services is relatively low (second last to Poland), its share of knowledge-intensive market services (excluding financial intermediation and high-technology services) is higher than that of all other new EU member states considered, except Estonia. Nevertheless, Croatia's share of knowledge-intensive market services remains below the EU27 average.

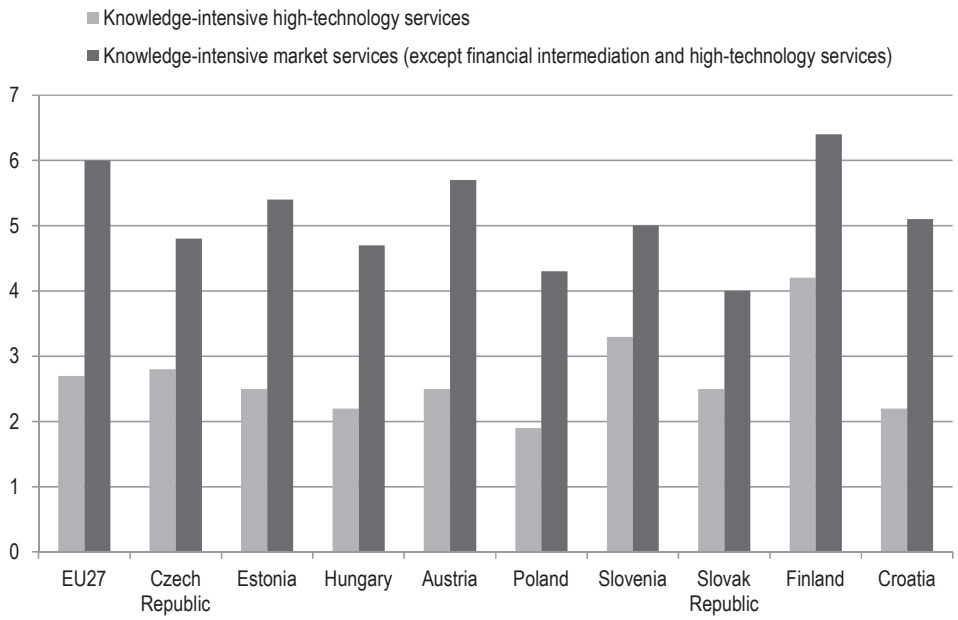
Croatia's shares of employment by technology intensity exhibit remarkable stability over time. The share of employment in knowledge-intensive market services was the only notable exception, with the value in 2010 one and a half times greater than in 2002.

Figure 1.9. Share of employment by technological intensity in manufacturing, selected countries, 2010



Source: Eurostat.

Figure 1.10. Share of knowledge-intensive employment in services, selected countries, 2010



Source: Eurostat.

International trade

In addition to its declining share of world exports, there are indications that Croatia's former strengths have weakened and its export structure is becoming more diversified. The concept of comparative advantage can be useful for examining the evolution of the

distribution of exports across different kinds of products or economic activities. The concept relates to the relative opportunity costs of producing goods and services in different countries and is widely used to evaluate export strengths. In practice, a country's comparative advantage in a particular commodity or industry is measured by an index based on observed trade patterns which is known as revealed comparative advantage (RCA).[6]

Table 1.5 presents the top 20 Croatian product exports by share of total and revealed comparative advantage (RCA) in 2010. Export shares are characterised by considerable dispersion across products; they highlight Croatia's comparative advantages in economic activities such as shipbuilding (sectors 8901 and 8505), the production of electrical equipment (8504, 8541 and 8544) and some pharmaceuticals (3004), sectors which, although not all high-technology, are nevertheless generally receptive to R&D and other knowledge-intensive activities. Table 1.5 also highlights comparative advantages in sectors that tend to be driven more by factor endowments (e.g. petrochemicals, iron and steel) and relative cost efficiency (e.g. apparel, footwear) than by innovation. The top two positions are taken by industries with important government stakes, such as the country's major shipyards (Uljanik, Brodosplit) and INA, the petrochemical company.

Table 1.5. Top Croatian exports by share and revealed comparative advantage, 2010

Rank	HS4 Code	Product name	RCA	Share
1	8901	Cruise ships and similar vessels for the transport of persons	10.42	8.62%
2	2710	Petroleum oils, refined	1.9	8.33%
3	8504	Electrical transformers	6.27	3.46%
4	8905	Floating or submersible drilling platforms	19.21	3.40%
5	3004	Medicaments, packaged	1.52	3.23%
6	2711	Petroleum gases	1.05	2.38%
7	4407	Wood sawn or chipped of a thickness exceeding 6 mm	8.31	1.64%
8	3901	Polymers of ethylene, in primary forms	3.52	1.54%
9	9401	Seats	3.82	1.43%
10	8541	Diodes, transistors, semiconductor devices; photosensitive etc.	1.67	1.29%
11	2716	Electrical energy	5.03	1.23%
12	3102	Mineral or chemical fertilizers, nitrogenous	8.52	1.21%
13	6403	Footwear, with leather body	3.59	1.19%
14	2523	Cement	14.78	1.12%
15	8544	Insulated wire; optical fiber cables	1.84	1.10%
16	7204	Ferrous waste and scrap	3.43	1.03%
17	8708	Parts and accessories of the motor vehicles	0.55	1.03%
18	7606	Aluminium plates, sheets and strip > 0.2 mm	5.95	0.98%
19	8411	Turbojets, turbo propellers and other gas turbines	1.53	0.96%
20	1701	Raw sugar, cane	4.43	0.93%

Source: The Observatory of Economic Complexity, using UN COMTRADE data; Simoes, A.J.G. and C.A. Hidalgo (2011), "The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development", Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence, San Francisco; and Hausmann, R., C.A. Hidalgo, S. Bustos, M. Coscia, S. Chung, J. Jimenez, A. Simoes and M. Yildirim (2011), *The Atlas of Economic Complexity*, Puritan Press, Cambridge, MA.

To appreciate how the structure of Croatian exports has changed over time, Table 1.6 presents the top 20 Croatian product exports a decade earlier. Differences are small and a general trend is hard to discern. The earlier distribution was characterised by a slightly higher concentration and a higher degree of RCA in the leading sector (cruise ships and similar vessels). Relative to 2001, the electrical equipment industry improved its position, with an increase in both share and RCA for electrical transformers; diodes, transistors, semiconductors, etc., are a new entry in the top 20. Antibiotics, a high-technology export with a prominent share in 2001, was absent from the top 20 in 2010[7].

Table 1.6. Top Croatian exports by share and revealed comparative advantage, 2001

Rank	HS4 Code	Name	RCA	Share
1	8901	Cruise ships and similar vessels for the transport of persons	27.23	13.40%
2	2710	Petroleum oils, refined	2.9	6.98%
3	2711	Petroleum gases	1.9	3.02%
4	6203	Men's suits, not knit	6.26	2.53%
5	2941	Antibiotics	17.15	2.47%
6	6403	Footwear, with leather body	4.68	2.15%
7	4407	Wood sawn or chipped of a thickness exceeding 6 mm	5.61	2.09%
8	6204	Women's suits, not knit	3.74	1.92%
9	6110	Sweaters, pullovers, sweatshirts, etc	3.87	1.90%
10	8504	Electrical transformers	2.96	1.65%
11	3004	Medicaments, packaged	1.02	1.63%
12	2523	Cement	19.34	1.57%
13	2402	Cigars	6.7	1.55%
14	9401	Seats	3.41	1.44%
15	8517	Telephones	1.06	1.26%
16	3901	Polymers of ethylene, in primary forms	3.78	1.21%
17	8544	Insulated wire; optical fiber cables	1.83	1.21%
18	6406	Parts of footwear	13.48	1.08%
19	9403	Other furniture and parts thereof	2.02	1.06%
20	3102	Mineral or chemical fertilizers, nitrogenous	7.75	0.82%

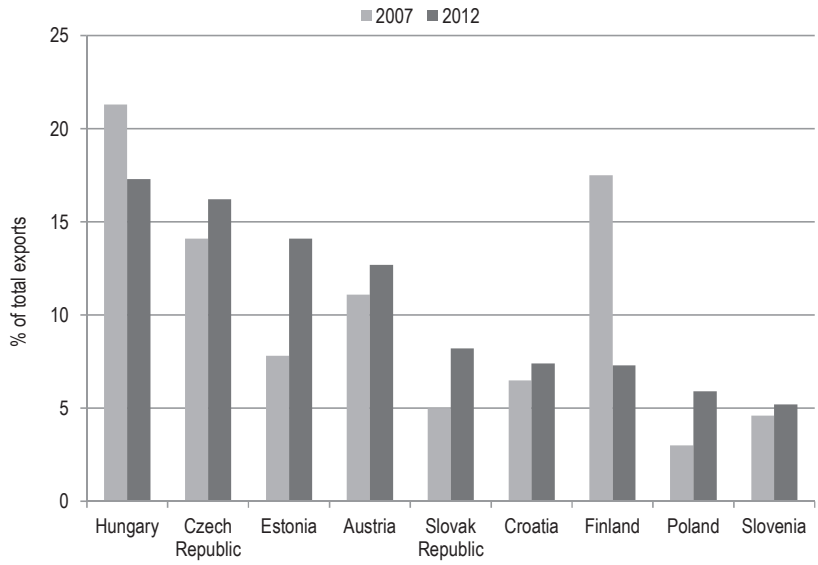
Source: The Observatory of Economic Complexity, using UN COMTRADE data; Simoes, A.J.G. and C.A. Hidalgo (2011), "The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development", Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence, San Francisco; and Hausmann, R., C.A. Hidalgo, S. Bustos, M. Coscia, S. Chung, J. Jimenez, A. Simoes and M. Yildirim (2011), *The Atlas of Economic Complexity*, Puritan Press, Cambridge, MA.

According to the IMF (2012, pp. 44 and 54) over 2000-08 Croatia's performance in terms of high-technology exports was below the eastern European average of new EU members. This may be partly due to relatively high labour costs, as few foreign companies have located their assembly operations in Croatia. The two exceptions were Office machinery and Communication equipment, which enjoyed high average export growth (about 45% and 20%, respectively).

More recent data show some encouraging signs of the tentative development of export capabilities in R&D-intensive sectors with potentially higher value added. Croatia increased its share of high-technology exports between 2007 and 2012 by about one percentage point, although the level remains low (Figure 1.11). Orszaghova et al. (2013,

pp. 26-28) report that over 2000-10, there was a decline in exports of low-technology and labour-intensive products such as textiles and a shift toward high-technology goods such as pharmaceuticals and machinery. They also report that export unit values for several of these sectors (e.g. medicaments, machinery) have increased over the period. However, according to the same study, these positive developments appear to be offset by a parallel increase in primary product exports and resource-based manufactures. Moreover, another study on the sources of Croatian export competitiveness finds that, unlike Slovenia where medium-high and high-technology intensive manufacturing has shifted from price- to quality-driven competitiveness, Croatian manufacturing continues to be driven by price competitiveness (Stojcic et al., 2012: 82).

Figure 1.11. Exports of high-technology products as a share of total exports, selected countries, 2007 and 2012



Source: Eurostat (2013), Statistics Database, accessed June 2013.

Firm demographics

Smaller firms are, on the whole (despite important exceptions), less likely to operate at technologically efficient scales (or for that matter use the latest production technology), to export to international markets or to engage in innovation. The presence of larger companies, and their obvious scale and scope advantages, can therefore be conducive to innovation and to its successful commercial exploitation. At the same time, a numerous and continuously replenished pool of dynamic SMEs is vital to maintaining a competitive environment, and new enterprises are a well-documented vehicle for the commercialisation of innovations. Dynamic smaller firms may be found in specialised economic activities where the technologically efficient scale is small. As it is often inefficient to incorporate such activities into larger firms, smaller firms of this kind are important nodes in global value chains and can be a source of innovation with a pervasive influence across sectors. Finally, some small firms eventually grow into large firms so facilitating start-ups is an important dimension of maintaining a balanced business sector. Framework conditions are crucial determinants of the quality and quantity of business firms insofar as they influence firm entry/exit, market orientation, firm growth, and innovative behaviour, including the propensity to collaborate.

The distribution of the number of firms, employment and value added across firm size bands in Croatia is close to that of the EU27 (Table 1.7). Whereas small and medium-sized enterprises (SMEs) account for over 99% of firms, they account for 69% of employment and 59% of value added. Importantly, while Croatia's SMEs account for a greater share of employment than EU27 SMEs (69.2% and 67.4%, respectively), they account for roughly the same share of value added, an indication that Croatia's SMEs are less productive.

Table 1.7. Enterprise demographics, Croatia and EU27, 2010

	Number of enterprises			Employment			Value added		
	Croatia		EU27	Croatia		EU27	Croatia		EU27
	Number	(%)	(%)	Number	(%)	(%)	Million EUR	Share (%)	Share (%)
Micro	156 848	92.1	92.2	338 258	31.5	29.7	4 191	20.3	21.5
Small	11 137	6.5	6.5	208 090	19.4	20.6	4 037	19.6	18.6
Medium-sized	1 929	1.1	1.1	197 276	18.4	17.2	3 940	19.1	18.3
SMEs	169 914	99.7	99.8	743 624	69.2	67.5	12 168	58.9	58.4
Large	430	0.3	0.2	331 177	30.8	32.5	8 480	41.1	41.6
Total	170 344	100.0	100.0	1 074 801	100.0	100.0	20 648	100.0	100.0

Source: European Commission (2012b), SBA Fact Sheet 2012 Croatia, DG Enterprise and Industry, http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/files/countries-sheets/2012/croatia_en.pdf, accessed 17 January 2013.

The Czech Republic and Slovenia are the two countries that most resemble[8] the overall Croatian distribution of employment across size bands (Table 1.8). The share of employment in larger firms is larger in Croatia (30.8%) than in Hungary (27.3%) and just above Slovenia (29.4%).

Table 1.8. Share of employment across firm size bands, 2010

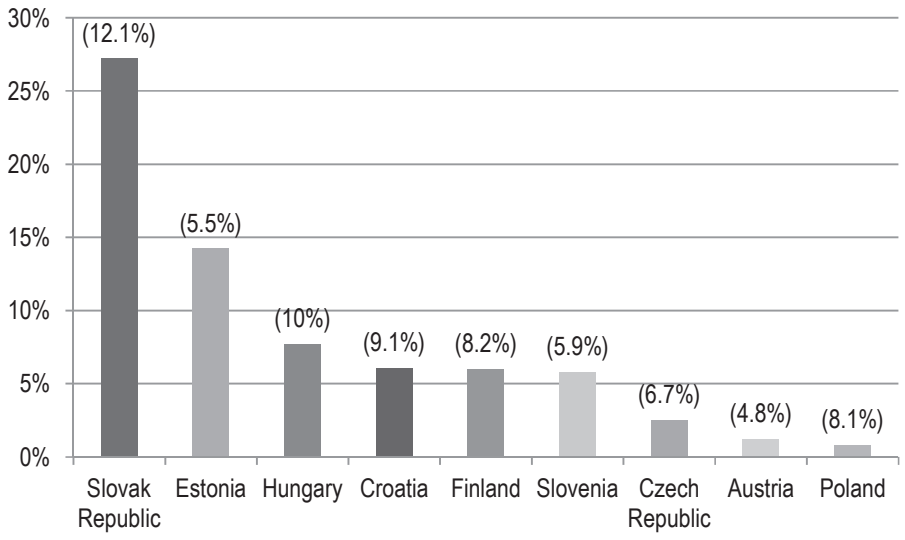
	Czech Republic	Hungary	Austria	Poland	Slovenia	Slovak Republic	Finland	Croatia	EU27
Micro	30.9	36.4	25.1	37.4	30.5	13.4	24.5	31.5	29.6
Small	19.3	19.3	23.7	11.9	19.4	21.5	20.5	19.4	20.6
Medium-sized	19.7	16.9	19	18.9	20.7	23.3	16.7	18.4	17.2
SMEs	69.9	72.7	67.9	68.2	70.6	58.3	61.7	69.2	67.4
Large	30.1	27.3	32.1	31.8	29.4	41.7	38.3	30.8	32.6
Total	100	100	100	100	100	100	100	100.0	100
Similarity to Croatia	99.8%	99.1%	98.2%	97. 6%	99.7%	81.9%	95.7%	100%	99.7%

Source: European Commission, various SBA factsheets.

The ratio of new businesses to the total number of businesses (firm birth rate) is an indicator that may be suggestive of the country's entrepreneurial potential (Figure 1.12). In terms of numbers, the equivalent of 6% of existing Croatian firms are founded every year, a rate Croatia shares with Finland and Slovenia. Firm entry may be motivated by the identification of market niches and/or the commercialisation of new products, services or business processes that provide opportunities for firm growth. However, it may also reflect an inflexible labour market, with the primary motivation behind firm formation the provision of employment for its founders. On average, countries with high unemployment rates tend to have higher firm birth rates. Judging by countries with comparable rates of unemployment, such as Hungary and Finland, Croatia's business birth rate appears proportional to its unemployment rate. In fact, the rate of business births is encouraging, given the difficulties involved in starting a business in Croatia in terms of number of procedures and start-up costs. The similarity with the EU averages in terms of firm numbers across size bands (Table 1.7) and the moderate firm birth rate suggest that the constraints on firm entry, while present, are not prohibitive, and may hint at the effectiveness of incentives provided to first time entrepreneurs.

Figure 1.12. Firm birth rate: Share of new businesses in total number of businesses, 2009

Unemployment rate in brackets



Note: For the Czech Republic: 2008 for numbers of businesses and 2009 for unemployment. For Estonia: 2007 for number of new businesses and 2008 for total number of businesses.

Source: OECD, based on World Bank/Eurostat.

1.4. Framework conditions for innovation

Framework conditions that influence a country's innovation performance include the macroeconomic framework, the general business environment, the level and quality of entrepreneurship, the intensity of competition, and product and labour market regulations, including institutions such as the intellectual property rights (IPR) regime. Cross-country studies have highlighted the importance of such conditions for innovation performance (Furman et al., 2002; Jaumotte and Pain, 2005; Westmore, 2013). There are several reasons why framework conditions are central to innovation performance:

- The economic returns to innovation usually take a long time to materialise, so the use of resources for innovation activity requires a stable or at least predictable economic environment.
- The legal and regulatory framework is important for innovators' ability to benefit from their efforts, for the absorptive capacity of firms, and for the speed of diffusion.
- The effectiveness of innovation policies depends crucially on the quality of framework conditions. For instance, the success of R&D tax incentives on bringing about a lasting change in the innovation activities of businesses depends on the size of the informal economy.

Innovation policy is unlikely to compensate for major shortcomings in framework conditions. Meaningful interventions often require co-ordination across different policy areas to establish and maintain framework conditions that are favourable to innovation.

With regard to the barriers to and facilitators of business activity in Croatia, the World Bank's "Doing Business" surveys provide an annual cross-country assessment. In 2013 Croatia ranks 84 overall out of 185, a drop of four positions from 2012 (World Bank, 2013a; World Bank, 2012). Although the number of administrative procedures involved in starting a business has fallen over time, the pace of change in Croatia is slower than elsewhere. Croatia is considerably better positioned than the comparator group in terms of obtaining electricity and paying taxes and moderately better in terms of obtaining credit and starting a business (Table 1.9). Broadband connectivity is high. According to Eurostat (2013), 90% of Croatian firms with 10 or more employees had broadband access, compared to 92% in the EU27. Among Croatia's relative weaknesses, the protection of investors is of particular relevance to innovation.

A number of recent initiatives have aimed at reducing the administrative burden on companies and facilitating investment. These include provisions for tax incentives and other support foreseen in the Act on Investment Promotion and Development of the Investment Climate, the establishment of the SME Observatory and the Agency for Investment and Competitiveness, and the drafting of a strategy for encouraging entrepreneurship (EC, 2013). The government's action plan to reduce regulatory burdens by streamlining legislation and eliminating unnecessary regulations began in 2007 but slowed in 2009 and has made little progress since (OECD et al., 2012).

Access to general business finance is not as much of a problem as in other countries in south east Europe. In a 2009 international survey (Business Environment and Enterprise Performance Survey) 43% of firms in Croatia reported that access to finance was not a problem against 34% on average in south eastern Europe and in Europe and Central Asia (EBRD and the World Bank, 2010). Croatia has a higher share of private credit over GDP than Poland, the Czech Republic and the Slovak Republic. There are several public financial support programmes for SMEs, including nine credit guarantee programmes by HAMAG-INVEST that cover start-ups, microcredit, the agriculture sector and new technologies (OECD et al., 2012). While there is a variety of arrangements in place to suit a relatively wide array of needs, many smaller companies still find it hard to secure funding due to strict technical regulations and the need for collateral. There is little capital available for risky investments (OECD et al., 2012), a limitation that Croatia shares with other countries. Several of the provisions of the 2012 Act on Investment Promotion and Development of Investment Climate are compatible with the attraction of investment for innovation, but it is too early to assess its impact.

Table 1.9. World Bank "Doing Business" rankings, selected countries

	Czech Republic	Estonia	Finland	Austria	Hungary	Poland	Slovenia	Slovak Republic	Comparator group average	Croatia
Starting a business	140	47	49	134	52	124	30	83	82	80
Dealing with construction permits	74	35	34	75	55	161	61	46	68	143
Getting electricity	143	52	21	24	109	137	31	100	77	56
Registering property	27	14	24	34	43	62	83	8	37	104
Getting credit	53	40	40	23	53	4	104	23	43	40
Protecting investors	100	70	70	100	128	49	17	117	81	139
Paying taxes	120	50	23	77	118	114	63	100	83	42
Trading across borders	68	7	6	26	73	50	57	98	48	105
Enforcing contracts	79	31	9	7	16	56	56	69	40	52
Resolving insolvency	34	72	5	12	70	37	42	38	39	97

Source: World Bank (2013), *Doing Business 2013: Smarter Regulations for Small and Medium-Size Enterprises*, Washington, DC, World Bank Group.

The European Commission's Small Business Act for Europe (SBA) Factsheets provide information from local experts on the country's progress in providing an SME-friendly environment over 2007-12 (EC, 2012b). They cover dimensions of the business environment such as entrepreneurship, second-chance policies, a responsive administration, access to finance, skills and innovation, the business environment and internationalisation. Croatia performs close to the EU average in all of the above dimensions except second-chance policies, and, especially, internationalisation. Nevertheless, the trend is positive in most areas, with the exception of a moderate decline in access to finance (EC, 2012b, p. 3). A bankruptcy law has been established and was further amended in 2010 to allow for more efficient and quicker bankruptcy proceedings (OECD et al., 2012, p. 187).

With respect to the efficiency and effectiveness of public administration there is considerable scope for improvement. Indirect evidence on the efficiency of public expenditure suggests that Croatia's public administration is less efficient than that of EU27 and OECD member countries (Aristovnik, 2009). The current performance evaluation system does not facilitate career progression based on merit, though foreseen amendments to the Civil Service Act aim to improve recruitment procedures and introduce performance appraisal (EC, 2013).

Corruption continues to be a problem both in the public administration and in wider business activities. Croatia ranked 66 out of 183 in Transparency International's Corruption Perceptions Index, below most EU countries except Italy, Romania, Bulgaria and Greece (OECD et al., 2012, p. 184). In addition, 90% of respondents to an international survey by Ernst & Young believed that corruption is widespread in business

activities (EC, 2013, p. 26). Interviews with various stakeholders suggested that there is a general a lack of trust, which appears to have pervasive consequences on financing innovation, on collaboration among inventors and cooperation within government. It is likely that lack of trust constrains the magnitude and influences the type of public support for business innovation. In addition to the influence of perceptions of corruption highlighted above, the problem is worsened by lack of transparency, weak monitoring and evaluation of government-financed schemes and lack of feedback once schemes have been completed.

The IPR system has been strengthened and is aligned with European standards. However, despite considerable efforts to prepare the IP system for EU accession, Croatian authorities failed to protect geographical indications and appellations of origin (IPW, 2013). Croatia has made considerable progress in IPR enforcement, as evidenced by the lowest estimated rate of software piracy in south-eastern Europe (OECD, 2010). The efficiency of the judiciary has improved in recent years, though shortcomings persist, such as a large backlog of unresolved civil and commercial cases (EC, 2013, p. 23).

Croatian firms' exposure to competition appears to be uneven. Single suppliers dominate in markets for energy, transport and postal services (EC, 2013, p. 22). Large-scale state aid and inefficient bankruptcy procedures create important barriers to dynamic firm entry and exit (World Bank, 2009). According to Tipurić and Pejić-Bach (2009), overall concentration decreased in Croatia over the period 1995-2006, although sectors vary widely. Sectors in which concentration was still high included forestry, logging and related service industries. Sectors with high and increasing concentration included Manufacture of tobacco products (D16); Manufacture of wearing apparel, etc. (D18); Manufacture of office machinery and computers (D30); and Manufacture of basic metals (D27). Retail trade (G52) also showed increasing concentration over time, but compared to the sectors mentioned above remained at a low level. The increases in concentration in some industries (such as computers and related services, manufacture of tobacco products and retail) happened in parallel to the entry of multinational enterprises. The prominence of state-controlled sectors and relatively low contestability in key service sectors (such as financial services, telecommunication and energy) dampen business dynamism and may pose obstacles to the emergence of new innovative businesses.

Croatia enjoys a favourable geographic location on the Adriatic coast and at the crossroads of central and south-eastern Europe as well as historical links with several OECD and emerging economies. These advantages have contributed to inward FDI, a small part of which is in knowledge-intensive or R&D-performing sectors. Three pan-European transport corridors cross Croatia. Recent public investment has strengthened Croatia's links along these corridors, focusing mainly on roads, motorways and ports. However, Croatia's railway sector will require investments before it is integrated with the EU network (World Bank, 2013b).

1.5. The role of innovation in Croatia's future economic development

The financial and economic crisis has revealed a number of weaknesses in the Croatian economy, even more sharply than in other countries. In the years since the crisis, it has become clear that sustainable growth and increasing living standards will require a repositioning of the country's economic growth and development model. Innovation would be a central element of a sustainable model and would be critical in fostering productivity improvements and strengthening international competitiveness.

Croatia's productivity gap with EU27 countries remains large. If current rates of improvement (which have been lower than in other new EU member states) are maintained, the gap will not be closed for another two decades. Evidence suggests that labour productivity improvements over the past decade are mostly due to capital deepening. However, capital deepening alone will not suffice. More pervasive technological change, adaptations to bring productive techniques as close to the global frontier as possible, substantial improvements in human capital and capability accumulation in firms that permit them to achieve these adaptations can all play a crucial role in accelerating productivity improvements and in closing the income gap with the EU. The more extensive process of innovation described above will be essential for ensuring that, as Croatia approaches the level of income of its wealthier EU peers, its economic growth is driven by TFP improvements and is therefore sustainable. Importantly, the policy interventions needed for innovation and TFP-driven growth are not just a concern for the far-off future. TFP-driven growth requires the accumulation of capabilities within firms over a long time – typically decades – to reach the levels required for pervasive economic impact. Therefore, the need for policy interventions as early as possible to support innovation is greater than what is implied by an unfulfilled opportunity for higher rates of growth in the present: what is at stake is the ultimate sustainability of Croatia's living standards.

The success of innovation policy in supporting future economic development in Croatia will be linked to:

- *Improvements in the economy's capacity to absorb knowledge from abroad*. An economy that is open to international trade and investment and with an outwardly-orientated business sector forms the basis for the international transfer of economically useful knowledge. Efficient knowledge and technology transfer can be facilitated by an internationally integrated science system that mediates between cutting-edge science and local social and economic needs. High international mobility of human resources and active participation in international research and innovation policy initiatives are also the hallmarks of systems that quickly absorb knowledge from abroad.
- Improvements in the circulation of knowledge within the economy and extensive engagement in innovation activities in as large a part of the business sector as possible. A dynamic business environment with a level competitive field provides incentives for productivity-enhancing innovation. Engagement in collaborative R&D, but also non-R&D forms of collaboration such as joint training schemes, strengthen knowledge circulation and nurture the emergence of trust over time. Strong universities and public research institutes that act as hubs of knowledge accumulation, generation and circulation are important elements.
- *The accumulation of capacities for new-to-the-world innovation*. Such capacities overlap in practice with those needed to absorb, adapt and diffuse knowledge. The distinction largely reflects differences in degree of accumulation and in the ambition with which they are deployed. While nurturing R&D activity is relevant at all stages of development of Croatia's innovation system, once the absorptive basis of the economy is sufficiently developed, a progressive change of policy focus to frontier-shifting R&D and new-to-the-world innovation will be necessary.

Notes

1. Even if the country's pre-crisis growth were restored, convergence would take another two decades.
2. Unit labour costs (ULC) measure the average cost of labour per unit of output and are calculated as the ratio of total labour costs to real output.
3. This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo Declaration of Independence.
4. Knowledge-intensive activities (KIA) is a sectoral classification based on the level of tertiary educated persons across sectors, and technology intensity is a sectoral classification by R&D intensity, http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/htec_esms.htm; http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/htec_esms_an3.pdf.
5. High technology manufacturing may of course not always reflect high value added activities, but is nevertheless a suggestive indicator of structure.
6. RCA is usually defined as a country's share of world exports in a particular commodity or industry, divided by the share of that country's world exports in all commodities: $RCA_{i,c} = (X_{i,c}/X_{i,\ world})/(X_{total,\ c}/X_{total,\ world})$, where $X_{i,c}$ and $X_{i,\ world}$ are respectively the exports of industry i by country c and the world, while $X_{total,\ c}$. and $X_{total,\ world}$ refer to total (manufacturing) exports by country c and the world. A value larger than one indicates that country c possesses a comparative advantage and is specialised in industry i, while a value smaller than one points to a comparative disadvantage.
7. This may be due to the end of the royalty stream for the popular antibiotic Zythromax, whose patent expired around 2005.
8. Similarity has been calculated as the correlation coefficient of the Croatian distribution versus the distribution of other countries, multiplied by 100.

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Chapter 2

Innovation performance

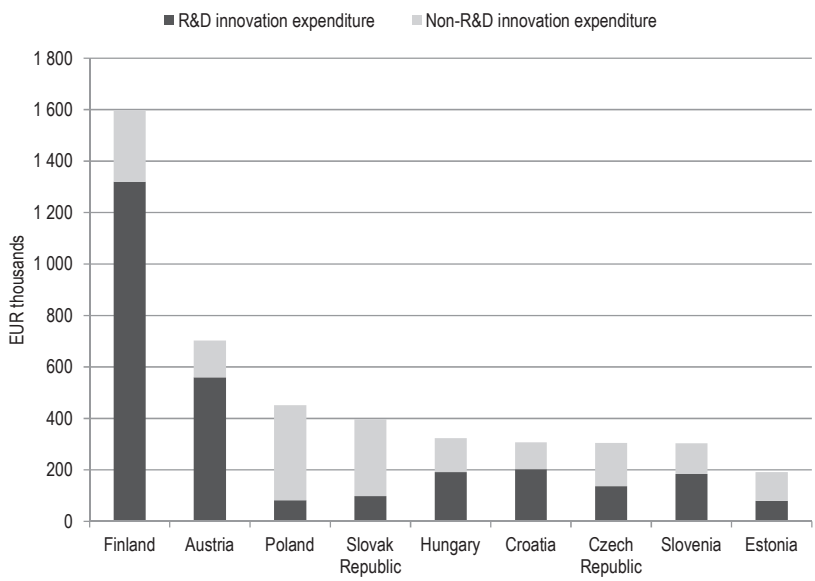
Croatia's innovation performance lags behind that of similar countries. Gross national expenditure on R&D (GERD) as a share of gross domestic product (GDP) is far below that of most EU countries. Business expenditure on R&D (BERD) as a share of GDP also lags most EU countries and is below what would be expected given the country's industrial structure. In terms of mobilising human resources for innovation, Croatia's performance is modest, with shortcomings in the quantity and quality of mathematics and science education, employment of scientists and engineers, tertiary education graduates, and employment of R&D personnel. Croatia also lags with regard to innovative outputs. Most Croatian firms did not engage in innovation activity during 2008-10. Patenting activity is also low, in relation to both the population and the amount of BERD. The above-average productivity and relative cost-effectiveness of Croatian scientists are the positive exceptions in a system that appears to be operating below potential. Finally, the Croatian innovation system is considerably less internationalised than those of comparable countries and the economic impact from innovation appears to be small. While there is modest improvement over time in some indicators (especially for scientific publications and, to a lesser extent, patenting), there have been setbacks: most notably, volatile and ultimately declining R&D expenditures (including by the business sector) and a relative decline in the standing of engineering.

2.1. Innovation inputs

Innovation expenditure

Inputs to innovation include expenditures for the adoption of the latest capital goods, training and other additions to the firm's stock of existing knowledge, such as licensing, as well as resources devoted to formal research and development (R&D). Innovation expenditure across countries can be gauged using firm-level averages from the Community Innovation Survey (CIS) 2008-10 (Figure 2.1). These figures cover only companies that introduced at least some type of innovation during 2008-10.[1] Croatia is at the lower end of the comparator countries, with the average innovating company spending just over EUR 300 000 on innovation. In Croatia, firms' innovation expenditure is roughly at the same level as in Slovenia, the Czech Republic and Hungary, one notch up from Estonia. Most Croatian innovation spending in 2008-10 was for R&D. By contrast Croatian firms surveyed in the previous wave of the CIS (2006-08) reported that most innovation spending was non-R&D[2].

Figure 2.1. Average innovation expenditure per innovating company, 2008-10



Source: Eurostat (2013), Statistics Database.

According to CBS (2012b), in 2008-10 the largest share of innovation expenditure was for in-house R&D, followed by acquisition of machinery, equipment and software. Large companies were more likely to spend on R&D; most innovation expenditure on medium and small companies was devoted to acquisition of machinery, equipment and software. The fact that Croatian firm spending on innovation was on a par with most other transition countries in the group could be because innovation activity in these settings is not as demanding and can be achieved with relatively low expenditure. However, the availability of finance is at least of some importance. Lack of external finance was the third most-cited obstacle to innovation in the CIS. In addition, in a study analysing Croatian CIS data, Božić (2011) found that lack of external finance was an important predictor of the abandonment of innovation projects. Much innovation

expenditure, and arguably most expenditure for new-to-the-firm innovation, cannot be considered risky – at least not in the sense that R&D is risky – so the bottleneck seems to be not simply the availability of finance for risky investment, but, more likely, the availability of financial capital in general for small companies and the liquidity constraints arising from the economic and financial crisis.

R&D expenditures

Gross national expenditure on research and development (GERD) has stagnated over the last decade. In absolute terms, there was a moderately positive, albeit inconsistent, long-term trend, which alternated between growth and contraction four times between 2002 and 2011. By 2011, however, GERD had reverted to 2004 levels (Table 2.1), unadjusted for inflation (Eurostat, 2012). In comparative terms, Croatia had the second-lowest growth rate of GERD (0.8%) among all European Research Area[3] countries over 2000-09 (EC, 2011a, p. 51). During the international financial crisis (2008-09), it had one of the largest declines in nominal GERD in Europe (fourth to last among 30 countries) (EC, 2011a, p. 64) and in government budget appropriations or outlays for R&D (GBAORD) (fifth to last among 31 countries) (EC, 2011a, p. 67). This indicates R&D budgets are not shielded from budget cuts, in contrast to e.g., Hungary and Slovenia (EC, 2011).

Table 2.1. Croatia's GERD, current prices, 2002-11

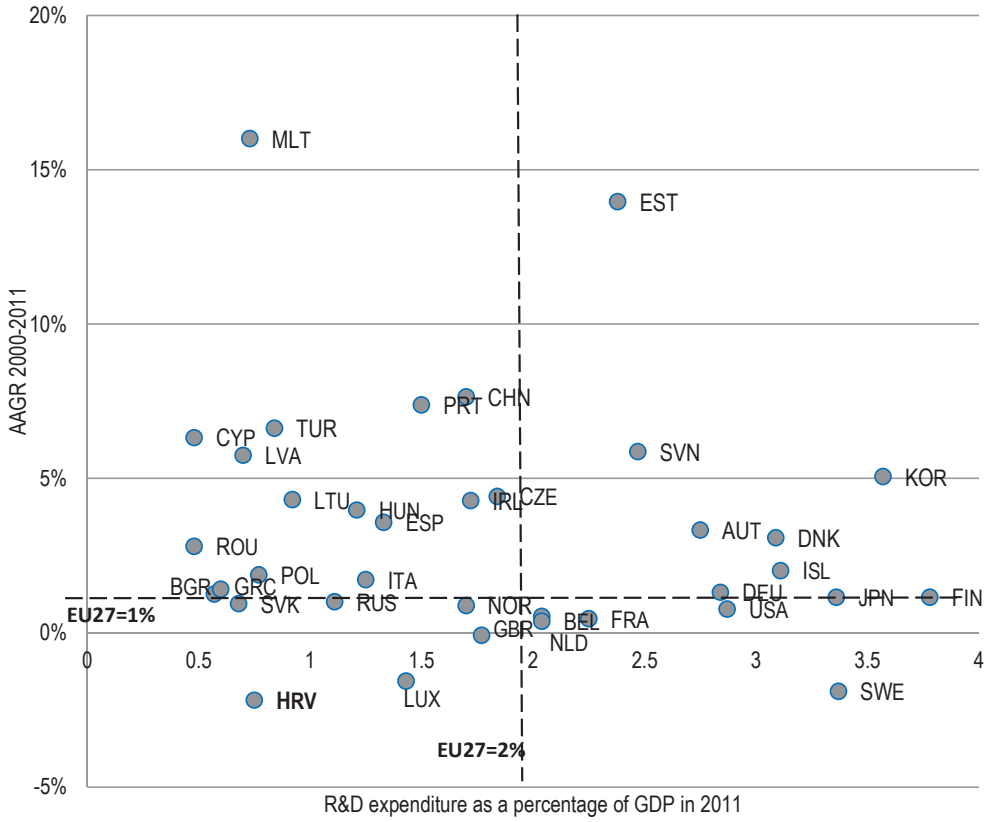
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
In million EUR	271	292	345	312	298	348	426	381	335	336
GERD per capita	61	66	78	70	67	78	96	86	76	76
% of GDP	0.96	0.96	1.05	0.87	0.75	0.8	0.9	0.85	0.75	0.75

Source: Eurostat (2013), Statistics Database.

The evolution of Croatia's R&D intensity (GERD as a share of GDP) is not encouraging. At 0.75% of GDP, Croatia's R&D intensity in 2011 was the lowest it has been since at least 2002, when Eurostat records begin (Table 2.1). Figure 2.2 offers summary view of the international dynamics of R&D intensity, which crosses selected countries' R&D intensity with the corresponding average annual growth rate (AAGR) of R&D intensity. Croatia's AAGR of R&D intensity was -3%, the worst performance of all countries in the group. This is against an international setting in which most OECD countries have increased their R&D intensity (at 2.40% in 2009; OECD, 2012b, p. 21) and EU countries have committed to a 3% target by 2020.

The decline in R&D intensity even before the crisis casts a new light on Croatia's otherwise encouraging 4% GDP growth rate over 2000-08, as it suggests that expansion occurred for the most part in sectors that conduct little R&D. As seen in Chapter 1, the contribution of TFP to growth was small. Indeed the percentage of employment in sectors classified as "knowledge-intensive" stood at 28% (as opposed to an EU average of around 40%), with almost no change over 2002-08 (Eurostat, 2013; see Figure 2.16). Evidence of growth without (or with little) structural change towards knowledge-intensive activities is especially worrying at this crucial juncture in Croatia's long-run economic development and in the catch-up process with the EU. The concern is that it could lead to a structural lock-in and a trajectory incompatible with sustainable economic growth.

Figure 2.2. R&D intensity, 2010 level and annual growth rate, 2000-11, selected countries.



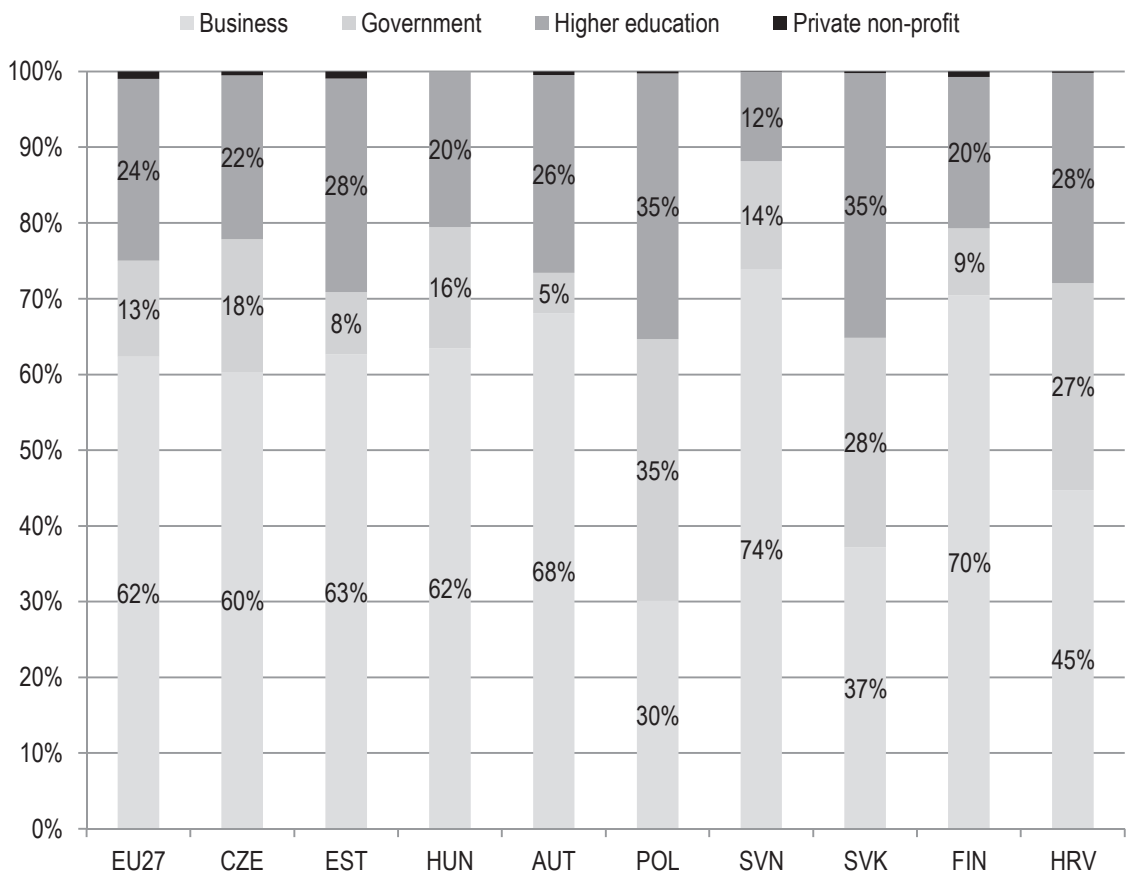
Note: The period covered varies for some countries: 2001-07 for Greece; 2000-09 for Iceland, Japan, Korea and the United States; 2001-10 for Turkey; 2001-09 for China; 2003-11 for Croatia, Luxembourg and Malta; 2001-11 for Sweden and Norway.

Source: OECD, based on Eurostat (2013), Statistics Database.

For the structure of R&D expenditure by sector of performance, Croatia is compared to a group of countries of similar size over time (Figures 2.3 and 2.4). For transition countries, the move to a regime in which a greater proportion of R&D is priced and eventually traded is crucial for the efficiency with which resources devoted to R&D translate into economically useful innovation. By 2011 the public sector still performed the majority of R&D, with business accounting for 45% of total GERD. The share of total R&D performed by the business sector remained more or less constant over the last decade, hovering around 40%. In terms of the share of business expenditure on R&D, Croatia is only doing better than Poland and is in sharp contrast to Slovenia (74%), which, together with Finland (70%), leads the group. A sizeable proportion of research in Croatia was performed by government (27%), a proportion only exceeded by Poland (35%) and the Slovak Republic (28%).

Figure 2.3. GERD by sector of performance, 2011

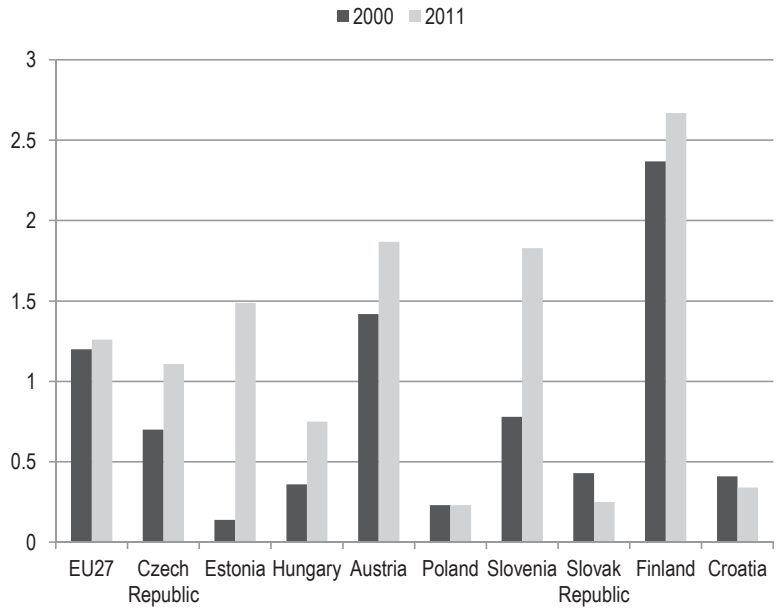
Percentage



Source: Eurostat (2013), Statistics Database.

It is also apparent from Figure 2.4 that Croatia and the Slovak Republic were the countries in which business expenditure on R&D (BERD) as a proportion of GDP had actually decreased by 2011 from a decade earlier (and, adjusting for inflation, even in absolute terms). This contrasts with the mildly positive OECD (OECD, 2012b, p. 43) and EU trends (EC, 2011a, p. 27) and the policy target, of EU member states in particular, of the equivalent of 2% of GDP to R&D from private sources (EC, 2011a, p. 73). Survey data from the World Economic Forum's Global Competitiveness Report confirm this observation. The answer to the question "To what extent do companies in your country spend on R&D?" shows that Croatia tumbled from 45th position in 2008 to 76th in 2012[4] (WEF, 2008, 2009, 2010, 2011, 2012). The fact that this decline is well recognised by the business community is important in its own right. Insofar as some may interpret it as a signal of the attractiveness of Croatia for private R&D investment, it can affect long-term investment dynamics[5]. This trend could be reversed as a consequence of changes in the framework conditions that should accompany EU membership - international openness and competition in particular.

Figure 2.4. BERD as a percentage of GDP, 2000 and 2011



Note: 2002-11 for Austria and Croatia.

Source: Eurostat (2012), Statistics Database.

To understand some of the main relationships between institutional sectors, it is useful to examine the structure of R&D spending by tracing the flow of funds from source of funding to sector of performance (Table 2.2). Owing to Croatia's particular institutional configuration, the government sector both funds and performs about half of all R&D. About 3% of government funding goes to business-performed R&D, while the average in the OECD is 8.9% and in the EU 7.2% (OECD, 2012b). This is partly because about two thirds of total government support to the business sector is directed via tax incentives (see Chapter 4). Higher education (45%) and public research institutes (52%) account for the majority of expenditure. With 7% of total business expenditure devoted to R&D performed by universities, the interest of private funders in the research capacities of universities is slightly above the OECD (6.3%, 2009) and EU (6.4%, 2009) averages (OECD, 2012b, p. 67). Croatia participates fully in the EU's Framework Programme as of January 2007 (EC, 2009) but only a relatively small proportion of funding from abroad in 2008 went to research performed by universities (14%), well below neighbouring Slovenia's 27% (OECD, 2012a). This percentage is rising and can be expected to increase further following EU membership, participation in a wider range of FP instruments and eligibility for the Structural Funds. Three-quarters of funding from abroad went to the business sector, owing to considerable investments by foreign multinationals; this amounted to about 11% of total BERD in 2009, down from a peak of 22% in 2007.

Table 2.2. GERD by sector of funding and performance, 2011

	Funding sector				
Performing sector	Government sector	Business enterprise sector	Higher education sector	Abroad	Share of GERD
Higher education sector	45%	7%	100%	14%	28%
Government sector	52%	2%	n/a	10%	27%
Business enterprise sector	3%	90%	n/a	75%	45%
All sectors	100%	100%	100%	100%	100%
Share of GERD	48%	38%	2%	12%	100%

Source: OECD, based on Eurostat (2013), Statistics Database.

BERD intensity decreased from 2002 to 2011, but the trend was not consistently negative (Table 2.3). The sharpest decreases occurred in 2005 and 2006, coinciding with the downsizing of the former Pliva Institute (a pharmaceutical R&D lab) the R&D expenditure of which declined significantly following its ownership transfer (from 102.5m in 2005 to 85m EUR in 2006) (EC, 2013). Higher education expenditure on R&D (HERD) intensity also underwent a relative decline over the period, following a tentative increase in 2003 and 2004. Interestingly, government expenditure on R&D (GOVERD) intensity remained more or less constant, in the face of considerable volatility in GDP. This suggests either a responsive public sector and/or a strong association between government expenditure and changes in economic output.

Table 2.3. Composition of R&D by performance sectors, 2002-11

Percentage of GDP

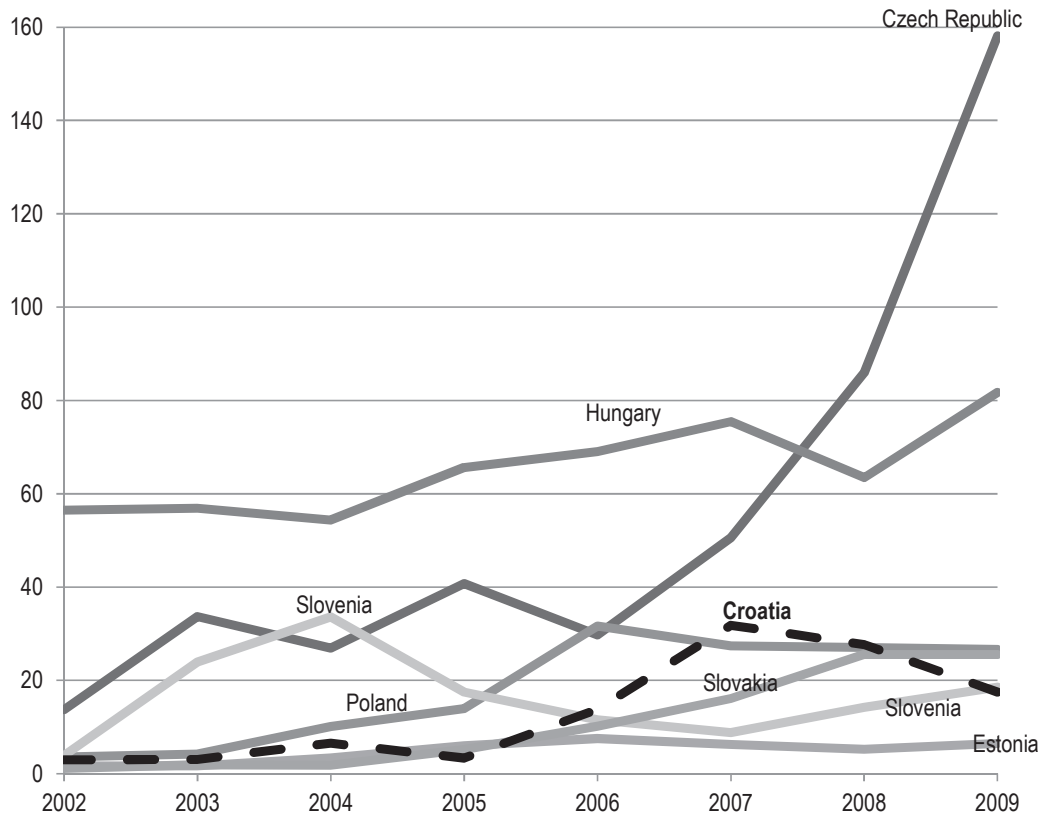
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BERD	0.41	0.38	0.44	0.36	0.27	0.33	0.4	0.34	0.32	0.34
GOVERD	0.21	0.21	0.22	0.21	0.2	0.2	0.23	0.23	0.21	0.21
HERD	0.34	0.38	0.39	0.3	0.27	0.27	0.27	0.27	0.21	0.21

Source: Eurostat (2013), Statistics Database.

As illustrated below (see Table 2.8), the decline in BERD and in BERD intensity happened at a time of stagnant R&D productivity, a key determinant of internationally mobile R&D (Thursby and Thursby, 2006). In fact, Croatia's ability to attract internationally mobile R&D funds may offer an indication of its attractiveness for private R&D in general. The evolution of foreign-financed BERD over time in Croatia as compared to the comparator group[6] is instructive (Figure 2.5). The trend was generally positive until 2007 but has been declining since. By comparison, Hungary, and especially, the Czech Republic saw large and continuing increases in the flows of BERD from abroad. The rest of the transition countries in the group experienced relatively stable trends. In international comparison, over 2002-09 Croatia attracted on average 3 million EUR of BERD from abroad per billion EUR of GDP, ahead of the Slovak Republic (2) and Poland (1) but behind Hungary (7) and Slovenia (6). When considering the cumulative total of private R&D expenditures from abroad over 2002-09, Croatia attracted EUR 132 million, moderately below Slovenia (EUR 153 million), and close to the Slovak Republic (EUR 117 million) but considerably less than Poland (EUR 192 million), the Czech Republic (EUR 586 million) or Hungary (EUR 624 million).

Figure 2.5. BERD funded from abroad, 2002-09

Millions of current EUR

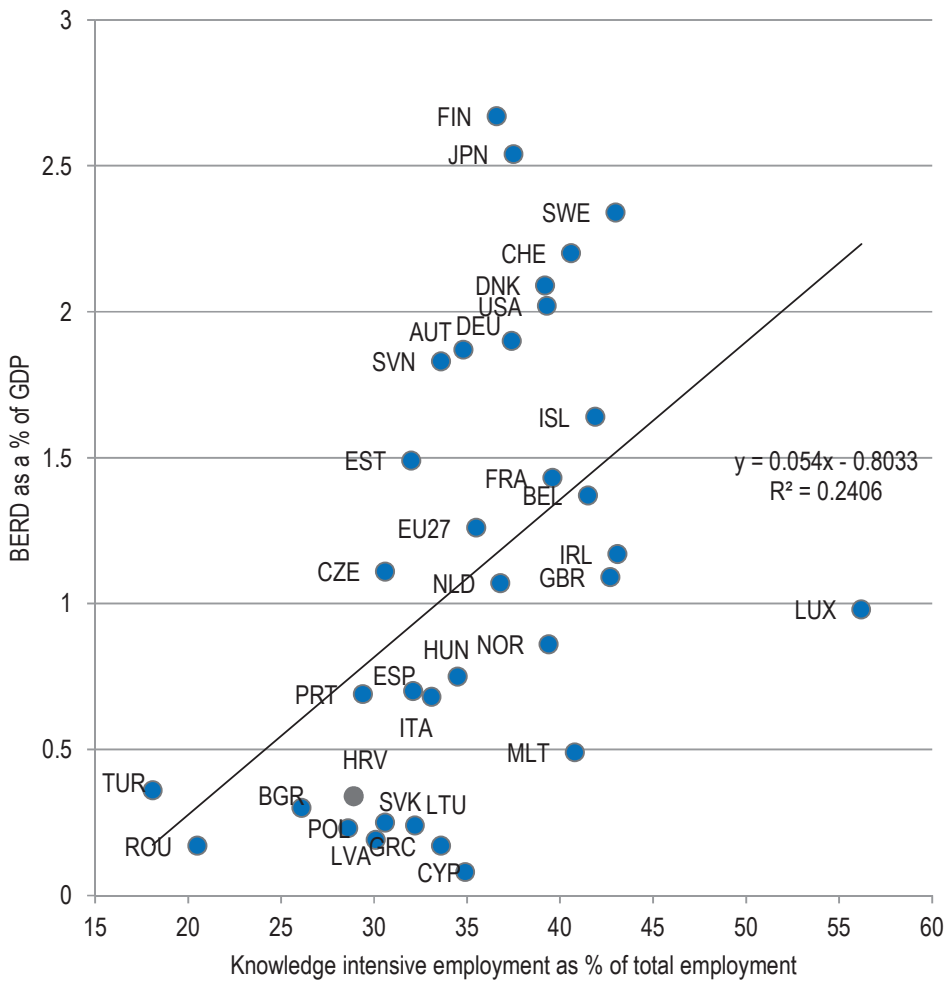


Source: Eurostat (2012), Statistics Database.

It is important to acknowledge however that the BERD shortfall is, at least to some extent, a reflection of Croatia's industrial structure. The question then becomes, how much of this low level reflects the country's industrial specialisation in sectors that tend not to rely heavily on R&D and what can plausibly be attributed to factors such as inappropriate framework conditions. Figure 2.6 proposes a more nuanced yardstick against which to judge the propensity of Croatian firms to invest in R&D. By plotting private-sector R&D intensity against a summary measure of industrial structure (knowledge-intensive employment[7]) it allows for comparing Croatia with peers with a similar structure[8] and also with the benchmark value (regression line) emerging from the collective performance of the 34 countries considered. Countries positioned exactly on the regression line can be considered to invest in R&D precisely as much as one would expect given their industrial structure; countries above the regression line are investing more in R&D than one would expect on the basis of their industrial structure alone, whereas countries below the regression line are investing less.

Croatia appears to be investing less in BERD than suggested by its industrial structure. It is positioned about the same distance from the regression line as Hungary, farther from it than Romania and Bulgaria, but closer than Poland or the Slovak Republic. Croatia's position has deteriorated somewhat over time, unlike the general trend in the EU (Table 2.4). The outlying positions of economies with large services sectors (which tend on average to spend less on R&D) such as Luxembourg, Cyprus[9] and Malta advice for caution in drawing conclusions. In principle, Croatia's large services sectors could negatively condition the scope for R&D. However, the Croatian services sectors actually perform well in R&D relative to other countries[10]. Therefore an explanation for Croatia's low BERD intensity should primarily be sought in features other than industrial structure: the size distribution of firms, the availability of finance in general and for risky investment in particular, the availability of relevant skills, the regulatory environment, market concentration, and a relative lack of international openness are all plausible candidates.

Figure 2.6. BERD intensity given a country's industrial structure, 2011 or latest year



Note: Latest years for which BERD intensity statistics are available are: 2007 for Greece, 2008 for Switzerland, 2009 for Iceland, Japan (2010 for knowledge-intensity employment) and the United States, and 2010 for Turkey.

Source: OECD, based on Eurostat (2013), Statistics Database.

Table 2.4. EU27 and Croatian BERD versus knowledge-intensive employment, 2008-11

	2008	2009	2010	2011
EU27 BERD in millions of EUR / Knowledge-intensive employment (thousands)	2.04	1.96	2.03	2.11
Croatia BERD in millions of EUR / Knowledge-intensive employment (thousands)	0.45	0.36	0.35	0.36

Source: OECD, based on Eurostat (2013), Statistics Database.

Most countries spend around half of GERD on engineering and technology and anywhere between a fifth and a third on the natural sciences. By comparison Croatia spends a rather smaller 38% on engineering and technology and another 17% on social sciences and humanities, disciplines in which most other countries in the comparator group spend around 10% GERD (Table 2.5).

Table 2.5. GERD by field of science (percentages), 2010

	Total	Natural sciences	Engineering and technology	Medical and health sciences	Agricultural sciences	Social sciences	Humanities	Not specified
Czech Republic	100%	24%	58%	8%	3%	4%	3%	
Estonia	100%	21%	7%	9%	3%	4%	6%	50%
Hungary	100%	24%	50%	7%	7%	6%	4%	2%
Poland	100%	25%	47%	10%	8%	6%	4%	
Slovenia	100%	38%	48%	3%	1%	6%	4%	
Slovak Republic	100%	20%	54%	7%	8%	7%	4%	
Croatia	100%	30%	38%	7%	9%	10%	7%	0%

Source: Eurostat (2013), Statistics Database.

Human resources for science, technology and innovation

The availability of qualified human resources for innovation is an important predictor of the quantity and quality of economically useful innovation. An uninterrupted flow of well-trained scientists, engineers and technologists can be central to the dynamism of an innovation system. An examination of the education and training pipeline for such skills can reveal important current and future bottlenecks in the innovation system.

Systematically gathered indicators of the flows of students and graduates and figures on the international testing of students in mathematics and science allow for cross-country comparisons (Table 2.6). In terms of tertiary education graduates in the fields of mathematics, science and technology, Finland and Austria lead the group with 31.8% and 29%, respectively. Croatia, with 20% of all graduates, is not far from the EU average of 21.4%. Prospects for the immediate future are moderately positive. Tertiary students in mathematics, science and technology represent 22.1% of all students in Croatia, ahead of Poland and Hungary, but still some way from the European average of 25%. Finally, in the PISA 2009 international student assessment exercise (OECD, 2010), Croatia occupied last place in the comparator group in student scores for both mathematics and science (94% and 98% of the EU average). Croatia also scored behind the OECD average on these two issues and the difference, though small, was statistically significant (OECD, 2010, p. 15). This last observation is worrying, as there is strong cross-country evidence linking the quality (as distinct from the quantity) of mathematics and science education to technological productivity (Varsakelis, 2006).

Table 2.6. Mathematics, science and technology enrolments and graduates, 2010

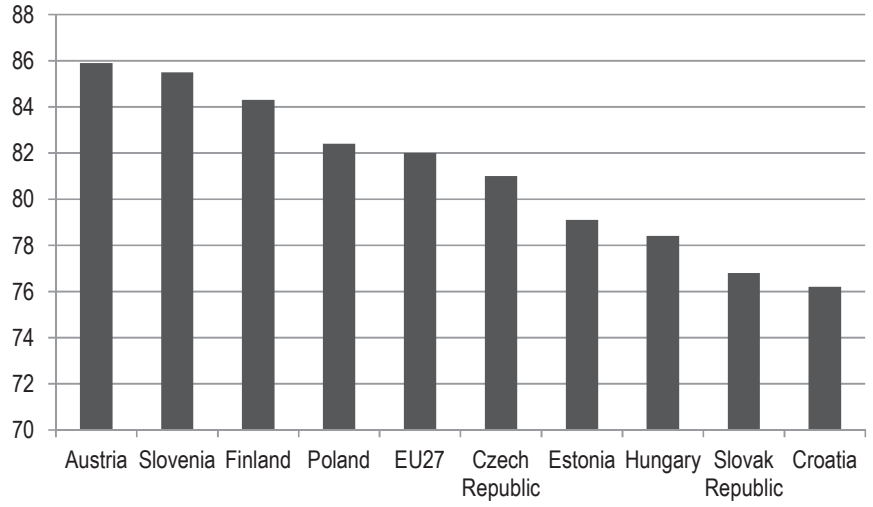
	Students in mathematics, science and technology as a % of all students	Graduates (ISCED 5-6) in mathematics, science and technology fields as a % of all fields	Student score in PISA 2009: Mathematics scale (% of EU average in brackets)	Student score in PISA 2009: Science scale (% of EU average in brackets)
EU	25	21.4	491 (100%)*	497 (100%)*
Czech Republic	25.3	24.2	493 (100%)	500 (101%)
Estonia	23.8	20.5	512 (104%)	528 (106%)
Hungary	21.1	15.6	490 (100%)	503 (101%)
Austria	25.7	29	496 (101%)	494 (99%)
Poland	21.2	15.8	495 (101%)	508 (102%)
Slovenia	25.6	21.1	501 (102%)	512 (103%)
Slovak Republic	23.3	20.8	497 (101%)	490 (99%)
Finland	35.1	31.8	541 (110%)	554 (111%)
Croatia	22.1	20.1	460 (94%)	486 (98%)

Note: EU average for PISA scores excludes Cyprus and Malta owing to lack of data. (Cyprus: see note 9 at end of chapter).

Source: Eurostat (2012), Statistics Database and OECD (2010), *PISA 2009 Results: What Students Know and Can Do: Student Performance in Reading, Mathematics and Science (Volume I)*, PISA, OECD Publishing, doi: 10.1787/9789264091450-en.

The share of tertiary-educated in total employment can be suggestive of broader knowledge intensity in the workplace, i.e. of the extent to which work content is demanding in terms of the information retrieval, communication and analytical skills possessed by the tertiary-educated, a necessary, if not sufficient, condition for innovation. About 22% of those in employment in 2011 were tertiary educated, behind most countries in the comparator group and against an EU27 average of 30%. The rate of employment of the tertiary educated can also be suggestive on the ability of the economy to absorb the highly educated. While over three-quarters of the tertiary-educated in Croatia are in employment, the country lags countries in the comparator group (Figure 2.7).[11]

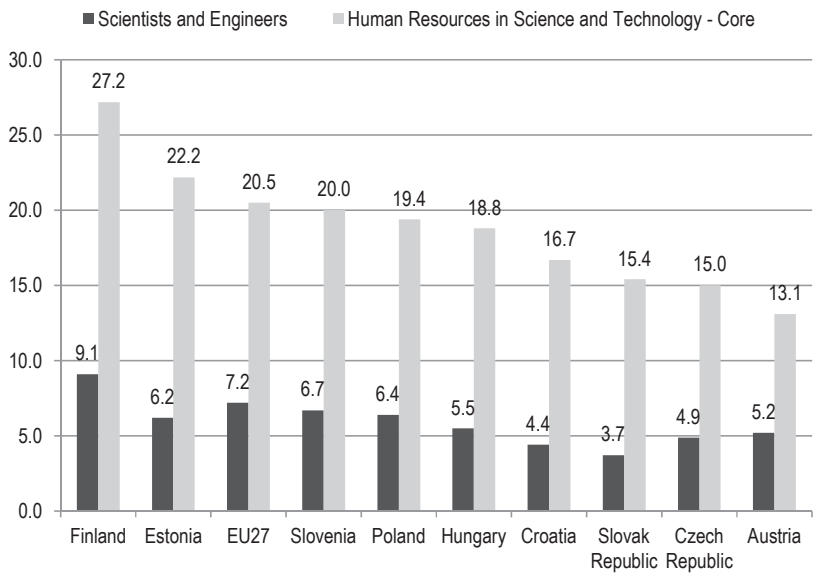
Figure 2.7. Tertiary-educated (ISCED 5 and 6) employment rates, 2011



Source: Eurostat.

A more focused view of knowledge intensity in employment and of its potential relevance to innovation activity can be obtained by examining employment shares of scientists and technologists. Human resources in the science and technology core (HRSTC) includes individuals who have completed education in a science and technology subject and are employed in a science and technology profession. The share of HRSTC in total employment, together with the narrower share of scientists and engineers, can be a useful proxy of the pervasiveness of scientific and technological skills in economic activity (Figure 2.8). Compared to other countries and the EU27 average, Croatia has a low share of both HRSTC and scientists and engineers.

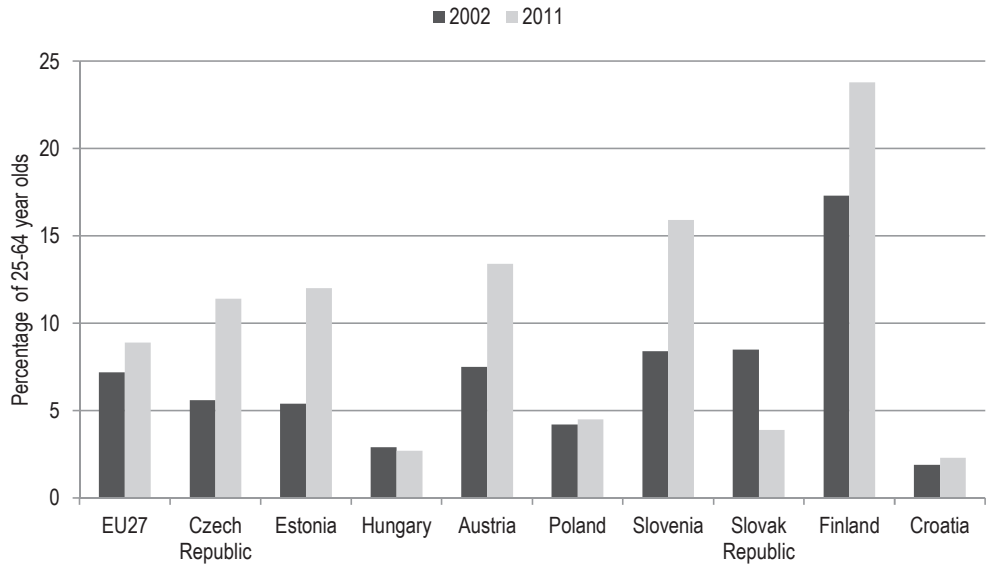
Figure 2.8. Scientists and engineers and human resources in science and technology (core), as a share of total employment, 2011



Source: Eurostat (2013), Statistics Database.

Continuing education and lifelong learning are important components of a dynamic innovation system. Participation in education and on-the-job training of working age adults can be an indicator of the acquisition of the new skills and knowledge necessary for the introduction of new workplace processes and organisational innovations in particular. It is also an indication of the extent to which private companies value knowledge and skills. Indeed, a study of perceived innovation constraints reported by Croatian companies in the CIS finds that lack of qualified personnel in their workforce is a significant predictor of abandonments and/or delays in developing innovations (Božić, 2011). Figure 2.9 presents the percentage of 25-to-64 year-olds who participate in education and training in Croatia and in the comparator group. Croatia occupies last position, with only Hungary at a comparably low level, and shows little improvement over time.

Figure 2.9. Participation in education and training among 25-64 year olds, 2002 and 2011



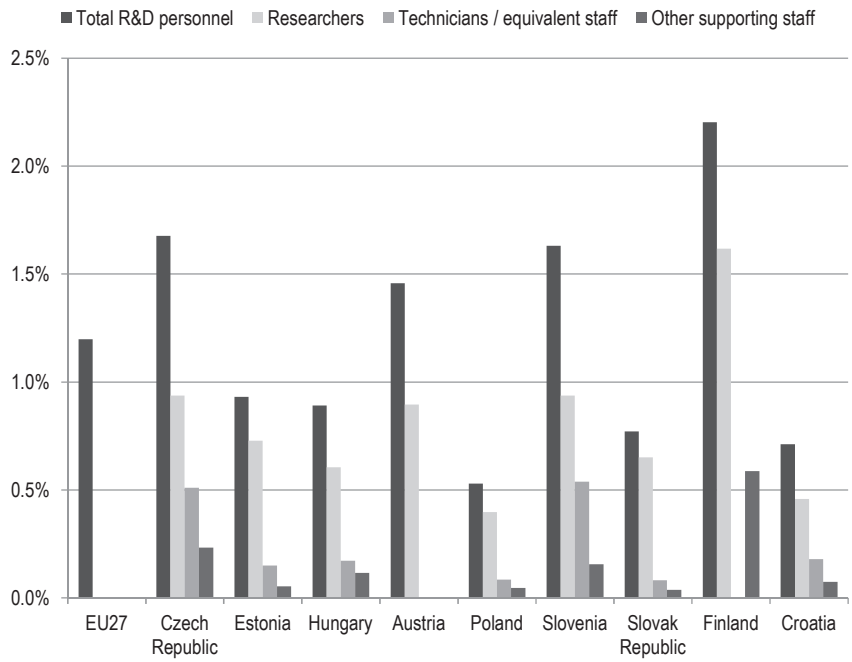
Source: Eurostat (2012), Statistics Database.

R&D personnel include researchers in addition to other support staff such as technicians and managers. The evolution of the number of R&D personnel and its various subdivisions over time can provide an alternative view of the scale and nature of R&D activity. The patterns here can be expected to correlate with R&D expenditures, as salaries for R&D personnel account for a large proportion of GERD.

At 0.46% of total employment, the share of researchers mirrors Croatia's GERD intensity for 2011 (0.75%) and is behind all other countries in the comparator group with the exception of Poland (Figure 2.10). Croatia maintains this position for all other subdivisions of R&D personnel, except technicians and equivalent staff, where it is at about the same level as Hungary and above Estonia, the Slovak Republic and Poland.

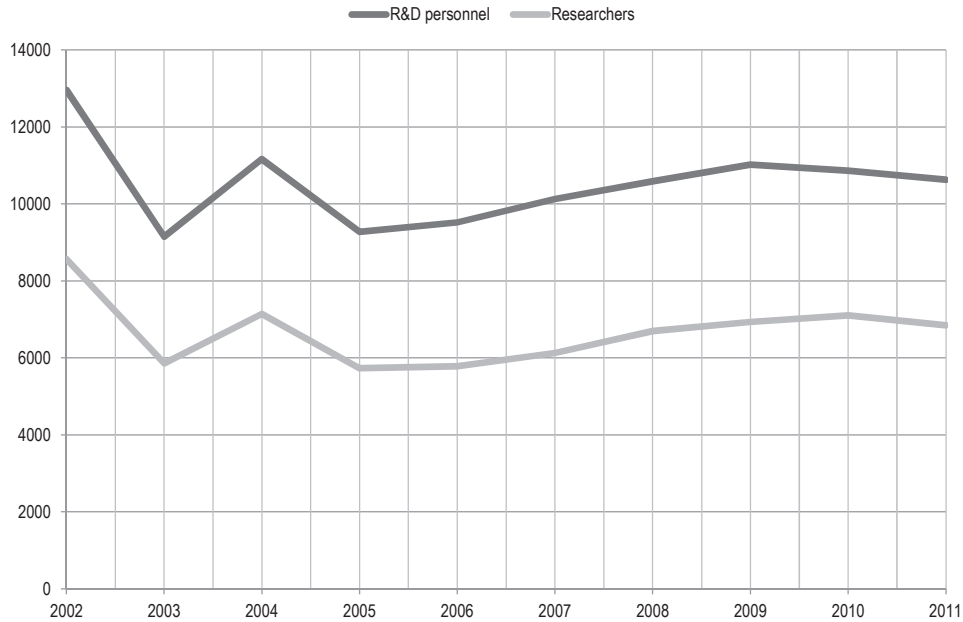
The funding shortfall has hit the employment of human resources for research hard. During 2002-08, Croatia had negative growth in total full-time equivalent (FTE) researchers (-4%) and business researchers in particular (-2.2%) (EC, 2011a, p. 103), a trend that is probably also connected with the downsizing of the former Pliva institute. A closer examination of trends over time reveals that after some volatility in 2003-05, the trend stabilised and was mildly positive until the interruption in 2009 (Figure 2.10). The overall trend for R&D personnel closely mirrored this behaviour, an indication that the determinants of their employment overlap.

Figure 2.10. Total R&D personnel, researchers (full-time equivalent) , technicians/equivalent staff and other supporting staff as a share of total employment, 2011



Source: Eurostat (2013), Statistics Database.

Figure 2.11. R&D personnel and researchers (full-time equivalent) in Croatia, 2002-11



Source: Eurostat (2013), Statistics Database.

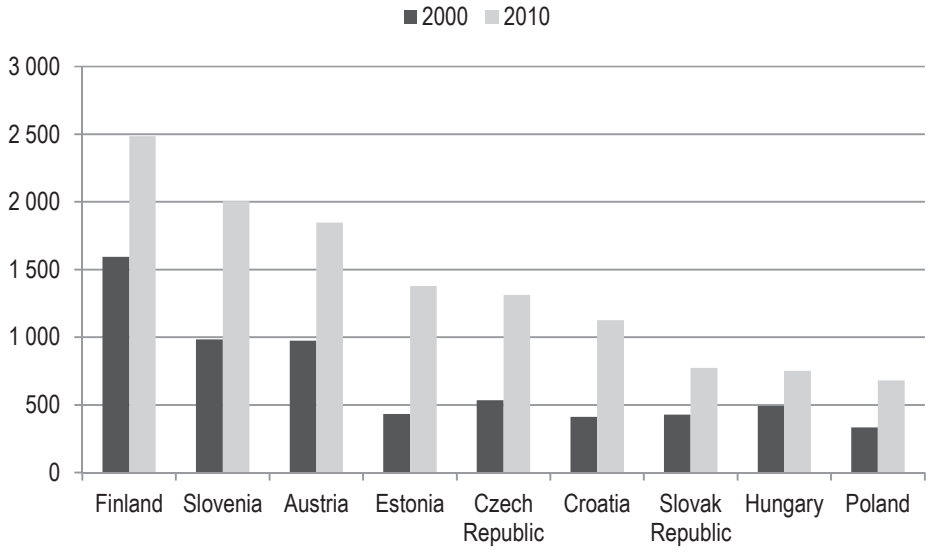
2.2. Innovation outputs

Scientific production

A country's innovation outputs are notoriously difficult to measure. New ideas do not always leave a paper trail and their impact on the economy is difficult to disentangle from other influences. Plausible proxies have to be used instead, including upstream measures such as scientific publications and patents and downstream measures such as innovation counts from surveys and income from technology licensing. Although such indicators capture only narrow parts of the entire spectrum of possible innovation, they present an opportunity to evaluate outputs systematically in a way that is consistent across countries and over time. The usage of such indicators carries the assumption that they correlate well with unmeasured dimensions of innovation. The above provisos notwithstanding, their use here aims to ascertain general trends and orders of magnitude.

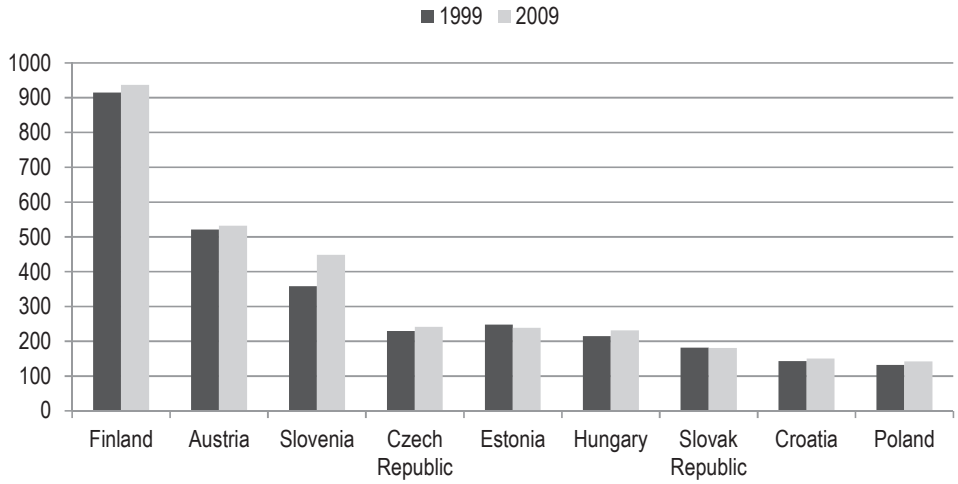
The following figures present scientific publication counts for Croatia and a number of other countries in general (Figure 2.12) and in science and engineering (S&E) (Figure 2.13) in particular. The two figures draw from different databases and use different definitions of "publication" and so are not directly comparable. Nevertheless, an immediately apparent, sizeable contrast is unlikely to be a measurement artefact: whereas the overall number of Croatian publications (citable documents) more than doubled over the last decade (Figure 2.12), the number of S&E articles (Figure 2.13) barely increased.

Figure 2.12. Citable documents in Elsevier Scopus, per million population, 2000 and 2010



Sources: SCImago (2007, 2012), SCImago Journal & Country Rank for citations and Eurostat (2012), Statistics Database for population.

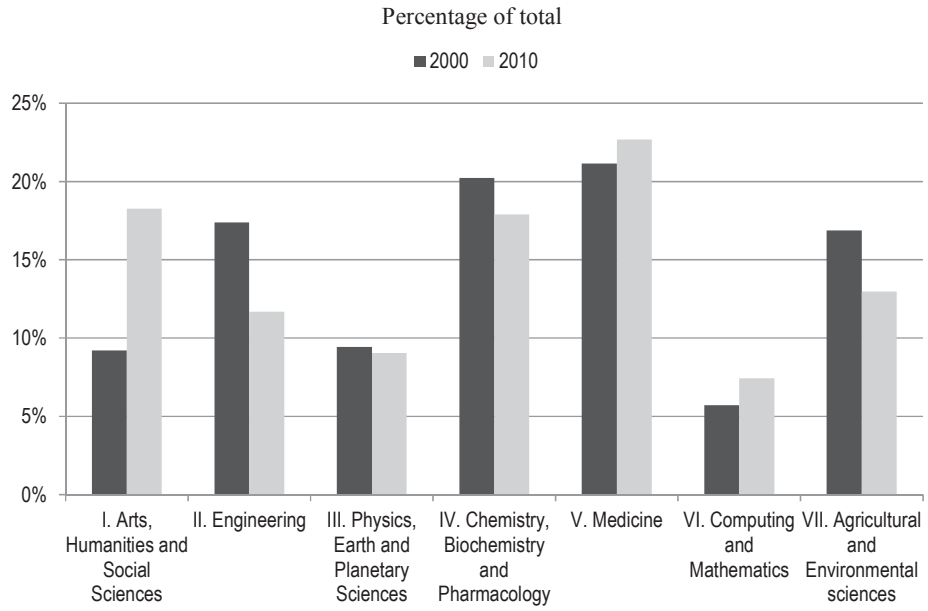
Figure 2.13. Science and engineering articles in Thomson Reuters Science Citation Index and Social Sciences Citation Index per million of population, 1999 and 2009



Sources: NSF (2012), Science and Engineering Indicators 2012 for S&E article counts and Eurostat (2012), Statistics Database for population.

A closer look at the distribution of scientific output across disciplines (Figure 2.14, with an *ad hoc* aggregation of Scopus disciplines that is closer to the delineation of typical university faculties) reveals that engineering in particular, and to a lesser extent, agricultural and environmental sciences and chemistry, biochemistry and pharmacology experienced a relative decline in prominence. Given the central place of engineering for technological development in general, and the importance not just of engineering but also chemistry, biochemistry and pharmacology, for the competitiveness of Croatian industry in particular, this trend can be a cause for concern.

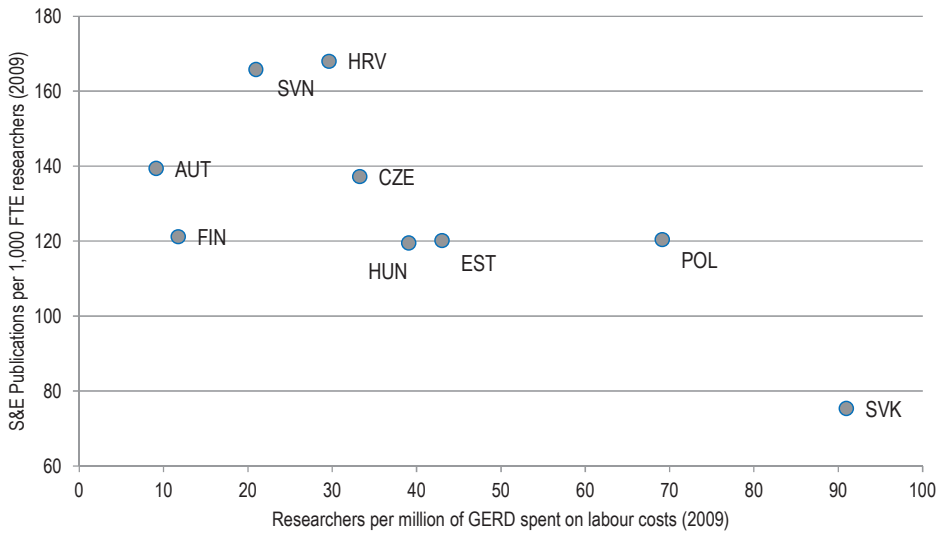
Figure 2.14. Citable documents by Croatia-based authors in Elsevier Scopus by broad scientific discipline, 2000 and 2010



Sources: SCImago (2007, 2012), SCImago Journal & Country Rank and OECD regrouping of Scopus areas of science.

One may usefully juxtapose a measure of the productivity of Croatian scientists (the ratio of science and engineering publications per 1 000 FTE researchers) against a rough proxy of their cost efficiency (the number of FTE researchers per million of GERD spent on labour costs) (Figure 2.15). As one would expect, the observations are indicative of a negative relationship between the two variables; better-endowed researchers are generally more productive, though there is variation in output even among countries with similar resource constraints. Croatian scientists are more productive than their peers in any other country in the comparator group, producing about 168 S&E publications per 1 000 FTE researchers, just above Slovenia with 165. In terms of cost efficiency, Croatia compares favourably to Slovenia and the older EU member states Austria and Finland, but lags all the other new EU member states. A comparison of Croatia and the Czech Republic is telling: while both countries have a comparable number of researchers per EUR million spent on R&D (30 for Croatia, 33 for the Czech Republic), Croatian scientists are 40% more productive. The combined presence of high scientific productivity and relative cost efficiency (especially in comparison to older EU members) would make Croatia an attractive place for privately funded scientific research and may explain why Croatia scores above the EU and OECD averages for that type of funding (see Table 2.2, share of university research funded by business and associated discussion).

Figure 2.15. The productivity and cost-efficiency of Croatian scientists

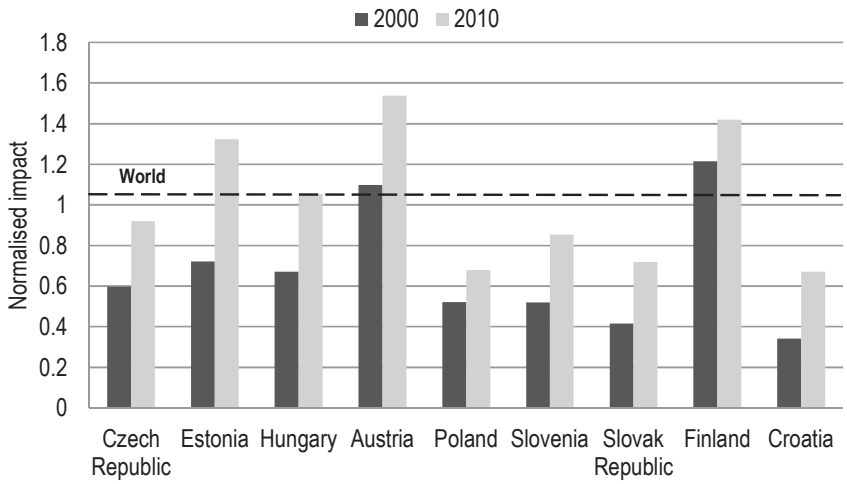


Source: OECD elaboration of NSF (2012) and Eurostat (2012) data.

Relative scientific impact can be gauged using the normalised number of citations per publication for Croatia and the comparator group (Figure 2.16). Citation-based impact can be considered a proxy of the quality of scientific research. It also correlates well with international scientific collaboration (OECD, 2011, p. 47). Over the period considered, Croatia's scientific impact almost doubled, with the fastest growth among the countries examined, followed by Estonia, the Slovak Republic and Slovenia. However, in absolute terms, Croatia is still a laggard, even for countries of comparable income per capita; it occupies the last place jointly with Poland. In terms of the quality distribution of Croatian publications, the percentage of total national publications among the 10% most cited worldwide can be a useful yardstick. On average, a country would have 10% of total national publications among the most cited; if more than 10% of the total are among the

most cited, this is indicative of the prominence of high quality research; if less than 10% of the total are among the most cited, this is a sign of less high quality research in the system. EC (2011a, p. 142) reports that over the 2007-09 citation window, the top 10% represented between 3.5% and 6.5% of the Croatian national total, on a par with Poland, the Slovak Republic, Estonia, Bulgaria and Romania and behind the Czech Republic, Slovenia, Hungary as well as Turkey, Israel, Iceland and Switzerland. Taken together with the observation on the overall number of citations and the distance from the world level (Figure 2.15), despite the high productivity of Croatian scientists, the overall quality of publications appears[12] to be lacking. Nevertheless, Croatia was among the leading countries in terms of growth in this indicator over the period 2000-08 (EC 2011a, p. 140), and the overall number of citations also increased (Figure 2.16) so there are hopeful signs of improvement.

Figure 2.16. The impact of scientific production



Sources: SCImago (2007, 2012), SCImago Journal & Country Rank for citations and Eurostat (2012), Statistics Database for population.

Patents

In terms of technological output the distance from EU countries is even greater. The production gap with the EU27 in patenting in particular is large enough to question the importance of patenting in Croatia's innovation system and its relevance as an indicator of innovation. Over the past decade, the EU27 filed over 25 times more patent applications to the EPO per million population than Croatia (Table 2.7). It is encouraging to note that Croatian patents were nonetheless, on average, just as likely to be granted as those from EU countries. Still, the very low volume of patents in Croatia needs to be kept in mind when interpreting the following patent-derived indicators; they are at best tentative indications of incipient activity and are not representative of Croatian technological output as a whole.

Table 2.7. EPO patents per million of population, 2002-11

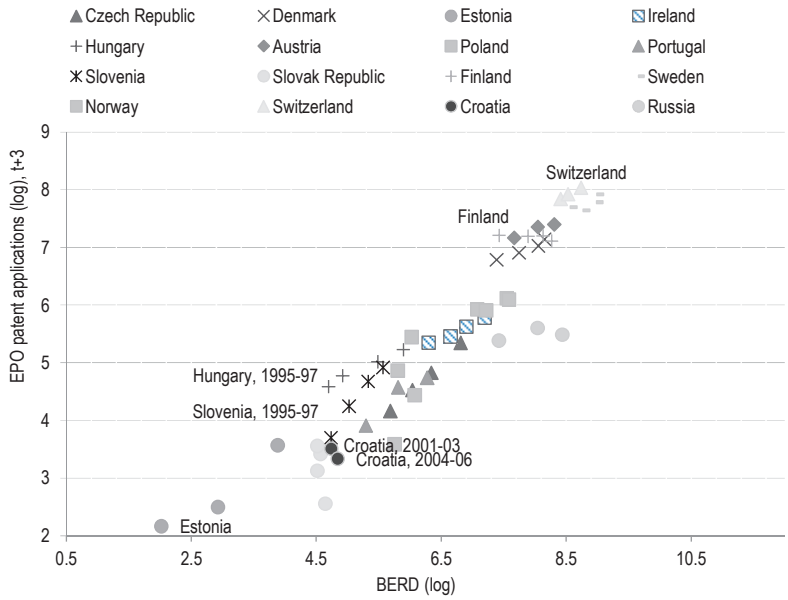
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
EU27 applications	102.2	111.0	115.3	119.2	121.9	125.9	131.5	123.9	133.0	128.2
Croatia applications	2.7	2.9	5.9	5.4	6.1	7.9	5.2	4.3	3.6	4.1
EU27 - % granted	48%	55%	52%	44%	50%	42%	45%	41%	42%	46%
Croatia - % granted	42%	92%	27%	38%	56%	40%	57%	79%	63%	28%

Source: EPO (2012a) www.epo.org/about-us/statistics/patent-applications.html, (2012b) www.epo.org/about-us/statistics/granted-patents.html and Eurostat (2012) Statistics Database, OECD elaboration.

Like bibliometrics, patent measures are very sensitive to scale, and small countries with small research systems fare worse than would be expected from a linear relationship between inputs and outputs (Katz, 2006). Figure 2.17 measures patenting output against business R&D inputs three years earlier (to allow for the intervening lag) on a logarithmic scale (to permit comparisons between very different scale levels) in order to assess technological R&D productivity across various levels of input. The figure also affords some perspective by plotting four three-year periods for each country (1995-97, 1998-00, 2001-03, 2004-06). For example, Hungary and Slovenia have done consistently better than Croatia with comparable levels of BERD (although at different points in time). This suggests that Croatia's weak performance in patenting is not merely due to small scale, but is also due to structural factors and framework conditions. The former factor has both a sectoral and an institutional sense (the centrality of the business sector being a distinguishing feature of developed innovation systems). The latter factor may include, for example, the strength and appeal of IP protection arrangements (Furman et al., 2002), or lack of finance to cover the considerable costs of patenting.

Every EUR 10 million spent on BERD results in one or two international patent applications, most of which are usually granted (Table 2.8). Interestingly, technological R&D productivity in Croatia reached a high point during 2005-07; this coincided with steady increases in BERD and the introduction of a number of relevant policy measures under the umbrella of HITRA (see Chapter 4) a few years earlier.

Figure 2.17. Technological R&D productivity over time



Source: OECD, based on Eurostat (2012), Statistics Database.

Table 2.8. Croatian R&D productivity: patents for every EUR 10 million of business expenditure on R&D

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Applications	1.0	1.1	1.8	1.9	2.5	2.5	1.2	1.2	1.1
Grants	0.4	1.1	0.5	0.7	1.4	1.0	0.7	1.0	0.7
Croatian application productivity as a percentage of EU27	25%	25%	39%	40%	56%	58%	28%	29%	25%
Croatian grant productivity as a percentage of EU27	22%	43%	20%	34%	63%	55%	35%	57%	37%

Source: OECD, based on EPO (2012a) www.epo.org/about-us/statistics/patent-applications.html, (2012b) www.epo.org/about-us/statistics/granted-patents.html and Eurostat (2012) Statistics Database,

Given the low volume of patenting output in general, inferences drawn from a sectoral breakdown would not be meaningful. For Croatia it may make better sense to look at historically accumulated stocks of patents, as they can be a useful proxy for accumulated experience. Indeed, if patents had been accumulated in the recent past, the stocks might also capture latent technological capabilities that could be redeployed at low cost.

It can therefore be useful to examine the cumulative number of EPO patents by Croatian inventors across industrial sectors during 1998-09 (Table 2.9). To reflect the fact that knowledge becomes obsolete, that people move, etc., the stocks are depreciated at an annual rate of 13% as in Park and Park (2006). The top positions are occupied by sectors with important shares in BERD and manufactured exports, such as pharmaceuticals, basic chemicals and motor vehicles, but there also a few industries that lack these characteristics, such as office machinery and computers, soap and detergents, and medical and surgical equipment. Whereas the sectoral aggregation schemes used here are heterogeneous in terms both of sectoral definition and level of aggregation, it is likely that the additional sectors have been important in recent times but are no longer. The relatively strong showing of office machinery and computers may be indicative of developing capabilities, as the sector exhibits strong growth in exports, albeit from a low starting point (IMF, 2012, p. 44).

Table 2.9. Cumulative number of EPO patents by Croatian inventors: Top 20 NACE sectors

Rank	NACE code	Industrial sector	Patent stocks since 1998 (depreciated annually by 13%)
1	DG244	Manufacture of pharmaceuticals, medicinal chemicals and botanical products	40.45
2	DG241	Manufacture of basic chemicals	11.80
3	DM34	Manufacture of motor vehicles, trailers and semi-trailers	9.91
4	DL30	Manufacture of office machinery and computers	9.63
5	DL322	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	8.92
6	DG245	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	7.33
7	DL331	Manufacture of medical and surgical equipment and orthopaedic appliances	6.57
8	DA15	Manufacture of food products and beverages	4.85
9	DN36	Manufacture of furniture; manufacturing n.e.c.	4.66
10	DL321	Manufacture of electronic valves and tubes and other electronic components	4.52
11	DK295	Manufacture of other special purpose machinery	4.29
12	DJ28	Manufacture of fabricated metal products, except machinery and equipment	4.26
13	DM35	Manufacture of other transport equipment	4.00
14	DG246	Manufacture of other chemical products	3.38
15	DK291	Manufacture of machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engines	2.46
16	DK292	Manufacture of other general purpose machinery	2.19
17	DL312_DL313	Manufacture of electricity distribution, control apparatus and insulated wire and cable	2.19
18	DJ27	Manufacture of basic metals	2.04
19	DH25	Manufacture of rubber and plastic products	1.94
20	DI26	Manufacture of other non-metallic mineral products	1.90

Source: OECD, based on Eurostat (2012), Statistics Database.

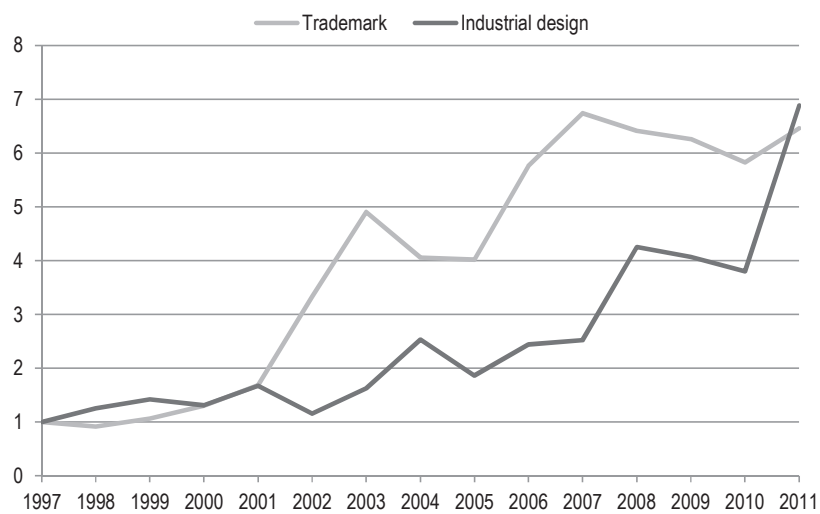
Trademarks and industrial designs

In light of the well-known limitations of patents as summary measures of innovation output in general, and of the low volume of patents in Croatia in particular, a look at broader indicators of innovation outputs is necessary. Evidence on non-technological innovation (organisational, marketing, service) can be gleaned from indicators on trademark applications.

Trademarks are meant to protect distinctive features of a company or its goods and services. A trademark application may reflect the introduction of a new good or service and, like a patent, can therefore be used as an indicator of economically useful innovation. Compared to patents, trademarks are especially useful as an indicator of non-technological innovation and may be better suited to track the innovation activity of services firms in particular and smaller firms more generally. Trademarks have been shown to correlate well with other innovation indicators (Millot, 2009) as well as with firms' market value (Sandner and Block, 2011) and are a proxy for activity that is closer to the commercialisation stage of an innovation (Mendoça et al., 2004).

The EU's Community Trademark,[13] given its applicability throughout the EU, can, in addition to the usual functions of trademarks, signal companies' tendency to trade internationally and may therefore be a useful gauge of service innovations of international appeal. According to the European Commission (EC, 2011b, p. 89), Croatia, with around one Community Trademark filing per EUR billion GDP, occupies one of the last positions among European Research Area (ERA) countries, ahead only of the Former Yugoslav Republic of Macedonia, Serbia and Turkey. In contrast, the top five countries (Luxembourg, Malta, Cyprus[14], Switzerland and Austria) had between 25 and 10 per EUR billion GDP and the EU average was about 5 (EC, 2011b, p. 89). Although Croatia possesses a sizeable and somewhat knowledge-intensive services sector (see Chapter 1, Figure 1.10), the low take-up of international trademarks may be due to the sector's domestic orientation. Indeed, in terms of nationally registered trademarks and industrial designs, the trend has been increasing, especially during the past decade (Figure 2.18). This is an encouraging sign which corresponds to the rise of the services sector. It may therefore signal intensifying activity in non-technological innovation that is new-to-the-country.

Figure 2.18. Trademarks and industrial designs in Croatia
(first year set to 1)

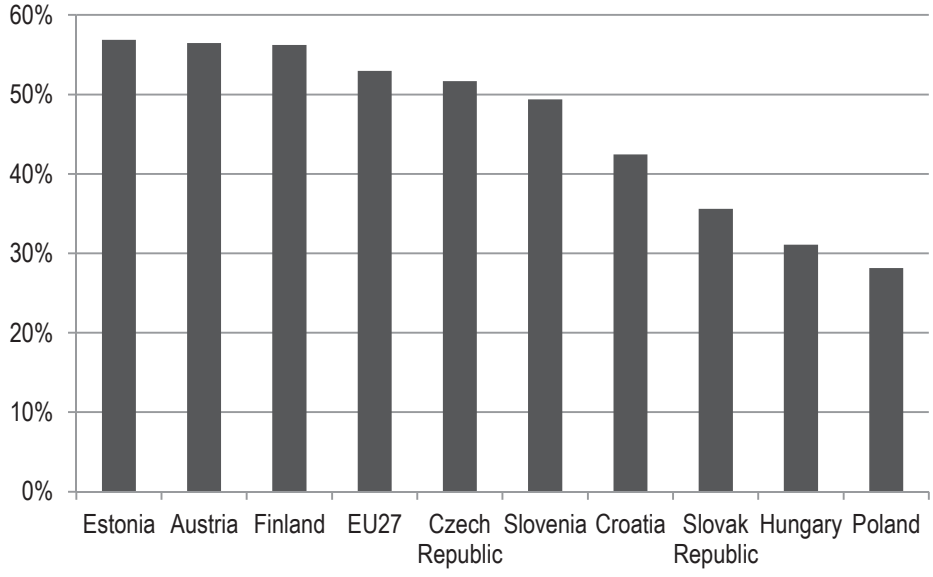


Source: WIPO (2012), "Statistical Country Profiles – Croatia", www.wipo.int/ipstats/en/statistics/country_profile/countries/hr.html.

Firm-level innovation

The EU-wide Community Innovation Survey provides evidence on the incidence, type, barriers to and impact of innovation at the level of individual firms. Evidence from the CIS is especially useful for capturing innovation that is only new to the industry or new to the firm and that may therefore not appear in indicators such as patents or trademarks. The latest wave finds that 42% of Croatian companies engaged in some innovation activity during 2008-10, defined as the pursuit of "product, process, on-going or abandoned, organisational and marketing innovation" (Figure 2.19). Croatia's share is low relative to the EU27 average, ahead of the Slovak Republic, Hungary and Poland but below all other comparator countries. This relatively low level is in part a reflection of average firm size: whereas only about a third of small enterprises had introduced at least one of these innovations, the proportion rises to half for medium-sized companies and to three-quarters for large companies (CBS, 2012b). Still, the proportion of innovating firms remains close to the 44% reporting some form of innovation in the 2006-08 wave of the survey (Eurostat, 2011). An econometric analysis of the determinants of innovation, based on the 2001-03 wave (Aralica et al., 2008), found that foreign direct investment and export orientation are statistically significant predictors of innovation even after controlling for factors such as firm size and a demand pull variable. This is presumably due to the effect of technology transfer and to the "raising the bar" effect of international economic integration. Therefore, the low innovation rates likely reflect to some extent Croatia's incomplete trade liberalisation process and perhaps even a bias in trade flows towards former Yugoslav Republics in particular and towards central and eastern Europe (Šošić and Vujčić, 2005). The increased trade and investment that should follow Croatia's EU accession may help boost innovation.

Figure 2.19. Proportion of innovative enterprises, CIS 2010



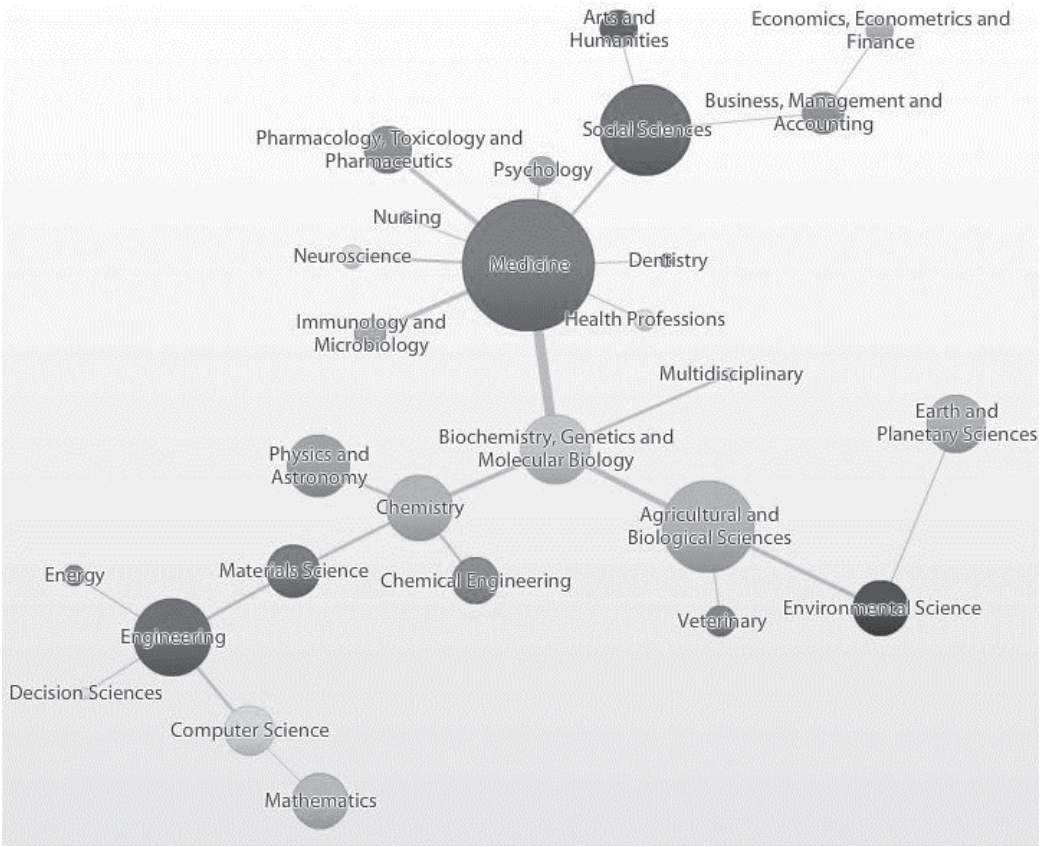
Source: Eurostat (2013), Statistics Database.

2.3. Knowledge flows and internationalisation

Co-citations can be a useful proxy of cognitive proximity, complementarity and information flows, both past and potential. Information on the co-citation network of scientific publications of Croatian-based authors gives an opportunity to assess some of these relationships. In a summary view of this network (Figure 2.20), the size of the node represents the number of publications and the thickness of connecting lines represents co-citations. The categories reported are based on the Scopus classification of science areas (27 major fields).

As in many other countries, medicine is not only the most prominent discipline in terms of the number of publications, it also has a central position in the co-citation network of Croatian science in general. Biochemistry, genetics and molecular biology are about as large as chemistry, and this area is well connected with a number of other areas. It is an important node in two co-citation "corridors" leading to medicine: one stretching from Earth and planetary sciences, to environmental science, to agricultural and biological sciences and then to biochemistry, and the other stretching from mathematics, engineering, and materials science and linking to biochemistry via chemistry. It is striking that engineering is relatively isolated, with a large number of nodes intervening between it and the central area, medicine, and only indirect links to otherwise proximate areas such as chemical engineering and agricultural and biological sciences.

Figure 2.20. Co-citation network of Croatian scientific publications, 2009-10



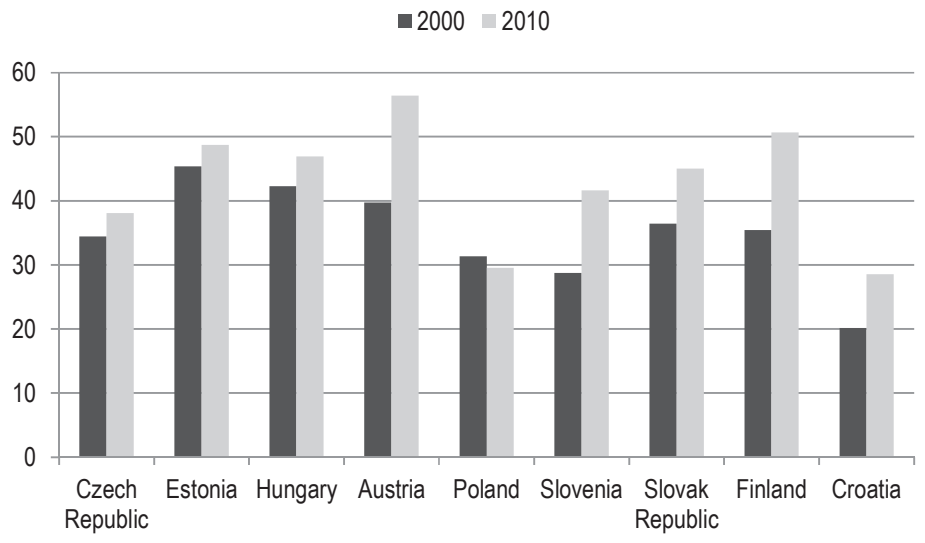
Source: SCImago (2012), www.scimagojr.com/mapgen.php, accessed 26 August 2012.

As mentioned, business sector funding of higher education is slightly higher than the EU and OECD averages (Table 2.2), a fact that reflects positively on the quality of Croatian university research. Multinational subsidiaries in particular value the capabilities of Croatian universities and are keen to co-finance doctoral students. However, university-industry collaboration, as measured by public-private co-publications per million population, stands at only about 50% of the EU27 average (EC, 2011b). The low propensity to collaborate may reflect a lack of willingness to collaborate (due, among others, to secrecy or a culture clash) or alternatively may reflect the ability of universities to move away from basic R&D and adopt a more applied orientation relatively quickly (which may imply recruiting new researchers) and/or the lack of R&D capacity in most businesses.

International scientific collaboration is considered an important channel for the diffusion of information, capacity building and the fostering of excellence; for integration into global knowledge production networks and therefore for the relevance of national research to cutting-edge scientific debates; and for international recognition of a country's efforts. Internationally co-authored articles are a commonly used proxy for collaboration and attract greater numbers of citations (Glänzel et al., 1999).

The share of publications with an international co-author can also be used to assess the internationalisation of Croatian science (Figure 2.21). Although the percentage of articles with international co-authors increased by 8 percentage points over the last decade, Croatia remains the least internationalised country among the comparator group. One of the stylised facts of bibliometric indicators on internationalisation is that the extent of internationalisation is inversely related to a country's size (Schubert and Braun, 1990). Croatia's low percentage of internationalisation is therefore unexpected. It is likely due to the fact that, unlike the comparator countries, Croatia was not yet a member of the EU and is only partly subject to the strong internationalising influence of the Framework Programme in particular. It is reasonable to expect that EU accession, combined with Croatia's geographically favourable location, will present further opportunities for internationalisation and result in benefits in terms of scientific productivity and the quality dividend that stems from operating at the global frontier.

Figure 2.21. Percentage of international co-publication (documents with authors from more than one country), 2000 and 2010



Source: SCImago (2007, 2012), SCImago Journal & Country Rank.

Additional information about the extent of international scientific and technological collaboration can be gleaned from Croatia's participation in the EU's Framework Programme (FP). Croatia became a full participant in the FP in 2006. The FP, by far the world's largest publicly funded collaborative R&D scheme, unites researchers across Europe (and beyond) on projects in so-called "pre-competitive" research (i.e. research that occupies a middle ground between basic and applied R&D). Currently in its seventh iteration and running from 2007 to 2013, it accounts for about 8% of all public R&D funding in the EU27 (EC, 2011a). By virtue of the FP's sheer weight and its focus on scientific excellence (Henriques et al., 2009), data on participation can offer valuable clues as to the international competitiveness and integration of Croatian research teams.

Among the comparator group, Croatia stands second to last in terms of the number of participations per researcher (Table 2.10). In terms of funds received per participation, Croatia does rather well. At 230,000 EUR it is ahead of Slovenia, Estonia, Hungary and the Slovak Republic. Total cost for participant already accounts for 11% of GERD, a share that is similar to that of countries that have recently joined the EU. Croatia does relatively well in terms of FP applications per researcher and occupies a middle position among comparable countries, but it does less well in terms of success rates, as it takes second to last place, ahead of Slovenia (EC, 2011a).

Table 2.10. Croatia's participation in FP7

	Number of participations per thousand FTE researchers (2010)	Funds per participation	Total participant cost as % of GERD (2010)	Number of applications per thousand FTE researchers	Application success rate
AUT	41	419,749	8%	165	21%
CZE	24	240,833	7%	104	20%
EST	66	219,267	25%	252	24%
FIN	31	486,976	9%	107	23%
HUN	37	212,331	15%	164	21%
POL	17	251,867	10%	81	19%
SVK	17	172,288	11%	78	20%
SVN	57	224,628	13%	301	16%
HRV	23	230,800	11%	140	18%

Sources: Numbers of participations and participant costs from Chorafakis (2012) as of April 2011. Number of applications and success rate from EC (2011) as of March 2011. Number of FTE researchers from Eurostat (2012).

Socio-metric indicators can be used to reveal each country's relative position in the research networks formed by FP7 (Table 2.11). By capturing the country's social position in international collaborative ventures, such indicators give information about more than scientific and technological capabilities. This includes social, political and cultural factors that ultimately impinge on the distribution of information, a key resource for innovation.

As one would expect, given that Croatia only recently joined the FP, it trails all EU member states in every measure. In addition to the usual comparator group, Table 2.11 also includes Serbia. A comparison with Slovenia, a former Yugoslav republic that has been a member of the European Union (with all that membership implies for access to information and networks), and with Serbia, another former Yugoslav republic that, like Croatia, was not an EU member over the period examined, is very revealing. Croatia is either marginally above or on a par with Serbia on every measure, but in most cases the differences are small.

Both countries are on a par in terms of local embeddedness with their relational neighbours (clustering), though Croatia is somewhat closer to the network core (coreness). According to EC (2011, Part II, p. 32), Croatia's neighbours (in terms of the number of collaborative links) were Germany, the United Kingdom and Italy. Slovenia, with a head start in EU membership and considerably larger R&D commitments, possesses about three times the weighted connections (degree centrality), is more locally embedded than Croatia (clustering) and is a lot closer to the network core (coreness).

Table 2.11. Socio-metric indicators of participation in Framework Programme 7
As of April 2011

Country (=node)	Degree centrality	Betweenness centrality	Closeness centrality	Eigenvector centrality	Page rank	Clustering	Coreness
AUT	5.4	1.0	149.8	10.1	2.2	0.4	19.5
CZE	2.0	0.0	148.6	5.2	0.9	0.3	10.0
EST	0.8	0.0	144.6	1.6	0.4	0.3	3.0
FIN	4.7	1.0	149.6	9.5	1.9	0.4	18.2
HRV	*0.5*	*0.0*	*137.9*	*1.0*	*0.3*	*0.2*	*1.9*
HUN	2.4	0.0	148.5	5.0	1.1	0.3	9.7
POL	3.2	0.0	149.1	7.5	1.3	0.4	9.7
SRB	*0.4*	*0.0*	*137.0*	*0.7*	*0.3*	*0.2*	*1.3*
SVN	*1.4*	*0.0*	*147.2*	*3.0*	*0.6*	*0.3*	*5.7*
SVK	0.8	0.0	144.8	1.7	0.4	0.3	3.3

Notes: The network is defined as a so-called "weighted network" where the weights or tie strengths are calculated on the basis of a probabilistic interaction propensity which takes into account the duration and cost of the project, the number of participants in a project, and the role of a participant as coordinator in a project. To aid comparisons, all indicators but degree and eccentricity have been scaled by multiplying them by 100.

Source: Chorafakis (2012), "Sociometric indicators of Croatian participation in the FP", study prepared for the OECD, University of Cambridge.

Box 2.1. Interpreting socio-metric indicators

Degree centrality: The number of connections normalised by the number of nodes. The greater the number of connections, the greater the likelihood of information diffusion.

Between-ness centrality: The normalised number of shortest paths that connect all other nodes through the specific node. High values indicate a crucial network node, in the sense that it is an intermediary to other nodes and could potentially act as a 'gatekeeper'.

Closeness centrality: The inverse of geodesic distance of the node from all others. A summary measure of relational proximity to other nodes.

Eigenvector centrality: Depends both on the number and the quality of a node's connections. Can be interpreted as an indicator of the influence of a node given the influence of its neighbours.

Page rank: A similar measure to eigenvector centrality based on an efficient variation of Google's ranking algorithm.

Clustering: The ratio of closed triplets to the sum of triplets connected to a node. A high value can indicate (relationally) local embeddedness.

Coreness: Proximity to the core of the network, where the core is defined on the basis of geodesic distance. The greater the proximity, the greater the access to information.

International co-patenting, or the number of patents with inventors from more than one country, can be a suggestive indicator of international technology transfer and of the functional similarity that facilitates integration into international knowledge production chains (Maggioni and Uberti, 2009). It may also reflect the innovation activities of multinationals, and thus highlight areas of international R&D strength.

Table 2.12 indicates that technology production is more internationalised in Croatia than in the EU27, as would be expected for a small country in which the pool of possible collaborators includes more inventors from abroad. Moreover, the degree of international co-inventorship is increasing over time, and reached a remarkable 44% in 2009. This can be seen as confirmation of the substantial R&D activities of foreign multinationals and of the presence of channels of international technology transfer.

Table 2.12. Patent applications to the EPO with foreign co-inventors, by priority year at the national level, 1999-2009

Percentage of total

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EU27	7.47	8.1	8.21	8.55	8.35	9.18	9.41	9.06	9.05	8.24	6.12
Croatia	19.05	17.65	42.31	7.89	27.66	35	30.77	40.91	43.24	48.72	44.44

Source: Eurostat (2012), Statistical Database.

The distribution of Croatian-invented EPO patents since 1991 according to the country of the owner (Table 2.13) can be a suggestive measure of economic links and channels for the transfer for knowledge and other R&D resources. The fact that the United Kingdom is in first place is not easy to explain as it does not correspond to a visible corporate presence in the recent past. Possible explanations include: the presence of equity shares in formerly state-owned enterprises, a reflection of strong scientific links between the two countries that are also captured by the FP, and/or a reflection of the European pre-eminence of the United Kingdom as a source of venture capital. Germany and Sweden stand second and fourth, the latter a reflection of the notable investment of Ericsson in ENT.

Table 2.13. Foreign ownership of Croatian-invented EPO patents

Partner country	Cumulative total, 1991-2008
United Kingdom	48
Germany (including former GDR from 1991)	46
United States	26
Sweden	17
Switzerland	16
Slovenia	9
Finland	9
Italy	8
Ireland	4
France	3
Netherlands	2
Austria	1
Canada	1
Japan	1
Australia	1

Source: OECD based on Eurostat (2012), Statistical Database.

2.4. Impact of innovation

Measures of the impact of innovation are difficult to come by and their coverage is still very partial. Traditionally, they have included income from royalties and licence fees as well as the technology balance of payments. As relatively few patents generate income and as the link between R&D expenditures and high-technology exports is, at best, indirect, these two indicators only provide a very partial assessment of the economic value of a country's technological output. Patent databases have recently made available a third, and very promising indicator, of impact, based on patent citations. For instance, forward patent citations (the number of citations found in patent documents after the cited parent's priority date) can be a meaningful indicator of the impact of an invention (Jaffe and Trajtenberg, 2002).

Three measures of technological impact are presented in Table 2.14. In terms of patent citations, Croatia trails the comparator group, as it has less than one citation for every ten Croatian patents. Slovenia and the Slovak Republic receive more than twice the number of citations, whereas Hungary and the Czech Republic do better still, with about half the citation impact of Austria and Finland. In terms of the ratio of royalties and licence fees to BERD (a measure of the weight of this source of income in private R&D spending) Croatia fares a little better. With 16%, it leads the Czech Republic and Slovenia. The percentage of high-technology exports is encouraging. At 9%, Croatia is ahead of all eastern European countries in the group except Hungary and the Czech Republic. Notable here is the relative decline of high-technology exports in Finland, down from about a quarter of manufactured exports earlier in the decade to 14% in 2008-10.

Table 2.14. Measures of technological impact

	Average number of citations received by EPO patents, within seven years after publication (average of 2003-04 priority dates)	Royalties and licence fees, receipts as % of BERD (2008-10 average)	High-technology exports (% of manufactured exports) (2008-10 average)
Austria	0.45	10%	12%
Czech Republic	0.26	5%	14%
Estonia	0.15	17%	7%
Finland	0.50	27%	14%
Hungary	0.27	105%	24%
Poland	0.19	20%	6%
Slovak Republic	0.21	50%	6%
Slovenia	0.21	9%	6%
Croatia	0.08	16%	9%

Source: OECD Patent Database for patents; the rest from World Bank, *World Development Indicators* and Eurostat (2012), Statistical Database.

Notes

1. The imperfect nature of international survey data calls for caution in drawing conclusions, especially for ratios where the possibility of biases in either term may affect accuracy. As such, this indicator is only meaningful in terms of comparing orders of magnitude.

2. As overall business R&D expenditure stagnated during that period, the apparent change in behaviour may: (a) reflect differences in the two survey waves which limit comparability (b) be a reflection of the introduction of R&D tax credits, which provided an incentive for companies to familiarise themselves with the definition of R&D, or (c) signify that some companies have increased the scope and ambition of their innovation activities (e.g. by moving from primarily new-to-the-firm towards new-to-the-market and new-to-the-world innovation), though this last possibility does not seem very likely on account of constancy or decline in various indicators of business innovation (see Chapter 3).

3. The EU's (then) 27 members and countries associated to the European Union's Framework Programme for research and technological development as of 2011 (Albania, Bosnia and Herzegovina, Switzerland, Faroe Islands, Croatia, Israel, Iceland, Liechtenstein, Republic of Moldova, the Former Yugoslav Republic of Macedonia, Montenegro, Norway, Serbia, Turkey) (CORDIS, 2011).

4. Respective WEF scores (with Croatia's rank over the total number of countries considered in brackets) were as follows: 3.5 (45/134) for 2008; 3.2 (49/134) for 2009; 3.1 (60/139) for 2010; 3.0 (71/142) for 2011 and 3.0 (76/144) for 2012 (Source: World Economic Forum *Competitiveness Reports* for 2008, 2009, 2010, 2011 and 2012).

5. Literature on the determinants of the location of R&D expenditure emphasises the importance of dynamic, positive feedback processes, whereby past R&D and other knowledge intensive activity is a significant predictor of future R&D expenditure (see e.g. Kumar, 2001; Varga et al. 2012 and references therein).

6. Austria and Finland were excluded for ease of exposition, as their values were considerably higher than the rest.

7. Eurostat identifies knowledge-intensive activities on the basis of "the level of tertiary education persons" across (NACE Rev. 2) industrial sectors. Employment data are from the European Labour Force Survey (ELFS), the Japan Labour Force Survey (LFS) and the US Current Population Survey (CPS). More information can be found at http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/htec_esms.htm (section 3.4, paragraph 10).

8. Alternatively, knowledge-intensive employment can be thought of as demarcating the upper bound of an innovation system's opportunities for R&D investment. From that perspective the distance from the regression line may indicate the system's ability to make use of these opportunities.

9. 1. Note by Turkey:

The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

2. Note by all the European Union Member States of the OECD and the European Commission:

The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

10. Croatian services sectors accounted for 58% of business R&D (2010, latest figure), higher than all comparator group countries except Estonia, and the difference between Croatia's overall BERD intensity and services BERD intensity was among the smallest in the comparator group (Eurostat, 2013), so the slant of the economy towards services does not appear to be unduly depressing BERD intensity.

11. A position that is maintained even when the former measure is divided by contemporary unemployment rates.

12. Given Croatia's small size and the sensitivity of bibliometric measures to scale, the apparent low standing of Croatian science internationally cannot be definitively attributed to lack of quality. For one, it is likely that factors such as the lack of internationalisation (dealt with below) also have a bearing on international visibility and therefore on the impact of Croatian science.

13. According to EC (2011b, p. 90), "The Community trademark gives its proprietor a uniform right applicable in all Member States of the European Union through a single procedure which simplifies trademark policies at European level. It fulfils the three essential functions of a trademark: it identifies the origin of goods and services, guarantees consistent quality through evidence of the company's commitment vis-à-vis the consumer, and is a form of communication, a basis for publicity and advertising."

14. See note 9 above.

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Chapter 3

Innovation actors

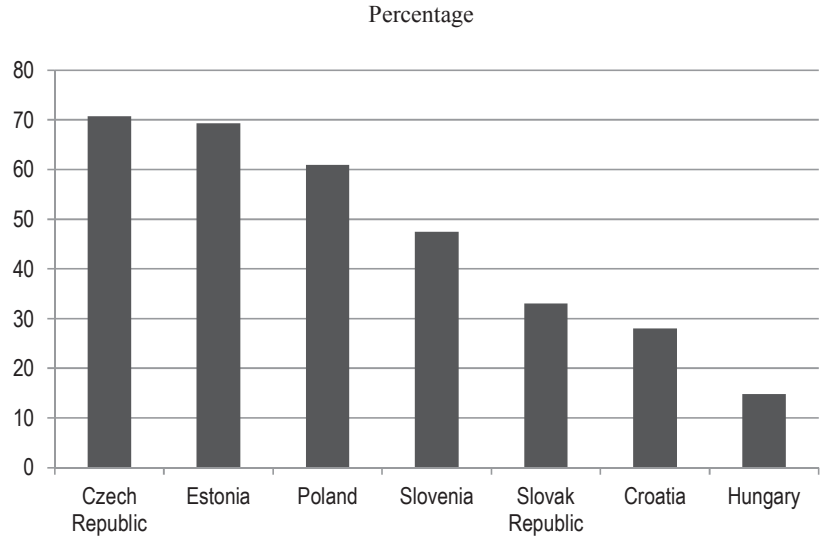
This chapter describes the main actors in the Croatian innovation system, their linkages and the main challenges. The business sector includes a number of internationally well integrated and innovative companies. Yet, the general picture is still one of rather low absorptive and innovative capacity. Overall the Croatian economy faces challenges as regards productivity and resilience which strengthened innovation can help to address. The university sector has many successful individual research groups. Higher education institutions and public research institutes have a traditionally strong position in the system, with a high degree of devolution of powers and some experience to integrate basic and industry-oriented research. Transfer and collaboration patterns are influenced by the organisational set-up of the public research sector, including numerous dedicated transfer institutions and programmes. However, some features of public research governance and funding have been detrimental to sustained innovation capacity building.

3.1. The business sector

A majority of Croatian businesses do not report systematic innovation activity in the EU community innovation survey (CIS). In such a context, the overarching challenge is to get more companies to innovate, and get companies which are already innovating to increase the intensity, ambition and variety of their innovation activities. Faced with such a challenge, an assessment of innovation performance and possible bottlenecks needs to examine evidence of broad innovation capacities[1] in the Croatian business sector. This section therefore examines in-house skills and diffusion of representative technologies (such as internet adoption and use) by Croatian businesses, as well as various aspects of their R&D and innovation activity.

Investments in human capital are essential for building the capacities businesses require to innovate. One way to gauge the propensity of firms to invest in human capital is to see whether they engage in formal training. Cross-country work has identified a statistical link between the provision of formal training by enterprises and firm-level innovation in transition economies (Nazarov and Akhmedjonov, 2011). In 2009, fewer than 30% of Croatian firms engaged in formal training, behind most of the comparable economies (Figure 3.1). As seen in Chapter 2, there is no indication that Croatian workers obtain formal education and training outside of the firm either[2]. This reflects deficiencies in vocational training and adult learning, which were highlighted in a recent review by the European Training Foundation (ETF, 2012).

Figure 3.1. Firms offering formal training, 2009



Note: 2007 for Croatia.

Source: World Bank, World Development Indicators.

A survey of the region carried out in 2012 by SEECEL (2013, p. 47) on enterprises that had been active for at least three years found that less than a fifth of Croatian companies had an annual budget for training, a share lower than Albania, Serbia, Turkey and FYR Macedonia. However, in terms of duration, Croatian employees spent more days on training than employees in the other countries except FYR Macedonia and Serbia. In addition, Croatian firms were more likely than firms in other countries to finance training using employee funds and tax incentives.

Skills constraints matter for firm performance in general and for business innovation in particular. In the 2007 *Enterprise Survey* conducted by the World Bank, an inadequately educated workforce was cited as the second most important constraint in the Croatian business environment, following access to finance (World Bank, undated). A study drawing on a representative sample of Croatian firms from the CIS, found that lack of qualified personnel within the company was a statistically significant predictor of abandonments and/or delays in developing innovations (Božić, 2011).

The EU CIS asks about companies' in-house skills in design, engineering, marketing, information technology and related capabilities (Table 3.1). This is a potentially suggestive measure of the presence of some key capabilities for innovation, including the ability to understand technical and scientific literature, to adopt and use internationally recognised standards and to possess capabilities in project management, logistics, product design, marketing and information management. However, as the share of firms with such capabilities does not establish the quality of these capabilities or their prevalence within firms, this indicator is best used for identifying broad patterns. Croatian firms' skills in engineering and applied sciences, market research and mathematics, statistics and database management are at around the median for the countries considered (Finland is excluded owing to a lack of data). Graphics arts, layout and advertising, multimedia and web design appear to be skills in which Croatian companies' in-house capabilities are relatively weak in international comparison. This weakness may not be detrimental as such firm needs are often adequately met by external service providers. However, the overall lagging share of in-house skills (last column in Table 3.1) can be a cause for concern. Evidence from developing innovation systems suggest that it is the internal activities of firms that are the demand generators for innovation and that they are especially important in the critical transition from performing innovation that is primarily new-to-the-firm, to performing innovation that is new-to-the-market and new-to-the-world (see OECD, 2007a; Bell, 2009).

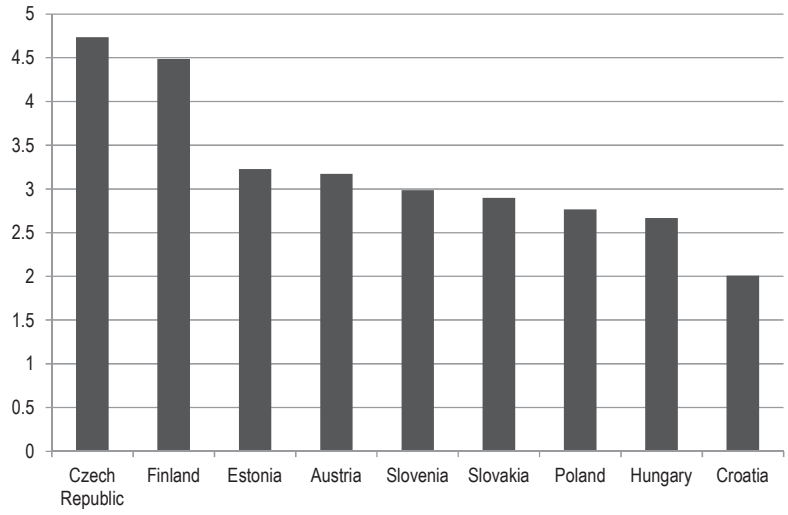
Table 3.1. Share of companies with engineering, marketing, IT and related skills, 2008-10

	Design of objects or services	Engineering/ applied sciences	Graphic arts/layout/ advertising	Multi-media skills	Market research	Mathematics/ statistics/ database management	Software develop-ment	Web design	*Average across skills*
CZE	12%	13%	18%	10%	25%	16%	10%	16%	*15%*
EST	14%	27%	8%	5%	17%	30%	9%	11%	*15%*
HUN	6%	13%	8%	5%	15%	16%	6%	8%	*10%*
AUT	19%	12%	17%	11%	9%	15%	11%	13%	*14%*
POL	13%	8%	14%	8%	14%	12%	9%	12%	*11%*
SVN	9%	21%	6%	5%	13%	14%	11%	8%	*11%*
SVK	9%	10%	10%	7%	26%	18%	5%	9%	*12%*
HRV	12%	14%	8%	6%	18%	17%	8%	8%	*11%*

Source: Eurostat (2013), Statistics Database.

Information and communication technology (ICT) specialists[3] have skills that are highly relevant for innovation activity. Indeed, it is hard to think of innovation activities that do not rely or would not at least benefit from some form of ICT infrastructure. In 2010, they accounted for 3-4% of total employment in most OECD countries, although the shares are lower in eastern Europe (OECD, 2012a). With a 2% share of ICT specialists, Croatia occupies the last position in the comparator group (Figure 3.2).

Figure 3.2. Share of ICT specialists in the total economy, 2010



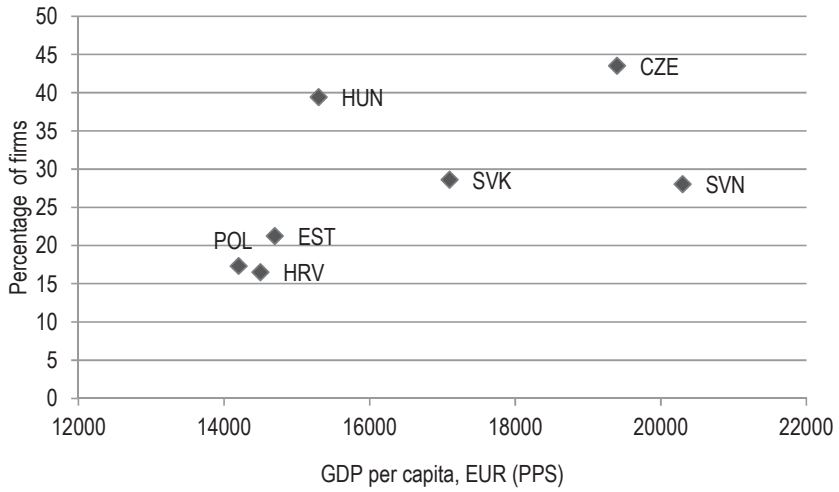
Source: OECD (2012a), "ICT Skills and Employment: New Competences and Jobs for a Greener and Smarter Economy", *OECD Digital Economy Papers*, No. 198, http://dx.doi.org/10.1787/5k994f3prlr5-en

A study of the availability of ICT skills in Croatia (USAID, 2007) found that, although the labour market for ICT specialists as a whole appeared to be functioning, there was a disproportionate demand for certain skill profiles (such as ICT infrastructure engineers certified by vendors) and estimated that the supply of ICT specialists would need to double in order to keep up with expected demand. Many of the policy recommendations made by USAID – the promotion of engineering, mathematics and science graduates by reallocating budgets, involvement of industry in curricula development, establishment of public-private partnerships for industrially relevant skills provision and a raft of measures for the support of the domestic ICT industry to stimulate demand – remain either partially implemented or have yet to be adopted.

The introduction of new organisational methods can play an important role in improving the productivity of the labour force. Assessing companies' receptiveness to new organisational methods is complicated by the differing needs of various industrial sectors and product categories. However, the presence of ISO (International Organization for Standardization) certification can be a suggestive, if partial, barometer of broad tendencies. As an indicator of product and service quality, ISO certification is a form of credential that signals readiness to operate at the global level. It also carries a reasonable expectation of productivity benefits. ISO certification appeals to all sectors, though it is more relevant for manufacturing. Importantly, ISO certification is the end result of a process that involves a comprehensive review of existing procedures and usually presupposes the adoption of related infrastructure and organisational methods. Figure 3.3 plots the share of companies with ISO certification against national income per capita.

Croatia trails the group of new EU member states, which as a whole command higher incomes per capita. The share of firms in Croatia with ISO certification is about the same as in Poland, a country with comparable income per capita.

Figure 3.3. ISO certification, 2009



Note: 2007 for Croatia.

Source: OECD based on World Bank, World Development Indicators and Eurostat.

Table 3.2. Firm-level technology use, 2009

	Percentage of manufacturing firms using technology licensed from foreign companies	Percentage of firms with their own website	Percentage of firms using email to interact with clients/suppliers
Czech Rep.	11.6	80.5	98.2
Estonia	25.5	67	96.3
Croatia	22.5	55	90.5
Hungary	13.1	69.6	95
Poland	6.4	64.5	84
Slovak Rep.	30.1	73	93.1
Slovenia	15.3	79.5	99.4

Note: 2007 for Croatia. If the previous available year is used for all other countries (2005 for comparator versus 2007 for Croatia), Croatia ranks behind most countries except the Czech Republic and Poland.

Source: World Bank, Enterprise Surveys.

Indicators on the use of firm-level technology can indicate the receptiveness of Croatian companies to technical change (Table 3.2). Owing to lack of coverage in the World Bank's *Enterprise Surveys*, on this occasion the comparator group excludes Austria and Finland and consists of only new EU member states. Within this setting, a relatively large share of Croatian manufacturing firms license technology from foreign companies, behind only the Slovak Republic and Estonia. However, Croatian firms stood last in terms of the share of firms with their own website. More recent data from Eurostat suggest that in 2012, 65% of Croatian firms had their own website and the country's relative position had improved a little, this time ahead of Hungary (62%). Moreover,

Croatian firms make less use of email, a mature technology of widespread appeal, than the other countries in the comparator group, with the exception of Poland. The last two observations may also be indicative of the markets that Croatian firms appeal to, which are likely to be geographically close and may not use ICTs.

The overall picture from the range of indicators and other evidence examined – the low capacity to use skilled labour[4], innovation-relevant skills constraints (Božić, 2011), weak efforts to upgrade existing workforce skills and lagging adoption and use of representative technologies - is one of low absorptive capacity and is in keeping with low technology intensity in production (see Chapter 1). This low absorptive capacity may be due both to supply-side obstacles (for individual firms or in the national business environment) and to issues of market structure and demand orientation for Croatian products and services, such as the prominence of the government as end clients, relative protection from international competition, and an export orientation towards regional markets, such as CEFTA (CEFTA, 2012), where competitors also tend to use older technologies.

Yet, despite the relatively low absorptive capacity of its firms, Croatia has achieved notable labour productivity improvements, owing for the most part to capital accumulation. To return to sustained growth and retain competitiveness in the context of EU membership it will be critical to mobilise the country's as yet underexploited potential for business innovation.

In terms of the business sector's formal R&D capacity (see Chapter 2), Croatia does not compare favourably to comparator countries. In fact, as a percentage of GDP, business expenditure on R&D (BERD) decreased over the past decade and stands at 0.32% (2010). BERD intensity in Croatia is lower than one would expect given the level of knowledge-intensive employment. It is striking that, after controlling for inflation (expressed in 2000 purchasing power standard prices[5]), Croatian BERD declined even *in absolute terms* (Table 3.3). In contrast, with the exception of the Slovak Republic, all comparator countries experienced steep increases in real BERD, in most cases a multiple of 2002 levels. Although less pronounced, the trend was the same in the EU and the OECD.

Table 3.3. Business expenditure on R&D, 2002-11

In millions of purchasing power standard EUR, 2000 prices

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Czech Republic	1028	1110	1189	1451	1757	1762	1723	1669	1867	2191
Estonia	29	37	51	70	92	100	104	104	136	270
Hungary	406	409	449	527	652	666	716	845	894	982
Austria	2932	:	3237	3755	3895	4159	4417	4232	4449	4501
Poland	411	556	631	736	762	799	912	953	1008	1242
Slovenia	284	271	325	307	360	355	454	467	563	727
Slovak Republic	205	185	155	165	149	143	168	156	219	214
Finland	2827	2975	3092	3238	3402	3631	3987	3731	3721	3753
Croatia	187	182	218	187	151	188	233	188	178	181

Source: Eurostat (2013), Statistics Database.

The distribution of R&D activity across firm sizes and industrial sectors may hint at structural sources of the R&D deficit. The R&D deficit in terms of R&D personnel (a more reliable indicator than expenditures across firm sizes) seems more pronounced in small (1-9) and in medium-sized firms (10-49) (Table 3.4). In Croatia large companies (500 employees or more) account for 48% of R&D personnel. Among comparator countries Croatia ranks third in terms of concentration in this size band, after Finland (60%) and Poland (59%). Overall, Croatian SMEs (1-249 employees) appear to have a smaller proportion of R&D personnel (37%) than most countries in the comparator group, but larger than Finland (29%) and Poland (24%). Considering that Croatian SMEs account for a slightly higher share of overall employment than is the case in the EU27 (Table 1.8) – a feature it shares with Poland but not with Finland – Croatia appears to have a lower than average propensity to invest in R&D in the firm size bands that are more prevalent in Croatia.[6] What this means in practical terms is that there may be specific constraints to the development of R&D activities in SMEs.

Table 3.4. Shares of R&D personnel in the business sector by firm size, 2010

	1-9 employees	10-49 employees	50-249 employees	250-499 employees	500+ employees
Czech Republic	2%	14%	36%	10%	37%
Estonia	12%	30%	23%	18%	17%
Hungary	13%	20%	20%	4%	40%
Poland	2%	7%	15%	17%	59%
Slovenia	5%	15%	32%	6%	42%
Slovak Republic	9%	10%	31%	22%	28%
Finland	4%	11%	14%	11%	60%
Croatia	1%	8%	28%	15%	48%

Source: Eurostat (2012), Statistics Database.

Innovation capacities are often specific to industrial sectors. An examination of the composition of BERD across industries and of its evolution over recent years can be useful for ascertaining sectoral strengths and relating them to needs for skills or for specific types of innovation, as well as for tracing some of the sectoral sources of recent decline (Table 3.5). Depending on the year concerned, the nine broad sectors reported here represent between half and two-thirds of all Croatian BERD. A prominent feature of this distribution is its relative diversity, with only telecommunications (J61) consistently commanding two-digit shares over time, joined by pharmaceuticals (C21) in the last two years of available data. Unsurprisingly, these are also the sectors in which large corporate research institutes, such as Ericsson Nikola Tesla (and to a much lesser extent, Končar) and Fidelta/Galapagos (the successor of the former Pliva Institute), are mostly active (see Box 3.1). These appear to have been the most important sectors historically and their importance has increased in recent years. The petrochemical sector (C19+C20), which is that of INA, the country's largest company and most important exporter, accounts for 4% of BERD. Moreover, the distribution of R&D activity across sectors tends to correspond to Croatia's export strengths; most of the sectors with notable shares of BERD in Table 3.5 can be (at least partially) matched to one of the top 20 products in terms of export market share in Table 1.5.

Table 3.5. Percentage of BERD performed in selected industries, 2005-09

NACE2 code	Sector	2005	2006	2007	2008	2009
C10 C11	Manuf. of food products and beverages	4%	7%	3%	6%	6%
C19+C20	Manuf. of coke, refined petroleum, chemicals and chemical products	3%	3%	3%	4%	4%
C21	Manuf. of basic pharmaceutical products and pharmaceutical preparations	3%	5%	4%	27%	15%
C26+C27	Manuf. of computer, electronic, optical products and electrical equipment	4%	6%	3%	2%	3%
C28+29	Manuf. of machinery, equipment n.e.c., motor vehicles, trailers and semi-trailers	7%	15%	12%	6%	6%
C301	Building of ships and boats	20%	4%	4%	1%	2%
F	Construction	5%	7%	6%	3%	5%
J61	Telecommunications	13%	17%	20%	15%	21%
J62	Computer programming, consultancy and related activities	0%	0%	0%	0%	6%
	Other	40%	36%	46%	35%	33%

Source: Eurostat (2012), Statistics Database.

Box 3.1. Major business R&D performers

In Croatia formal R&D capacities and expenditures are concentrated in a relatively small number of large firms (ERAWATCH, 2012). These include corporate research institutes such as Ericsson Nikola Tesla (ICTs), INA (oil and gas), Končar – Electrotechnical Institute (engineering) and Galapagos (former Pliva Institute). Following the acquisition and restructuring of Pliva, the single most significant industrial research spender on R&D is Ericsson Nikola Tesla. Other important R&D spenders include Podravka, in the food industry, the Končar–Electrotechnical Institute and Belupo, a pharmaceutical company (ERAWATCH, 2012). Notable examples of smaller innovating companies with R&D activity include Dok-ing (a producer of demining robots and robots for mining), Banko (machine drills), Altpro (railway signalling equipment) and Sestan-Busch (military helmets).

Ericsson Nikola Tesla (ENT)

ENT can trace its roots back to the mid-20th century and has historically been a major telecommunications equipment supplier in central and eastern Europe. Since its incorporation into Ericsson, ENT has specialised in telecommunications software and services design. Over the last couple of years ENT has spent over EUR 25 million on R&D. Out of ENT's total workforce of 1 600, around 750 are employed in R&D, including 10 doctorates and 125 masters of science graduates. ENT actively collaborates with the University of Zagreb on research training. The performance of ENT's R&D centre in 2012 was highly ranked by Ericsson's R&D Operational Steering Group (ENT, 2013).

Fidelta / Galapagos Research Center Ltd.

The Galapagos group is a biotechnology company specialising in the development of new medicines. The company is headquartered in Belgium, employs around 800 people and spends around EUR 85 million on R&D worldwide. Galapagos operates in Croatia through its subsidiary Fidelta/Galapagos Research Center Ltd., a fee for service company within the Galapagos Group's Service division. Fidelta employs over 100 scientists with more than 11 years of experience in the pharmaceutical industry on average. More than 60% of its scientists are doctorate holders with international experience at prestigious universities in Europe and the United States.

Končar – Electrotechnical Institute

Končar–Electrotechnical Institute (KEI) is a joint stock company (owned by Končar Electrical Industry Inc.), whose core business is applied research in support of the development of power equipment and plants within the Končar Group. In 2012 KEI spent about EUR 1 million and invested a similar amount on equipment and refurbishments. It also spent about EUR 200 000 on education (including scholarships, conferences fees, professional literature and education trips) (KEI, 2013).

Source: ERAWATCH (2012), ENT (2013), KEI (2013), written correspondence with ENT and Končar Institute, information from www.fidelta.eu.

Table 3.6 presents innovation activity by broad type of innovation in Croatia and comparator countries based on the 2008-10 wave of the CIS. In Croatia 42% of surveyed companies had introduced some kind innovation (product, process, on-going or abandoned, organisational or marketing innovation). Overall innovation propensity was around the middle for the comparator group – ahead of the Slovak Republic (36%), Hungary (31%) and Poland (28%), but below the rest – and had declined relative to the 2006-08 wave, when 44% of surveyed companies had introduced some kind of innovation.

Companies in the manufacturing sector are more likely to engage in technological innovation, as demonstrated by their preference for intellectual property instruments such as patents and industrial designs. By contrast, service sector firms are more likely to engage in non-technological innovation, such as organisational or marketing innovation. As one would expect given Croatia's balanced sectoral structure, firm-level innovation does not appear to be skewed towards either technological or non-technological innovation (Table 3.6). By contrast, Estonia and Finland had a greater share of companies engaging only in technological innovation, while in Slovenia non-technological innovation had a greater share.

For middle-income countries with developing innovation systems, the transition from a regime in which most firms do not innovate or only engage in new-to-the-firm innovation to a regime in which most companies engage in some form of innovation, a sizeable proportion of which is new-to-the-market and therefore of potentially wider economic impact, is critical to their long-term prospects. This transition depends on the accumulation of intra-firm capabilities, including skills and experience in design and engineering (Bell, 2009). The CIS usefully distinguishes firms that introduce new or significantly improved products that are new to the market, which makes it possible to assess the extent of the transition. The share of new-to-the-market innovating firms in Croatia stood at 27%, around the middle of the countries examined and ahead of Poland, Estonia and Hungary (Table 3.6, last column), a sign that the transition is incomplete.

Table 3.6. Innovative enterprises by type of innovation, 2008-10

	Enterprises with innovation activity (product, process, on-going or abandoned, organisational and marketing innovation)	Technological innovation only (product, process, on-going or abandoned)	Non-technological innovation only (organisational and/or marketing innovation)	Enterprises that have introduced new or significantly improved products that were new to the market
EU27	53%	12%	14%	
Czech Rep.	52%	9%	17%	27%
Estonia	57%	20%	10%	21%
Hungary	31%	8%	13%	23%
Austria	56%	13%	13%	38%
Poland	28%	7%	12%	20%
Slovenia	49%	10%	15%	35%
Slovak Rep.	36%	7%	7%	35%
Finland	56%	16%	10%	34%
Croatia	42%	9%	11%	27%

Source: Eurostat (2013), Statistics Database.

The sectoral and firm size distribution of innovation (Table 3.7) reveals a number of interesting patterns. First, there is a clear relationship between the proportion of innovators and firm size. Second, manufacturing firms are considerably more likely to be innovators. Third, for the balance between technological and non-technological innovators, firm size, and industrial sector in particular, are good predictors of the propensity to innovate. Firms with 250 employees or more are almost twice as likely to engage in technological than in non-technological innovation. Firms in the services sector are more likely to engage in non-technological innovation only. Differences with EU27 average shares are more pronounced among smaller firms. This last observation, echoes closely the pattern observed with R&D and suggests that SMEs face particular constraints in their innovation activities.

Table 3.7. Innovative enterprises, by type of innovation, broad sector and size, 2008-10

(Croatian difference from EU27 share in brackets)

	Enterprises with innovation activity (product, process, on-going or abandoned, organisational and marketing innovation)	Technological innovation only (product, process, on-going or abandoned)	Non-technological innovation only (organisational and/or marketing innovation)
From 10 to 49 employees	39% (-11%)	8% (-4%)	11% (-4%)
From 50 to 249 employees	53% (-12%)	14% (0%)	11% (-2%)
250 employees or more	73% (-5%)	13% (0%)	7% (n/a)
Mining and quarrying (NACE B, including extraction of crude petroleum)	34% (n/a)	14% (n/a)	2% (n/a)
Manufacturing (NACE C)	46% (n/a)	12% (-3%)	9% (n/a)
Services of the business economy (NACE G-N)	38% (n/a)	7% (n/a)	12% (n/a)
Total	42% (-11%)	9% (-3%)	11% (-3%)

Source: Eurostat (2013), Statistics Database.

A survey of a sample of 300 Croatian firms conducted on behalf of the OECD Investment Compact in 2012 sheds further light on constraints on innovation activity. Firms may be dissuaded from engaging in innovation either because of demand obstacles – innovation is not profitable relative to other activities – or supply bottlenecks – lack of availability of finance and qualified human resources.

The survey found that supply barriers were somewhat more important obstacles than demand for innovation expenditure. Lack of internal resources and qualified personnel were the most often cited barriers, ahead of uncertain market demand, competition and external funds. Indeed, on the issue of the sources of innovation expenditure, the survey found that own funds were the most commonly cited source (over 50%). Additionally, just over 30% used commercial bank loans, while financial support from the government was cited by just over 15% of respondents. Fewer than 5% of respondents cited co-financing with other firms or funding from the EU. The fact that a third of all companies obtained loans indicates that the financial system has at least some provisions for innovation activities. Support for innovation from the EU can be expected to increase considerably following accession. As an indication, the 2008-10 CIS indicates that 16% of Czech and 15% of Slovenian companies received EU support for innovation.

An additional explanation for the input shortfall can be sought in Croatian firms' willingness to engage in innovation (rather than in their ability to dedicate resources for that purpose). One of the survey questions directed to the group of innovating companies concerned the impact of own innovations on their turnover, which provided a measure of the attractiveness of innovation as a business activity. A small majority of respondents (56%) reported that innovation has had either a low impact (29%), no impact (24%) or negative impact (3%). Only 12% reported a high impact and 33% a moderate impact. The overall picture of the attractiveness of innovation as a form of investment is mixed, but on balance more negative than positive.

Past studies of innovation survey data in Croatia have examined both obstacles to and facilitators of innovation. Aralica et al. (2008) and Radas and Bozic (2009) performed econometric analyses of earlier CIS data (2001-03 for Aralica et al. and 2004 for Radas and Bozic) that control for other determinants of innovation. Radas and Bozic found that firms that face financing obstacles are not less likely to innovate. Lack of finance, although present in the minds of managers, therefore does not appear to be a binding constraint for most companies. According to these authors, SMEs in Croatia find ways to work around financial constraints, as most of the firms that reported obstacles managed to secure either internal funding or credit from banks and suppliers. Among facilitators of innovation activity, they found that "market scope" (defined as the tendency to serve mainly local, national or international markets) was positively associated with innovative activity. Aralica et al. also found that innovation behaviour and outcomes in Croatian firms were statistically associated with foreign direct investment (FDI) and export orientation. These findings may suggest that the greater internationalisation of Croatian markets (which entails stronger competition from EU firms) and the greater diversification of Croatian exports following EU accession may encourage innovation in Croatian firms.

Table 3.8 presents information from the CIS 2008-10 on the incidence of co-operation on innovation among companies in Croatia. Only 33% of Croatian firms engage in such co-operation, which places Croatia last among the comparator countries though above the EU27 average of 27%. In Croatia as in the comparator group, international collaboration was primarily with European partners. The CIS also indicates that most companies expect future co-operation to be with companies (75% with customers and 64% with suppliers), while fewer than half (46%) expect to co-operate with universities. Co-operation with suppliers is especially encouraging as a way of propagating innovation activity across the supply chain.

The low propensity of Croatian companies to collaborate with universities, and with public research institutes (PRIs) in particular, is evident in the number of public-private co-publications per million population, which is only about 50% of the EU27 average (EC, 2011a). This may be due to a lack of willingness to collaborate for reasons such as secrecy or a culture clash. Alternatively, it may reflect both the difficulty of universities and PRIs to shift relatively quickly from basic R&D towards applied research (which may be partly due to the fact that it is not part of their formal mission and requires considerable reorganisation, including the recruitment of new researchers) and a lack of R&D capacity in most businesses. In Croatia, the low level of R&D capacity, especially in companies, seems to be the immediate constraint, as Croatian universities conduct more applied (and experimental) research than universities in comparable countries (see below).

Table 3.8. Innovation activity and co-operation, 2008-10

	All types of innovation co-operation with other enterprises or institutions	Co-operation partners		
		From another EU27 member state, EFTA or acceding country	From the United States	From China or India
	Percentage of all product and process innovative enterprises			
EU27	26.5	11.4	3.1	2.0
Czech Republic	34.2	20.9	3.8	2.8
Estonia	42.1	30.0	3.0	1.8
Hungary	43.2	17.0	2.2	1.9
Austria	51.0	30.1	5.5	2.9
Poland	33.5	15.6	3.0	1.9
Slovenia	44.7	34.8	7.6	6.0
Slovak Republic	34.7	30.0	4.8	3.4
Finland	39.8	27.5	12.2	8.9
Croatia	32.6	19.9	3.9	2.8

Source: Eurostat (2013), Statistics Database.

International evidence suggests that, as a rule, companies perform most of their innovation activities in-house, collaborate on only a minority portion of their innovation activities, and when they do collaborate, overwhelmingly do so with other companies rather than with universities or PRIs (Arundel et al. 2008; for case studies see Giuliani and Bell, 2005; Dantas and Bell, 2011). Compared to other countries, companies in Croatia appear to derive little value overall from co-operation on innovation (Table 3.9), an observation that is compatible with low in-house innovation capacities but may also be related to lack of experience in cooperation and the attractiveness of available partners. Only 1% of CIS respondent firms in Croatia perceived co-operation with universities or PRIs as the most valuable form of co-operation on innovation, the lowest and second-lowest percentages among the countries considered.

Table 3.9. Most valuable form of co-operation, 2008-10

Share of product and/or process innovative enterprises

	With other enterprises within the enterprise group	With suppliers of equipment, materials, components or software	With clients or customers	With competitors or other enterprises of the same sector	With consultants, commercial labs, or private R&D institutes	With universities or other higher education institutions	With government or public research institutes
Czech Rep.	7%	9%	9%	1%	2%	4%	1%
Estonia	13%	11%	9%	2%	3%	1%	1%
Hungary	7%	11%	6%	4%	6%	9%	1%
Austria	12%	13%	8%	4%	5%	8%	1%
Poland	7%	11%	5%	1%	3%	3%	3%
Slovenia	13%	27%	25%	12%	21%	21%	14%
Slovak Rep.	9%	12%	9%	2%	1%	1%	0%
Croatia	5%	13%	7%	3%	2%	1%	1%

Source: Eurostat (2013), Statistics Database.

3.2. Universities (higher education institutions)

Basic characteristics of the university system

Higher education institutions (HEI) include universities and other tertiary institutions regulated by the Act on Scientific Activity and Higher Education (2003). Croatia possesses a two-route system of professional and academic education (EACEA, 2010). Professional education is offered by polytechnics (veleučilišta), schools of professional higher education or colleges (visoke škole) and, exceptionally, universities (sveučilišta). Academic education is offered exclusively by universities, which are distinguished from other HEI institutions by their research activities. The academic route tends to be more popular, as four-fifths of higher education students opt for an academic route.

The Croatian HEI sector has grown considerably in recent years. Though historically concentrated in Zagreb and other major urban centres, the establishment of new public universities and private institutes over the past decade has contributed to a more geographically balanced distribution. When the Law on Scientific Activity and Higher Education was introduced in 2003 there were 6 universities, 7 polytechnics and 15 colleges in Croatia. By the end of 2011, there were 10 universities, 15 polytechnics and 30 colleges (Table 3.12). The new public universities are the University of Zadar (established in 2002), the University of Juraj Dobrila in Pula (established in 2006) and the University of Dubrovnik (established in 1996 as a polytechnic but gained university status in 2003). The public sector is by far the main provider of higher education, accounting for 93% of all students enrolled in HEIs. Private HEIs have made relatively greater inroads in the provision of professional education. The number of study programmes has also increased (from 400 in 2005 to 1 225 in 2011) during the period of capacity expansion and the implementation of the Bologna principles. The expansionary trend has significantly slowed during the last few years, partly owing to an insufficient number of potential students and partly to the effects of the economic crisis. By 2011 the system appeared to have reached stability (ASHE, 2011).

The HEI sector is also characterised by a great deal of institutional complexity. The four older universities (Zagreb, Split, J.J. Strossmayer in Osijek and Rijeka) are divided into faculties and academies, which are set up as separate legal entities and possess considerable autonomy. Such within-institute legal fragmentation is uncommon today, and the universities established over the last decade do not possess this fragmented set-up. However, because the HEI sector has resisted attempts to reform (see discussion below), the government, when managing the sector's governance, budgeting, planning, external quality assurance, etc., must deal with 122 separate actors rather than 55 HEIs (Table 3.10).

Table 3.10. Number of higher education institutions 2003-11

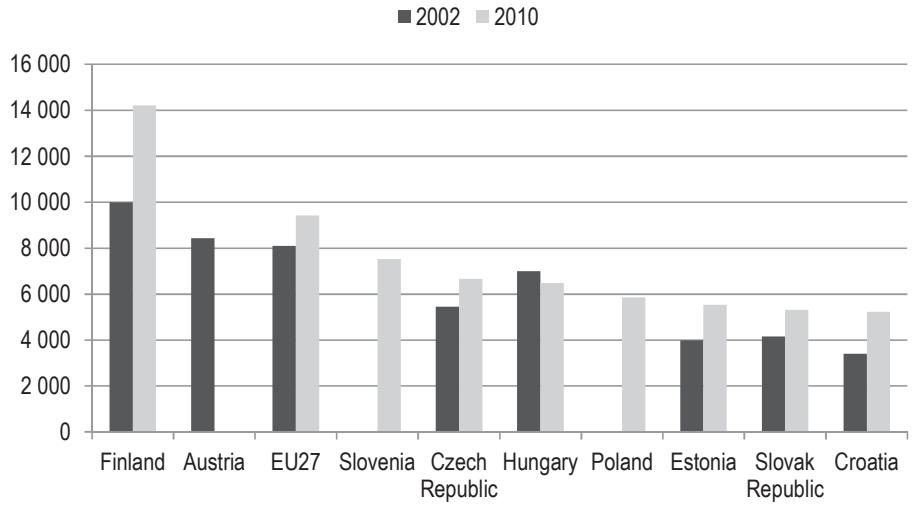
	2003 (1)	2008 (2)	2011 (3)
Universities	6	10	10 (7 public, 3 private)
Polytechnics	7	15	15 (13 public, 2 private)
Colleges	15	27	30 (3 public, 27 private)
Total	28	52	55 (23 public, 32 private)
Faculties and academies		67	67 (67 public)
Legal entities		122	122

Sources: 1) NCHE (2011), Report on the National Council for Higher Education in 2010, National Council for Higher Education; 2) ASHE (2008), "Short Overview of Higher Education in the Republic of Croatia", January; 3) ASHE (2011), Self-evaluation.

Periods of expansion typically mobilise considerable resources and new institutes take some time to reach full capacity owing to the inevitable delays in infrastructure procurement, staff recruitment, drafting of organisational routines and associated learning and adjustment. The expansion of tertiary education occurred in a setting of relative resource scarcity, as the amount of expenditure per student in purchasing power standard (PPS) terms in Croatia has lagged all comparator countries (Figure 3.4). It is nevertheless encouraging that the amount has increased over time (from EUR 3 400 PPS per tertiary student in 2002 to EUR 5 200 PPS in 2010). In addition to the overall capacity expansion, the Croatian HEIs had to manage the transition towards the Bologna regime, which implied considerable adjustment costs. The combined needs of expansion and adjustment mean that the resource constraints faced by HEIs in Croatia are probably even more pronounced than implied by expenditure per student figures alone.

Figure 3.4. Annual expenditure on public tertiary (ISCED 5-6) educational institutions per student

In PPS, based on FTE



Note: Austria: 2000, no data for 2010; EU27, Estonia, Poland: 2009; Slovenia and Poland: no data for 2002.

Source: Eurostat (2013), Statistics Database.

Despite the recent expansion, HEI capacities remain concentrated in older universities. The University of Zagreb still accounts for more than half of the academic staff and students (Table 3.11) and three-quarters of PhD graduates. The other three older universities (Split, J.J. Strossmayer in Osijek and Rijeka) account for another third of academic staff and students. Given the prominence of older universities in setting the national agenda and in acting as role models for others, their central position in national and international research networks and their links with PRIs, it is clear that the governance and management of these four universities are tantamount to the governance of the HEI sector as a whole. Taken together, newer universities have better student/staff ratios and a considerably smaller average constituent subdivision (faculty/department) size (Table 3.11). Possible reasons are the newer universities' overall smaller size, the fact that they are still likely to operate below full capacity, and that their functional integration permits a more efficient use of resources.

Table 3.11. Croatian public universities: Number of academic staff, students, faculties/academies and departments

University	No. of academic staff, FTE (1)	No. of academic staff %, FTE (1)	No. of students (2010-11) (2)	No. of students % (2)	No. of students per FTE academic staff	No. of faculties / academies (3)	No. of university departments (3)	Total constituent subdivisions	Number of FTE academic staff per constituent subdivision
University of Zagreb	4 932	56.7%	76 946	51%	16	33	1	34	145
University of Split	1.036	11.9%	21 879	15%	21	12	2	14	74
University J.J. Strossmayer in Osijek	958	11.0%	20 421	14%	21	12	4	16	60
University of Rijeka	1 105	12.7%	20 013	13%	18	10	4	14	79
University of Zadar*	352	4.0%	5 293	4%	15	0	22	22	16
University Juraj Dobrila in Pula*	161	1.9%	2 993	2,0%	19	0	5	5	32
University of Dubrovnik*	154	1.8%	1 975	1,3%	13	0	7	7	22
Total	8 698	100%	149 520	100%		67	45	112	

Note: * denotes a new university.

Sources: 1. Croatian Bureau of Statistics (2011); 2. ASHE (2013); 3. ASHE (2011).

In the academic year 2009/10, 79% of students were in universities and four-fifths of students were already studying towards Bologna-compliant degrees (EACEA, 2010). Table 3.12 provides an overview of ISCED level 5 (undergraduate and research preparatory degrees) and ISCED level 6 (research degrees such as PhD) graduates in 2000 and in 2008 for Croatia and comparator countries. At both levels 5 and 6, the number of graduates grew at around 10% annually between 2000 and 2008, a considerably higher rate than the comparator countries, with the exception of the Slovak Republic. The data covering up to 2011 indicate no slowdown in the rate of annual growth (CBS, 2012a). In terms of gender, 60.8% of graduates in 2010 were female.

Table 3.12. Tertiary graduates: Total ISCED 5 and ISCED 6

	ISCED 5			ISCED 6		
	2000	*2008*	*Average annual growth*	*2000*	*2008*	*Average annual growth*
EU27	3 500 154	4 234 477	4.9%	95 350	110 535	3.8%
Czech Republic	37 481	86 593	11.0%	895	2 382	13.0%
Estonia	7 626	11 184	4.9%	117	161	4.1%
Hungary	59 166	62 190	0.6%	717	1141	6.0%
Austria	23 191	41 439	7.5%	1 790	2 205	2.9%
Poland	426 704	552 407	3.8%	4 400	5 616	3.5%
Slovenia	11 201	16 816	5.2%	296	405	4.0%
Slovak Republic	22 253	63 371	14.0%	446	1 655	17.8%
Finland	34 344	58 124	6.8%	1 797	1 951	1.0%
Croatia	16 570	26 444	9.8%	321	494	9.0%

Source: EC (2011b), Innovation Union Competitiveness Report, EUR 24211, Office for Official Publications of the European Communities, Luxembourg. pp. 94 and 98).

In terms of the distribution of graduates across types of degrees, Croatia and Slovenia are the two countries with the lowest share of ISCED 5A second-level degrees, which typically correspond to postgraduate/masters' qualifications (Table 3.13). According to the Croatian Bureau of Statistics (2012b), only three to four out of hundred higher education graduates complete the master's level and the share of master's graduates has changed little over time.

This aspect of the Croatian HEI system may be problematic for two related reasons. One is the skills content of master's degrees, which tends to be occupation-specific and closer to the state of the art in the corresponding scientific or technical discipline than an undergraduate degree. Therefore, raising the share of graduates with master's level qualifications may help improve the industrial relevance of academic graduates, raise the level of graduate employment to that of comparable countries and deal with some of the skill constraints reported by businesses in the CIS. The second reason is that master's degrees are typically the basis of advanced research degrees, so that a low share of master's graduates may constrain the quantity and quality of the talent pool for the formation of researchers. Of course, the low share of master's graduates is closely linked with the labour market's limited ability to absorb the highly skilled (see section 3.1 and Chapter 2). About a third of tertiary graduates acquire a degree with a professional orientation, (typically in polytechnics and college), a share that is similar in Estonia, Austria and Slovenia. However, there are indications that the share of professionally oriented graduates and of secondary-level vocational skills in Croatia may be lower than what it requires. One is the relative lack of in-house capabilities in the Croatian business sector in skills such as graphics, layout and advertising, and in ICT skills such as programming and web design (discussed in section 3.1) and moderate in-house capabilities in design and engineering. Another emerges from the World Bank's examination in 2007 of job vacancies data across skills types (2009, p. 29). It found a shortage of workers with high and specialised skills and an excess supply of workers with low and only general skills.

Table 3.13. Share of HEI graduates by ISCED qualification level and type, 2010

	ISCED 5&6 (all tertiary graduates)	**ISCED 5A, first** (undergrad, academic orientation)	**ISCED 5A, second** (postgrad/ masters, academic orientation)	**ISCED 5B, first** (tertiary, professional orientation)	**ISCED 5B, second** degree, professional orientation)	**ISCED 6** (postgraduate research doctorate)
Czech Republic	100%	59%	31%	7%	1%	2%
Estonia	100%	42%	22%	34%		2%
Hungary	100%	70%	16%	12%		2%
Austria	100%	56%	16%	23%		4%
Poland	100%	57%	42%	1%		1%
Slovenia	100%	49%	7%	40%	1%	2%
Slovak Republic	100%	55%	41%	1%		4%
Finland	100%	63%	33%	0%		4%
Croatia	100%	66%	3%	28%		2%

Source: Eurostat (2013), Statistics Database.

In terms of the distribution of graduates by discipline, Croatia has the largest combined share of social sciences and humanities graduates among comparable countries (Table 3.14). This is a feature that Croatia partly shares with Slovenia. The recent expansion of tertiary education provision (and private tertiary education) have contributed to the imbalance. The social sciences and humanities had largest share of doctorates (36.7%, of which 17.5% in humanities, and 19.2% in social sciences), followed by biomedicine and health (22.5%), and life sciences (18.4%). The remaining 22.4% were in engineering, biotechnical science and interdisciplinary scientific fields (METRIS, 2011, p. 48).

Table 3.14. ISCED 5-6 graduates, by field of education, 2010

	EU27	CZE	EST	HUN	AUT	POL	SVN	SVK	FIN	HRV
Teacher training and education science	11%	15%	8%	12%	12%	16%	7%	14%	6%	5%
Humanities and arts	12%	7%	13%	13%	9%	8%	6%	7%	13%	12%
Social sciences, business and law	35%	34%	38%	40%	34%	43%	44%	32%	23%	44%
Science, mathematics and computing	9%	9%	10%	7%	10%	7%	6%	8%	8%	8%
Engineering, manufacturing and construction	12%	14%	11%	9%	19%	9%	16%	13%	24%	12%
Agriculture and veterinary	2%	3%	2%	2%	2%	2%	3%	2%	2%	3%
Health and welfare	15%	9%	11%	9%	11%	9%	9%	19%	18%	7%
Services	4%	5%	8%	9%	4%	6%	9%	6%	5%	9%
Unknown	1%	3%	0%	0%	0%	1%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Eurostat (2013), Statistics Database.

Research funding and performance in the higher education sector

Resources for research

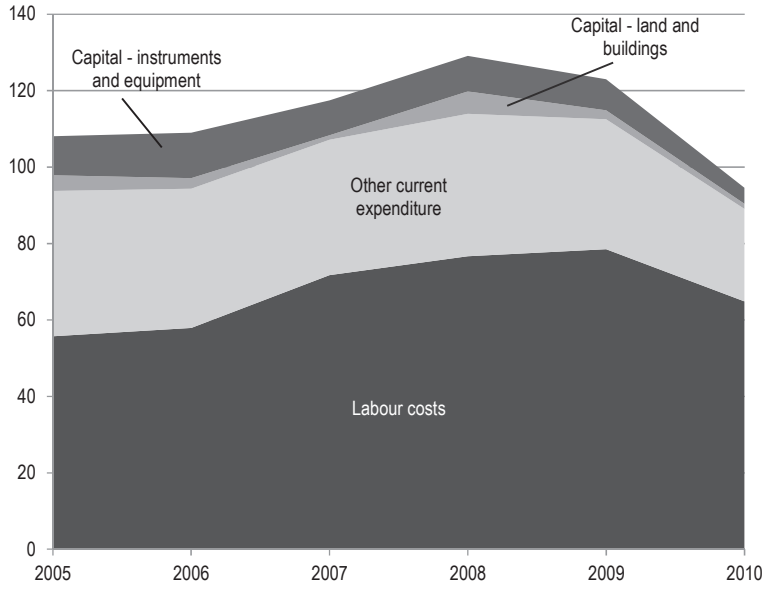
In 2010 higher education expenditure on R&D (HERD) accounted for 28% of GERD and 0.21% of GDP (CBS, 2012b). In absolute terms HERD increased during the last decade, from around EUR 110 million in 2005 to a peak of around EUR 130 million in 2008 (Figure 3.5). HERD has since declined to levels not seen since 2002 (Eurostat, 2013), in common with public R&D expenditures in general, and has been exceptionally susceptible to budget cuts (EC, 2011b, pp. 64 and 67).

The evolution of capital and labour costs can be suggestive of the phases of the system's long-term expansion and contraction and of some of the challenges it faces. Increases in capital costs may herald periods of expansion of labour costs to staff new facilities. The increasing share of capital costs in Croatian HERD during much of the last decade was accompanied by only a moderate and short-lived increase in labour costs.

This indicates that even before the contraction that began in 2008-09, the system was operating below capacity in terms of human resources. In the aftermath of the economic crisis, capital costs and other current expenditure shrank faster than labour costs, probably reflecting the fact most researchers have protected employment. Collectively, these observations suggest that research personnel in higher education work under considerable resource constraints.

Resource endowments have improved over time as R&D funding per FTE R&D personnel in higher education has almost doubled over the past decade (Table 3.15). However, Croatia remains at the bottom of the comparator countries, above only the Slovak Republic. In concrete terms, such resource constraints, coupled with a lack of flexibility for budget re-allocation, can translate into difficulties for obtaining equipment, research support services and overheads. Internationally low resource endowments per FTE R&D personnel also mean that attracting internationally mobile talent is a serious challenge.

Figure 3.5. Higher education R&D expenditure by type of cost, million EUR



Source: Eurostat (2013), Statistics Database.

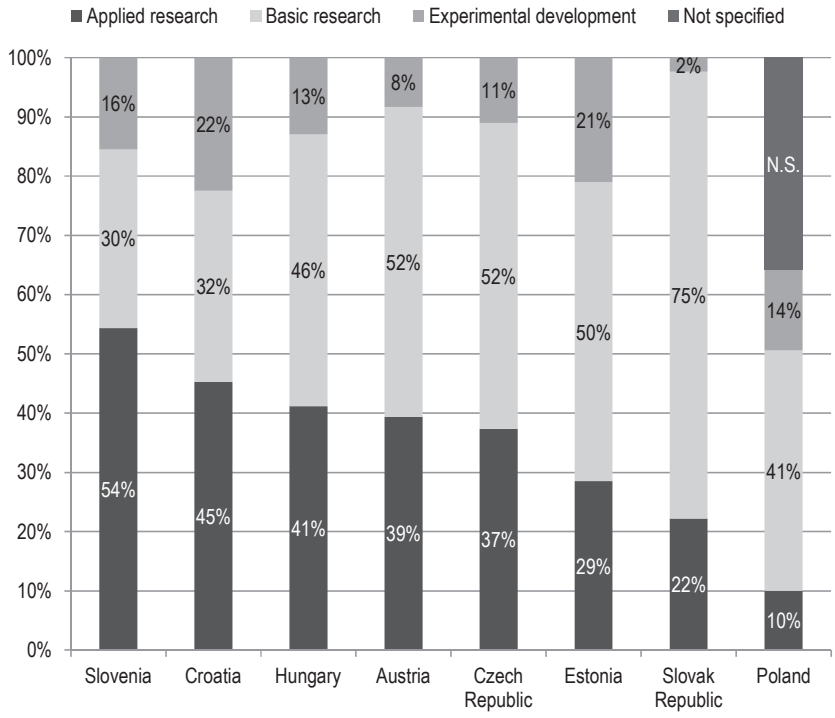
Table 3.15. R&D funding per R&D personnel (FTE) in the higher education sector
PPS EUR at 2000 prices

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Czech Republic	44 987	46 383	46 066	34 881	33 547	38 508	35567	36906	38496	26935
Estonia	17 806	21 200	21 555	29 436	36 587	36 934	43415	36454	41980	44452
Hungary	33 766	35 971	31 509	37 446	38 577	39 697	37611	36937	36084	38434
Austria	120 034		110 907	107 670	105 262	103 234	107256	107709	108318	107083
Poland	15 643	14 461	15 432	16 359	18 028	20 953	22816	29925	32664	32762
Slovenia	44 750	40 607	42 334	41 576	42 660	47 375	44808	44710	42319	38649
Slovak Republic	5 428	7 529	8 682	9 452	10 226	10 613	11062	10165	13644	18791
Finland	45 923	46 384	48 972	49 876	51 481	56 779	57785	59887	60927	67186
Croatia	20 697	48 767	41 734	39 371	37 133	35 579	34439	33391	24699	25132

Source: Eurostat (2013), Statistics Database.

A large share of Croatian HERD is devoted to applied research, second only to Slovenia (Figure 3.6). When combined with experimental development, as much as 67% of Croatian HERD goes to what may be termed market-oriented research, placing Croatia at the top among comparator countries. This is a recent development, as the shares of basic and market-oriented research were previously quite evenly matched. Though the precise reasons for the shift are unclear, it appears that universities in Croatia are attempting to move in an area that is traditionally occupied by public research institutes (such as Fraunhofer in Germany). By comparison, in most OECD and EU countries, especially in those with developed innovation systems, a majority of HERD tends to go to basic research. The relatively low share of basic research in Croatia is partly a reflection of the small share of competitive funding for scientific research, which amounts to only about EUR 10 million over six years, channelled through the Croatian Science Foundation (CSF).

Figure 3.6. Share of HERD by type of research, 2010



Note: 2009 for Austria; 2010 for Hungary, Poland, Slovenia and Croatia.

Source: Eurostat (2013), Statistics Database.

Scientific publications

By virtue of its large share of public R&D expenditures and the public nature of its mission, the higher education sector plays the leading role in the production of scientific publications (Table 3.16). According to a survey by the Croatian Bureau of Statistics (2012c), HEIs account for 65% of all publications, followed by the government sector with 29% and the business sector with 6%. The higher education sector publishes the majority not only of basic research results but also of applied research and experimental development (Croatian Bureau of Statistics, 2012c, p. 34). This distribution is as expected given the uncharacteristic slant of Croatian HERD toward applied R&D.

Table 3.16. Publications in the higher education, government and business sector, 2010

	Higher education	Government sector	Business sector	Total
Basic research	64%	34%	2%	100%
Applied research	66%	30%	4%	100%
Experimental development	66%	22%	12%	100%
Total	65%	29%	6%	100%

Source: Croatian Bureau of Statistics (2012c), "Research and Development, 2010: Statistical Report 1474", Zagreb.

On the basis of scientific publications, higher education researchers appear more productive than their colleagues in the government sector, as they publish almost twice as much yet are endowed with similar budgets. Croatian researchers tend to publish two-thirds of their papers internally, i.e. inside the organisation or inside Croatia (Table 3.17). This is related to the high level of applied research and experimental development and reflects the fact that the current reward structure for advancement in scientific careers accords value to internal publications. Even so, compared to the government and the business sectors, the higher education sector is the least inward-looking.

Table 3.17. Publications by sector, 2010

	Own	Own (%)	Others in country	Others in country (%)	Foreign	Foreign (%)	Total
Business sector	562	66%	192	23%	95	11%	849
Government sector	997	30%	1 080	32%	1 294	38%	3 371
Higher education	1 400	23%	2 196	36%	2 565	42%	6 161
Total	2 959	29%	3 468	33%	3 954	38%	10 381

Source: Croatian Bureau of Statistics (2012c), "Research and Development, 2010: Statistical Report 1474", Zagreb.

Patents

In keeping with the system's overall patenting performance, university patenting is low in Croatia (Table 3.18). In 2010, the higher education sector applied for a total of 13 patents in Croatia and 8 abroad or the equivalent of 7% of all patent applications. No patent was granted in that year, an indirect indication of the low level of activity in previous years. The few patent applications from the higher education sector were mostly made at the national office. The share of higher education patents in the national total appears low in relation to the sector's market-oriented research expenditures. Lack of patenting capabilities and experience can be suggestive of wider problems for engaging with industry and becoming commercially relevant, especially as the primary function of patenting in a public research environment is not commercial exploitation but a demonstration of competence that can enhance visibility and reputation and facilitate participation in globally relevant research networks and in the provision of services to businesses. A low propensity to patent or to file other forms of intellectual property such as industrial designs may also reflect a lack of awareness, lack of incentives for researchers, or lack of resources of institutions to cover the costs of filing.

Table 3.18. Inventions and patents by sector, 2010

	Inventions and patents				Rights granted for		
	Patent applications		*Granted patents*				
	In Croatia	Abroad	In Croatia	Abroad	Industrial designs	Service brands	Trade brands
Business sector	14	56	20	84	2	7	18
Government sector	26	8	2	1	0	0	0
Higher education	13	5	0	0	0	0	0
Total	53	69	22	85	2	7	18

Source: Croatian Bureau of Statistics (2012c), "Research and Development, 2010: Statistical Report 1474", Zagreb, p. 39.

A survey of the activities of research institutions in Croatia (conducted on behalf of the OECD Investment Compact) indicates that among responding university faculties and universities, only 3% reported income from intellectual property rights (IPR). This is consistent with the small number of applications and grants. The predominance of institutional over competitive funding (see also Chapter 4) has discouraged the diversification of revenue, a key incentive for the commercialisation of research (World Bank, 2009).

Participation in the European Framework Programme and international research infrastructures

Scientific research is largely a collaborative endeavour. Collaboration in research is increasingly necessary owing to the need for specialisation and interdisciplinarity. Moreover, grant applications and papers are evaluated by peers; participation in European projects, particularly the Framework Programmes (FP), but also involvement in international research infrastructures, serves as an indication of visibility and esteem and gives access to global networks of knowledge circulation.

Despite unfavourable conditions, the Croatian research community has made significant progress in linking up with the European research community particularly through the FP. In FP7 it had attracted by March 2011 a total of EUR 27.47 million through its involvement in projects with total funding of EUR 511.80 million. The higher education sector is the most active both in terms of applications (530 out of 1 238) and in terms of generated grant income (EUR 11.26 million). The leading organisation in terms of FP involvement in Croatia is the Ruđer Bošković Institute (RBI), with 11 participations, EUR 2.99 million and a 10.90% share. The most active HEIs are the Medical Faculty of the University of Rijeka (3 participations, EUR 2.94 million, 11%), the Faculty of Electrical Engineering and Computing of the University of Zagreb (7 participations, EUR 1.53 million, 6%), and the Faculty of Textile Technology of the University of Zagreb (2 participations, EUR 0.96 million, 3.5%). In some cases the FP has acted as a resource for procurement of scientific equipment (e.g. a particle detector system at RBI for around EUR 1.5 million, and the Medical Faculty in Rijeka received EUR 1.8 million for equipment) (Švarc and Račić,2012).

Croatia also participates in international research infrastructures. It has co-operation agreements with CERN and with the European Centre for Medium-Range Weather Forecasts and has become a member of the European Molecular Biology Laboratory and EMBO. Given that meaningful returns to participation in such organisations require a

minimum level of absorptive capacity, this rather selective approach seems appropriate in light of limited capacities and scarce resources. The Ruđer Bošković Institute plays a useful role as a hub for a number of involvements in international research initiatives, including those concerning research infrastructures.

Steering and funding of universities

Governing universities

The governance of HEIs is very fragmented. The most recent institutional evaluation of the University of Zagreb by the European University Association found its structure held little regard for function (Kralj et al., 2011). The current state of institutional and functional fragmentation, especially in Croatia's largest, oldest and most significant universities, prevents the HEI sector from reaching its full potential and harbours important risks:

- Fragmentation militates against setting up "new combinations", in particular interdisciplinary approaches to education and research. As many regional issues require a concerted interdisciplinary and multidisciplinary approach, a fragmented institutional structure weakens institutional capacity to respond to regional concerns and correspondingly to attract funding from industry (OECD, 2008a).
- The limitations on the ability of constituent units to co-ordinate efforts and programmes and to pool resources to provide common services may lead either to redundancy or to uneven coverage (the latter being very likely under resource constraints) in support functions, such as administrative, procurement, technical and student support services. Functional fragmentation may discourage strategic planning on resources, the set-up of larger research programmes, research infrastructure investments, participation in major research initiatives and, more broadly, the achievement of critical mass in scale-critical contexts.
- Fragmentation presents an obstacle to the development of a common mission, a sense of purpose and a clear identity. These are important for a university's ability to differentiate itself, increase its visibility, occupy a position in the national and international higher education landscape and consequently for its long-term success.
- Finally, fragmentation complicates improvement of the governance of institutes through negotiated performance-based and future-oriented funding principles (see below).

A second class of problems stems from the fact that decision making in HEIs is largely delegated to collective actors. At a minimum, the law stipulates that universities are to be governed by the Rector, the Senate and the University Advisory Board. Universities may also create additional management and advisory bodies within the scope of their institutional autonomy. In addition, a university may entrust the management of its business or part of it to a certain body (managing director, managing board or similar actors). The Senate is the decision-making body. It is composed of teaching staff, student representatives and representatives of other employees. The University Board has 6 or 12 members, half of them appointed by the Senate, and half of them appointed by the founder, local government bodies and the Chamber of Commerce. The Dean, an expert council (usually the Faculty Council) and other bodies, as stipulated by the university statute or other acts, govern the faculty and the academy of arts (EACEA, 2010, p. 4). Such settings tend to support compromises at a low common denominator and hence to become an obstacle for realising more fundamental reforms.

A third class of problems for the governance of the higher education sector is related to attitudes and values. There is a general reticence regarding evaluation and quality reviews, accountability, performance-orientation, etc., which supports reluctance to engage in more radical changes in general and priority setting in particular. In the 2008 *OECD Review of Higher Education in Croatia*, the country's clear commitment to the principles of the Bologna Process was noted. At the same time, the positive general impressions were counter-balanced by questions about quality assurance and evaluation (OECD, 2008a, p. 37ff.): absence of indicators of quality, at both institutional and national level; lack of awareness of concepts of accountability and self-assessment among academics; resistance to academic self-evaluation; little or no involvement of social and regional partners in assessments of quality or relevance; scepticism at all levels of institutions regarding the usefulness and impact of current quality reviews and of the national accountability body. In addition, quality assurance did not appear to be central to the strategic planning process of institutions. Since then ASHE has made progress in addressing such concerns, especially with respect to the monitoring of quality. However, judging by the limited progress in addressing industrial concerns and the strong resistance to attempts at reform, some of the above-mentioned attitudes may persist.

Finally, a fourth class of problems concerns public funding. The current budgeting rules and procedures are very inflexible in terms of exchanges between salary and investment and in terms of funding and implementing long-term programmes and investments.

Improvements in governance will also hinge on achieving a good balance in the division of responsibilities between the central government (MSES and its agencies such as CSF) and the HEIs (see Box 3.2). The move to a regime of greater university autonomy can only succeed if accompanied by increased accountability. Governance instruments to increase accountability include the monitoring of performance or outputs and the establishment of performance reporting, performance contracts or similar instruments. Such contracts increase accountability as regards output without compromising the universities' intellectual independence. These policy practices can be found in Australia, Canada, Ireland, New Zealand, the Netherlands, South Africa, the United Kingdom and the United States (OECD, 2008b). Data on a range of HEI activities, such as performance indicators, are an important stepping stone for the implementation of customised performance-based and forward-looking contracts (discussed below) and for sound planning in general. However, even with agreement on a transition towards a more explicitly negotiated performance-based funding contract, it would largely be impossible to implement effectively under the current management configuration of the older universities. The major impediment is that Croatia does not have ten universities (like countries of comparable size) but 122 separate actors. This means that contracts cannot be negotiated, as is typically the case, in a series of three to five meetings, in order to agree on performance contracts that are valid for three to five years and tailored to each institution's profile. The unstable budgetary situation compounds the problem because it does not allow for long-term planning.

Perhaps the most notable missed opportunity is the inability to build the requisite "critical mass" for major economic and social impact. For instance, it is difficult to set up large-scale, networked projects, and particularly to bring together private and public stakeholders in joint development and strategic research activities, such as joint technology initiatives, platforms, etc. For example, the Czech Republic was able to use the Structural Funds to establish large-scale regional research centres and centres of excellence, ranging from 50 to 960 staff, which receive budgets of up to EUR 360 million over five years.

Finally, tertiary education strategies can be useful steering instruments over the long term. Shorter-term monitoring of independent institutions can be strengthened by improving capacities in data collection and analysis, the use of performance-related funding and negotiated performance contracts as well as institution-level investment planning exercises (OECD, 2008b, p. 95).

Box 3.2. Distribution of functions between national and institutional levels: Striking the right balance

The principle of subsidiarity is useful for considering the appropriate distribution of governance functions between government, its agencies and tertiary education institutions. Subsidiarity means that matters ought to be handled by the smallest, or lowest level of, competent authority. The central authority should perform only the tasks that cannot be performed effectively at a more immediate or local level.

According to the subsidiarity principle, functions should be carried out at the level at which it is most efficient and effective to do so. It is not appropriate, for example, for ministries to control the detailed allocation of staff numbers to HEIs. Institutions are in the best position to assess staffing needs, but if they depend on state funding they should be required to do so within clear financial budgets, frameworks, constraints and rules.

Detailed national control and regulation of staff qualifications are not appropriate. Accreditation of individual courses, curricula and programmes at the central level is also not the most appropriate approach for a society with the ambition and capacity to be a full participant in the modern knowledge-based economy. Autonomous institutions anxious to attract high-quality students and to establish reputations for high quality in teaching and research and to contribute to national development will endeavour to recruit the best possible staff within their means to do so, and to provide the best regarded programmes and courses.

National controls, whether administered by governments or by national academic bodies, run the risk of creating inflexibilities and damaging the capacity for innovation. They tend to respond poorly to the need to recruit staff in new academic disciplines, to promote interdisciplinary studies and research, and to recruit staff from abroad or with foreign qualifications. Many countries with well-regarded higher education systems do not have such nationally administered controls. Instead, governments can play an important role in promoting high-quality outcomes by ensuring appropriate levels of competition between HEIs as a stimulus for better performance, and by ensuring that the higher education system is outward-looking, nationally and internationally.

Source: OECD (2008a), *OECD Reviews of Tertiary Education: Croatia 2008.*

Funding of universities

The sources of HEI funding include founder's funds, local authorities' funding, the state budget (MSES), CSF project-based funding, institutions' own funds and donors (EACEA, 2010). During the 2003-07 period, the state budget accounted for 70% of HEI funding. By 2010 the government (mainly the central government) funded 80.1%, while 10% came from public and private enterprises, 6.9% from own resources, 2.8% from foreign investors and 0.2% from non-profit institutions (CBS, 2012c).

A primary characteristic of the current funding regime is the lack of an explicit connection between funding and performance (see Box 3.4). At the same time, universities have considerable discretion over their costs, as the current legal framework delegates to them decisions on admission quotas, tuition fees levels and schemes (EACEA, 2010).

Institutional funding is the main source of research funding in higher education, and particularly in the PRIs (Švarc and Račić, 2012). These block grants cover gross salaries and material costs. Although the legal framework implies a link between quality assessment and the amount of funding, the principal criterion determining the block grant amount in practice is the number of employees in the organisation. There is no direct or even negotiated relation to performance indicators (EACEA, 2010). The legal framework stipulates that disbursement is to be made according to the lump-sum model, whereby the institute is permitted to distribute the allotted amount at will. In practice, collective staff pay agreements regulate the amount allocated for staff salaries; this limits flexibility for using funds for different purposes (EACEA, 2010).

In addition to the block grants, the institutes submit capital investment plans to the MSES in order to finance additional efforts, in particular for investment and maintenance. As in the case of block grants, there is no explicit link to the quality or quantity of past research performance, such as publications or patents, income from grants and contracts, nor is there any promise to achieve certain levels or kinds of research or education. Overall, there is little flexibility for redirecting funds, mainly because the block grants are determined on an annual instead of a multi-annual basis, the numbers of existing staff mainly determine the magnitude of funding, and funds for salaries, material costs and investments cannot be shifted.

Universities generate more than twice the income from the business sector as the public research institutes sector, in terms both of shares and volume. This is consistent with the broad range of research performed by universities, which includes a substantial share of applied research and experimental development, while industry-funded research of PRIs is rather low (see below).

The business enterprises that fund public research are primarily large, research-intensive firms with their own in-house research entities. The principal co-operation mechanisms are contract research projects that include development as well as routine quality control and testing services. The main public research partners are PRIs and universities. The strongest R&D potential is at the Ruđer Bošković Institute and the University of Zagreb, especially in the faculties/departments of electrical engineering, computing, food technology, chemical engineering and agriculture. There is anecdotal evidence that the income from contracts is quite skewed, owing mainly to a small number of larger companies.

Contract research between universities or PRIs and central or local government is another source of funding. Various projects financed by cities and counties contribute to the revenue of both, but they often revolve around direct applications. Unfortunately, there is no systematic data collection on the revenues generated from these projects.

There is a lack of data on the income from different (central) government sources, in particular on the breakdown into institutional funding/block grants, contracts and grants (EACEA, 2010). However, the fact that funding from the CSF – the principal funder of competitive scientific projects – amounts to less than EUR 10 million over a period of six years suggests that non-institutional/competitive funding does not play a substantial role.

As regards the FP, universities account for 41% of funding grants in terms of volume (Table 3.19). However, unlike the business sector and PRIs, which have quite high rates of success, the higher education sector has a rather poor rate of return, in terms both of successful applicants and the requested contribution. This highlights a need to review their participation in the Framework Programmes, as many factors affect success or

failure. The principal determinants of universities' success in terms of the frequency of participation and the magnitude of the grants awarded in the FP are typically the magnitude and quality of their scientific output (Henriques et al., 2009). Raising the quality and visibility of university research in Croatia by way of governance improvements (the role of competitive funding and other interventions to support rigour by the CSF are central) and ensuing funding increases will go a long way towards addressing the current low returns to participation.

Table 3.19. Grants funded by FP7 to Croatia

Performing sector	No. of applications	Success rate (applicants)	Success rate (requested contribution)	No. of grant holders	Contribution million EUR	% total contribution to grant holder
Higher education	530	13.02%	8.59%	52	11.26	41%
Business sector	267	23.97%	20.14%	59	8.20	30%
Research organisations	182	19.78%	8.54%	27	4.85	18%
Others	122	13,93%	10.47%	7	0.46	2%
Public body	110	30.00%	32.05%	19	2,67	10%

Source: European Commission (2011b), Country Profile: HR – Croatia, p. 34.

There are major problems with the universities' funding regime. One is the unstable government budget, which reveals the low priority accorded to research and innovation. The other main problem is the way in which block grants are allocated, which neither makes explicit reference to quality or quantity of past achievements nor rewards future promise, but is largely an incremental determination based on past history, with some deviations. This is undesirable for two reasons. First, lack of social accountability may fail to maximise efficiency as well as social and economic relevance. Second, insofar as HEIs fail to make a convincing case for the relevance of their activities, they will not obtain the increased funding needed to overcome the various resource deficiencies identified earlier.

Altogether, the present situation has favoured incremental policy responses that have so far failed to address the core issues.

Relations to society and stakeholders

Relations between HEIs and society and stakeholders have improved in various ways over time. The increase in the number of universities and students and the broader geographical distribution of HEI capacities, aside from their direct effect on participation, also allow for more interaction with stakeholders. The massive expansion in study programmes and their take-up by students is another indicator of the higher education sector's improved ability to respond to student demand. Initiatives at the periphery of the HEI sector (such as incubators and technology transfer centres, the support of spin-offs and of contract research) have been a priority for a long time. Even if Croatia lags internationally in this area, efforts to improve the industrial relevance of universities are bearing fruit, as universities perform more contract research with the business sector than PRIs, are filing patents and increasingly participate in joint research projects with industry. Importantly, a change in attitude seems to be occurring in the academic community, as

initial experience confirms that scientific excellence and commercialisation of research can be mutually supporting (rather than necessarily rival) activities (World Bank, 2012).

There remains however considerable room for increasing not only the intensity but also the scope of engagement with industry. Intense policy efforts to foster university-industry co-operation on research have not been accompanied by efforts to strengthen co-operation on education and skills development. While most HEIs require some form of on-the-job training for many students prior to graduation (EACEA, 2010), it is not easy to evaluate the adequacy of these arrangements in the absence of impact studies. In spite of high-level industry representation (e.g. at the National Council for Science, Technology and Higher Education), there are no formal mechanisms for aligning university education with market demands. The business sector could have a greater say in the distribution of resources across subjects and greater involvement in curriculum development. Support mechanisms could also encourage inter-sectoral staff mobility and the training of business staff at universities (e.g. tailor-made courses for business training and more part-time master's courses). Moreover, as long as within-university functional fragmentation persists, there will be important limits on the regional role of universities (OECD, 2008a) and many other opportunities to pool resources, plan strategically and attract the requisite funding for world-class research will continue to be missed.

Croatia has made strong efforts, with the financial backing and know-how of the European Commission and the World Bank, to establish infrastructures at the interface of universities and PRIs. While these are certainly useful instruments and approaches, arguably, too strong a policy focus on the commercialisation of university research and technology transfer carries an opportunity cost, as it does not solve the fundamental problems at the core of the HEI sector. There is an urgent need to improve the governance structures of HEIs, incorporate interaction with business and the public sector as a genuine part of their mission and provide them with sufficient resources.

An agenda for a better internal university set-up

A comprehensive reform of governance arrangements in the country's older universities seems long overdue and is indispensable if the universities are to fulfil their social role fully. To achieve a more coherent national system, it may also be worthwhile to consider steps to limit inter-organisational fragmentation by establishing co-ordination mechanisms between HEIs and by improving the ways in which institutions collaborate.

Croatia has made several attempts to reform the higher education sector. The adoption of the Bologna process commenced in 2003 with the adoption of the Law on Scientific Activity and Higher Education. This involved the implementation of the Bologna process, the legal and functional integration of universities, a lump-sum budgeting principle for the funding of HEIs, implementation of the European Credit Transfer and Accumulation System (ECTS), and the implementation of quality assurance mechanisms.

However, as reported by Švarc and Račić (2012), the reform was not fully implemented and failed to deal with the issue of internal fragmentation. There was a renewed attempt to legislate in 2010 (Box 3.3), but the proposed legislation was withdrawn in the face of opposition from the academic community. Concerns voiced by parts of the community centred on the loss of the autonomy and legal independence of constituent units; moreover, it was argued that giving external members a stronger role in governing bodies implied an attempt at political control of the university that could jeopardise its public purpose.

Box 3.3. A short history of recent reforms in the higher education sector

The current Law on Scientific Activities and Higher Education (LSAHE) and the implementation of the Bologna process have given universities more autonomy in a variety of areas (MSES, 2011): enrolment criteria and procedures, tuition fees, quotas, issues related to studying, hiring procedures and decisions, distribution of resources. Funds from the state budget are allocated to universities, polytechnic schools and colleges as lump sums. In turn, they break down their budgets to individual cost items. The Senate, following the recommendation of the University Council, adopts the consolidated university budget. MSES collects draft budgets from tertiary education and research institutions and makes a draft overall budget. The Council for Financing Science and Higher Education submits it to the National Council for Science (NCS) and the National Council for Higher Education (NCHE) together with its opinion. These bodies approve the final proposal for the allocation of funds and deliver it to the minister.

While the current law makes HEIs autonomous in many respects, the government is relatively passive. It more or less adopts the proposals of the respective institutions, except for budgeting and related restrictions.

In order to reform the higher education and research system, the government proposed in October 2010 three laws: the Law on Science, the Law on Universities and the Law on Higher Education. The proposed Law on Universities (MSES, 2011) attempted to introduce changes that would strengthen the position of the university in relation to its constituent units and in terms of accountability. However, the proposal was strongly opposed by a significant part of the academic community. Stakeholders argued that partial centralisation of functions affected the autonomy and legal independence of constituent units, and that giving a stronger role to external members in governing bodies implied an attempt at political control of the university that could jeopardise its public purpose.

In December 2011, the new government withdrew the draft laws prepared by the former government. It introduced new draft amendments to the Law on Science and Higher Education of 2003. The public debate ended in May 2012, during which MSES received more than 200 remarks regarding the proposed amendments and a significant number of proposals for new stipulations to be included. The main issues addressed by the amendments include: the establishment of the new National Council for Science, Technology and Higher Education; introduction of clearer and more transparent hiring procedures for research and academic positions; new institutional financing of public scientific institutes and universities through three-year programming contracts; a new definition of part-time study programmes; definition and use of the ECTS system in line with EU standards; and determination of the obligation of HEIs in the introduction of electronic communication systems.

Elements of an agenda for more effective higher education

The period ahead is replete with challenges and opportunities. The major challenge for the older universities will be to negotiate a workable reform proposal with their constituent faculties and academies, on the one hand, and with the government, on the other. A shared understanding of the opportunities that await and, importantly, of the concerns that motivate the backlash against perceived "centralisation" will be essential in reaching a widely accepted solution. Like all consensus-building exercises, success will hinge on dialogue and on the accumulation of trust between the various stakeholders. Functional integration should permit not only greater university autonomy but also set a basis for the substantial and sustainable upgrading of resources which would allow HEIs to achieve their full potential.

The next step will be the rigorous implementation of performance-based funding of HEIs and PRIs. This is a far from trivial task, mainly for two reasons. The first is the challenge of striking an appropriate balance between the formula-based (retrospective) and negotiation-based (forward-looking) components and their relationship; both components are of key importance. It will be crucial to anticipate and avoid the introduction of perverse

incentives that may result from a strict adherence to quantitative assessments. The second is timing. It typically takes three rounds of performance contracts to implement the system fully: one, to become familiar with the instrument; two, to roll it out fully and attend to details; and three, to make constructive and creative use of it. The experience of the United Kingdom, Austria and Finland can be instructive in this respect (Box 3.4).

Box 3.4. Mechanisms to steer and fund universities in the United Kingdom, Austria and Finland

While the United Kingdom concentrated on introducing a performance-based research funding system, thus linking research quality with funding, Finland and Austria embarked on broader management-by-results systems, combining performance contracts with formula-based funding systems.

United Kingdom

The United Kingdom introduced the Research Assessment Exercise (RAE) in 1986; subsequent exercises took place in 1989, 1992, 1996, 2001 and 2008. The United Kingdom was one of the first countries to institutionalise university research assessment and to link it to the allocation of institutional funding.

The RAE looks at performance based on the quality and volume of research. It has been largely based on peer review since the beginning. It was perhaps the first occasion on which peer review was involved in assessing entire university departments on a systematic, nationwide basis.

A first reason for introducing research assessment was the growing cost of research at a time of increasing pressures on public expenditure. Rapid rises in costs and overheads meant that it was increasingly important for universities to maximise their research income. The aim was a mechanism for allocating institutional funding more selectively. A second reason was to respond to political demands for greater accountability and better "value for money".

The RAE has had profound effects – positive and negative – on the research system as a whole, on the way research is conducted, on the research culture, and on power structures in the research system. Probably the most direct effect is the concentration of funding in a relatively small number of excellent universities.

Austria

The Austrian University Act of 2002 granted far-reaching autonomy to universities and completely changed their governance and financing as of 2004. The reform re-invented universities as strong institutions led by a powerful manager-rector, a new management structure, and many new responsibilities and tasks.

The two main mechanisms for allocating institutional funding aim at balancing competition among universities – in the form of a formula-based budget – and each university's individual development as defined in performance contracts. Thus, the system is based on universities' past achievements (as assessed by the formula budget) and on contractually agreed plans for the future (as agreed in the performance contracts).

In their present form, both the performance contracts and the formula budget are extensive and complex and it remains to be seen whether they can fulfil their task as steering instruments effectively.

For the ministry, the autonomy of universities means that the ministry directs its attention to overarching issues that cannot be dealt with by individual universities.

…/…

Box 3.4. Mechanisms to steer and fund universities in the United Kingdom, Austria and Finland *(continued)*

Finland

In Finland, the transition to results-based higher education management policy began in 1986 when the Finnish government decided to grant universities a 15% increase in their research and teaching budget. However, a precondition of the increase was better conditions for results-oriented management. This represented a dramatic change, as Finland had at the time one of the most centralised higher education systems in Europe.

The main element in relations between the Ministry of Education and the universities is steering based on financing, legislation and information. The key means to this end include performance contracts concluded by the Ministry of Education and the universities, a formula budget, and a feedback and monitoring system. Performance contracts date from the early 1990s; targets for institutional activities and the resources needed for their implementation are determined in negotiations between the Ministry of Education and each university. The allocation of (part of) university funding on the basis of a formula began in 1998, and the current system dates from 2010.

A unique feature of the reform was the establishment in the mid-1980s of a national university database to obtain better information on university inputs and outputs. Data are collected each year on the number of applicants, the number of entrants, student mobility, degrees, graduate placement, median graduation times, teachers, other staff, annual accounts, expenditure by performance areas, university premises, teacher and researcher visits, scientific publications, etc. Without the database it would have been impossible to create contracting and funding models and a planning system, as they depend heavily on reliable institutional information.

An important lesson from Finland is that continuity is important for changing the steering and the funding of the higher education system. Although governments have changed, all political forces have been willing to go through with the modernisation of higher education steering and funding.

Source: Arnold et al. (2011). "The Quality of Research, Institutional Funding and Research Evaluation in the Czech Republic and Abroad", Thematic Report No. 3, International Audit of Research, Development & Innovation in the Czech Republic.

The success of performance-based funding in improving efficiency and relevance will depend on the functional integration of the older universities and their readiness to negotiate the universities rather than faculties / academies. This is necessary to exploit fully the opportunities presented by internal collaboration in education and training programmes, in research, but also in investments, ranging from larger buildings to joint operation of core facilities.

In addition, a fully functioning research council will be needed to shift the balance towards competitive funding and thus strengthen the commitment to quality. Research funding agencies (such as "research councils") are important for strengthening university research. They contribute to quality primarily by making research funding conditional on high standards of scientific rigour. In doing so, research councils also affect researchers' behaviour by changing incentives and stimulating competition; they may also influence the direction (including internationalisation), relevance and impact of university research. It is fair to say that this is not yet the case in Croatia, as the CSF is too small, in terms of its budget and the scope of its instruments, to play the role of a fully-fledged research council. CSF will need to have sufficient resources to make quality-assured research part of the public research system.

Efforts are also needed to identify and address present and future skills needs of relevance to innovation in general and to the innovation capacities of the business sector in particular. The focus over the past decade on researchers, the scientific diaspora and other cutting-edge skills, important as these are, needs to be complemented by a focus on a much wider range of specialised, occupation-oriented skills. This should be the subject of a comprehensive study, followed by formal mechanisms for identifying skills needs and better aligning the skills supply.[7]

Available evidence points to the need to strengthen (non-academic) professional education at tertiary as well as master's level, areas that seem weak relative to comparable countries and that are important for strengthening innovation capabilities in general and in the business sector in particular. An important element of this effort will be transfer of expertise from abroad, possibly by pairing with leading tertiary vocational education providers, e.g. from Germany, United States, Ireland, to develop and deliver professional undergraduate programmes and academic master's programmes. In addition to improving the quality of Croatia's vocational and master's programmes, the association with prestigious providers may help improve the attractiveness of vocational education to prospective students. The private sector's strong response over the last decade in the supply of this education in polytechnics is a clear sign of a gap. However, private provision alone may not suffice, in terms of quantity and quality, to meet Croatia's needs for innovation-relevant skills in a timely or sufficiently inclusive manner. Addressing this issue calls for commitment at a high political level and sufficient resources, including innovative uses of the Structural Funds. Ireland's experience with using Structural Funds to develop its highly successful and respected institutes of technology may be a useful guide.

On-going performance contracts at the level of efforts to strengthen linkages and alignment with the needs of business sector should continue. It would be important to adopt a wider definition of university-industry linkages, one that goes beyond joint research projects, technology transfer and spin-offs to include continuous consultation on content of skills, the introduction of sandwich courses with longer (typically one year) work placements, joint workshops, industry involvement in doctoral schools, development of professional doctorates with clear criteria for advancement, and tailored study programmes for those in the workforce (part-time/summer courses). Innovative instruments to capitalise on the unique production and design knowledge of multinational enterprises by way of government-sponsored and university-led on-the-job-training schemes on the premises of multinational subsidiaries can also be explored (the example of Singapore may be useful, see OECD (2007a, p. 179-182).

A gradual expansion of doctoral education, e.g. through the establishment of doctoral schools, should be considered, not least because it would set the basis, in terms of human resources, for a comprehensive long-term upgrading of research capacities. In addition, the training of young researchers can be directly linked to and made dependent upon the use of Structural Funds for research infrastructure and competence centres. PhD students and postdocs are the preferred candidates for collaborative projects funded from European programmes, in particular the follow-up to the FP, Horizon 2020.

Each HEI has to develop and project a profile that distinguishes it from others. This should be a continuous exercise. It involves identifying or developing key strengths, including a clear mission with respect to its regional role which allows it to position itself in national and international settings (south-eastern Europe, the EU, the world). The goal is not to reiterate what all universities are doing in some form or other, but to show the individual character of each university. It may focus on multilingual instruction to help

attract international students, on a small number of disciplines (e.g. engineering, the life sciences, or social science) or contrarily polyvalence and interdisciplinarity, on world-class research or on the employability of graduates. Such an exercise can facilitate decisions for major investments (e.g. by the Structural Funds), but also for setting internal priorities.

The long-term evolution of higher education research will hinge on the extent to which universities develop an outward-looking (European and increasingly global) orientation and aspirations. Science is a global effort and if universities are to shift the frontier they must increasingly converse and participate in the global scientific community. Even though Croatia is a small country there remains considerable room for further internationalisation in terms of funding, collaboration, recruitment, mobility and evaluation. To attract excellent academic faculty irrespective of origin may require adequate incentives and attractive career paths, the introduction of multilingual instruction, especially at postgraduate level, or a comprehensive national strategy for internationalisation, which is also reflected in the missions of HEI.

Looking at the history of recent reforms in the higher education sector, one of the lessons is the important role of an external stimulus and related reference systems. One was the adoption of the Bologna process in 2003 and it is now accession to the EU and therefore access to Structural Funds. This is a large amount of money (several hundreds of millions of EUR), which can be used for strategic investments and for general expansion of research capacities. Learning to plan, implement, operate and use these investments is far from trivial. It can take time to ensure a high rate of absorption of the funds and to ensure effective investments (see Chapter 4, section 4.4). In addition, the transition can be used to launch reforms, in particular to deal with systemic problems in the higher education sector: the overdue move to performance-based budgeting and increased research capacity. More generally, in charting the long-term path of higher education, care should be taken to avoid short-term stop-gap measures. Rather, each policy initiative should form part of a carefully designed strategic plan, with a long-term, all-of-the-system perspective.

3.3. Public research institutes

A basic characterisation of PRIs

Croatia's PRIs are very diverse. In terms of legal status, ownership and funding, the core group is composed of organisations managed by MSES and listed in the Register of Scientific Organisations. A more extended group, which is not necessarily part of the government sector, derives a substantial proportion of its income from public procurement and fulfils important public missions[8] (Tables 3.22 and 3.23). The latter organisations are frequently attached to business, cultural, health and state institutions (often as a combination of research and service providers) and many operate as legally and financially independent entities, sometimes as non-profit organisations (e.g. Energy Institute Hrvoje Pozar).

The variety of organisational configurations and missions owes a great deal to the roots and historical evolution of these entities. Some institutes were established at the University of Zagreb and the Croatian Academy of Arts and Sciences (and were subsequently separated), and some were founded as independent institutions. The institutes differ in terms of target groups and activities, such as involvement in state-sponsored or industry-related projects, internationalisation of research activities, or staff participation in teaching activities. The transition period (after 1990) led to the privatisation of institutes with a certain commercial potential. For example the Civil Engineering Institute of Croatia developed into one of the leading civil engineering companies in the region.

Most of the institutes, however, remained public and tried to adapt to the changing circumstances, with the weakening, and even severance, of links with former industrial partners that had often lost markets, downsized and underwent delays in the introduction of new technology. Moreover, co-operation between PRIs and HEIs was at best sporadic. Despite some joint projects and the participation of researchers in university teaching, linkages between them have been somewhat neglected.

In terms of the distribution of capacities by primary field of research, both the core and the extended sector range widely (Tables 3.20 and 3.21). While the social sciences (including economics) and the humanities appear over-represented in the core group, the distribution is more balanced when the extended group is included. In the core group, agriculture, fisheries and veterinary medicine lead, in terms both of number of organisations and number of staff, while engineering leads when the extended group is included. Institutes that remain under direct government control are predominantly linked to support for policy making.

Table 3.20. PRIs in the MSES Register of Scientific Organisations (core), by field of research

PRIs in MSES's Register of Scientific Organisations (core)	No. staff	Engineering	Health	Agriculture, fishery, vet. med.	Life Sciences	Physics	Chemistry	Mathematics	Geo-Sciences	Social sciences	Economics	Humanities	Arts
Croatian Geological Survey	100								1				
Croatian Institute of History	61											1	
Croatian Veterinary Institute	240			1									
Forest Research Institute	61			1									
Institute for Adriatic Crops and Karst Reclamation	52			1									
Institute for Anthropological Research	37											1	
Institute for International Relations	43									1			
Institute for Medical Research and Occupational Health	157		1										
Institute for Migration and Ethnic Studies	32									1			
Institute for Social Research	40									1			
Institute for Tourism	22									1			
Institute of Agriculture and Tourism	45			1							1		
Institute of Archaeology	28											1	
Institute of Art History	37											1	
Institute of Croatian Language and Linguistics	62											1	
Institute of Ethnology and Folklore Research	35											1	
Institute of Oceanography and Fisheries	99			1									

.../...

Table 3.20. PRIs in the MSES Register of Scientific Organisations (core), by field of research *(continued)*

PRIs in MSES's Register of Scientific Organisations (core)	No. staff	Engineering	Health	Agriculture, fishery, vet. med.	Life Sciences	Physics	Chemistry	Mathematics	Geo-Sciences	Social sciences	Economics	Humanities	Arts
Institute of Philosophy	26											1	
Institute of Physics	85					1							
Institute of Public Finance	21										1		
IVO PILAR Institute of Social Sciences	118									1	1		
Old Church Slavonic Institute	25											1	
Rudjer Boskovic Institute	870	1	1		1	1	1		1				
The Institute of Economics	45										1		
Agriculture Institute, Osijek	74			1									
Total Register of Scientific Organisations	2415	1	2	6	1	2	1	0	2	5	4	8	0
Share of staff (fractional by field)		6%	13%	23%	6%	10%	6%	0%	10%	8%	6%	13%	0%

Sources: Euraxess and websites of respective organisations (as of March-April 2013).

Table 3.21. Scientific institutes not in the MSES Register of Scientific Organisations (extended), by field of research

Scientific institutes not in MSES' Register of Scientific Organisations (extended)	No. staff	Engineering	Health	Agriculture, fishery, vet. med.	Life Sciences	Physics	Chemistry	Mathematics	Geo-Sciences	Social sciences	Economics	Humanities	Arts
Brodarski Institute	170	1											
Civil Engineering Institute of Croatia	1174	1											
Croatian Institute for Brain Research	n/a		1										
Croatian National Institute of Public Health	n/a		1										
Energy Institute Hrvoje Pozar	70	1											
Hydrographic Institute of the Republic of Croatia	n/a								1				
Institute for Public Health Zagreb	n/a		1										
Croatian Centre for Agriculture, Food and Rural Affairs	156			1									
Institute of Transportation and Communication	80	1											
KONCAR - Electrical Engineering Institute Inc.	172	1											
Mediterranean Institute for Life Sciences	n/a				1								

.../...

Table 3.21. Scientific institutes not in the MSES Register of Scientific Organisations (extended), by field of research *(continued)*

Scientific institutes not in MSES' Register of Scientific Organisations (extended)	No. staff	Engineering	Health	Agriculture, fishery, vet. med.	Life Sciences	Physics	Chemistry	Mathematics	Geo-Sciences	Social sciences	Economics	Humanities	Arts
Meteorological and Hydrological Service	440								1				
Miroslav Krleza Lexicographic Institute	n/a											1	
The Political Science Research Centre	n/a									1			
The Zagreb Institute for Breeding and Production of Field Crops	18			1									
University Computing Centre, University of Zagreb	n/a	1											
Vukovar Institute for Peace Research and Education	n/a									1			
Croatian Academy of Sciences and Arts	168	1	1			1	1	1		1		1	1
Total, core and extended (excl. n/a)	*4863*	*8*	*6*	*8*	*2*	*3*	*2*	*1*	*4*	*8*	*4*	*10*	*1*
Share of staff, core and extended (fractional)		*38%*	*7%*	*15%*	*3%*	*5%*	*3%*	*0%*	*14%*	*4%*	*3%*	*7%*	*0%*

Sources: Euraxess and websites of respective organisations (as of March-April 2013).

Special mention should be made of two organisations, the Ruđer Bošković Institute (RBI) and the Croatian Academy of Science and Arts, in light of their long history and prominence. RBI is regarded as Croatia's leading scientific institute; its research includes theoretical and experimental physics, physics and materials chemistry, electronics, physical chemistry, organic chemistry and biochemistry, molecular biology and medicine, the sea and the environment, information and computer sciences, and laser and nuclear R&D. RBI is significantly involved in the training of young researchers. According to RBI (2010), at the end of 2009, it had a total of 887 employees, of whom 308 were scientists, 68 postdoctoral researchers, 172 PhD students, and 112 support scientists and technicians. In 2009, RBI scientists published a total of 559 research articles, a majority of them in high-ranking international journals. In the same year, two patents arising from its work were granted, one by the European Patent Office (EPO) and one by the United States Patent and Trademark Office (USPTO). In addition, also in 2009, Ruđer Innovations applied for six patents on behalf of the RBI. RBI also acts as a hub for international research infrastructures such as CERN or EMBO and is Croatia's most active participant in FP7 projects.

The Croatian Academy of Science and Arts has a special status defined by the Croatian Academy of Sciences and Arts Act. It is smaller than RBI in terms of staff but is the most interdisciplinary of the PRIs and its research spans the technical, natural and human/social sciences. Its main tasks include the promotion and organisation of scientific research, the development of artistic and cultural activities, and the protection and affirmation of Croatia's cultural heritage. Fellows of the Academy are organised into nine

departments. The Academy also has 30 scientific councils and committees, and smaller research units (institutes). However, owing to the traditionally decentralised nature of the research system, the role of the Academy in research has been more limited than in many other eastern European countries.

Research funding and performance in the public research sector

The government research-performing sector is of roughly the same size as that of the higher education sector. In 2010 it accounted for 27% of GERD and 0.20% of GDP; the figures for the higher education sector were 28% and 0.21%, respectively (Table 3.22). In terms of sources of funding, PRIs have a slightly higher share and a slightly larger amount of government funding than the higher education sector: EUR 74.57 million (84.2%) versus EUR 72.73 million (80.1%). A small 4.7% of government R&D is funded by the business sector, less than half of the 10% attracted by the higher education sector. In comparison, industry funding of government-performed research in 2010 was 4.7% in the Czech Republic, around 10% in Finland, around 13% in Slovenia, Hungary and the Slovak Republic; the EU27 average in 2009 was 8.8%, (OECD, 2012b, p. 74).

Table 3.22. Sources of funding for R&D, all sectors, 2010

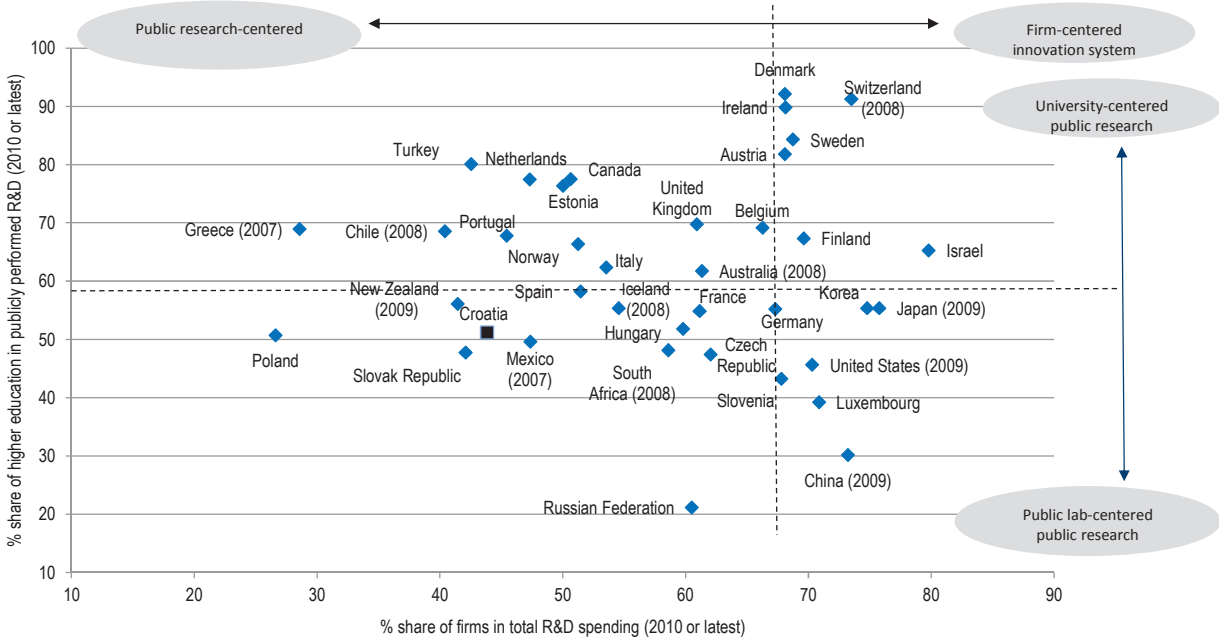
EUR thousands

Performing sectors	Own resources	Central and local government	Private and public enterprises	Non-profit institutions	Foreign investors	Total % of total
Total	10 877	153 103	27 436	629	32 927	322 872
%	33.8%	47.6%	8 5%	0.2%	9.9%	100%
Business sector	97 486	5 587	14 203	26	24 612	141 914
%	68.7%	3.9%	10%	0.1%	17.3%	44%
Government sector	5 090	74 570	4 177	381	4 367	88 585
%	5.8%	84.2%	4.7%	0.4%	4.9%	27%
Non-profit sector	16	215			250	481
%	3.4%	44.7%			51.9%	0.1%
Higher education sector	6 316	72 731	8 793	221	2 513	90 574
%	6.9%	80.1%	10%	0.2%	2.8%	28%

Source: Croatian Bureau of Statistics (2012c), "Research and Development, 2010. Statistical Report 1474", Zagreb. p. 14.

As in other new EU member states, a large share of public-sector research is performed by the government sector. The dominance of the public sector in these countries is mainly due to the traditional separation of higher education and research. In common with the trend in OECD countries, however, the balance is shifting from PRI-performed research towards university-performed research (Figure 3.7). Croatia occupies a middle position, with about half of public research performed in PRIs and the other half in universities. In this respect it is similar to the Czech Republic, Hungary, the Slovak Republic and Slovenia. However, in contrast to Croatia, the Slovak Republic and Poland, most of these countries' total R&D activity is performed by firms. OECD countries with developed innovation systems tend to have a small share of publicly performed research, with universities performing more than PRIs.

Figure 3.7. Share of R&D expenditures in firms, higher education and public research institutes, 2010



Source: OECD, Main Science and Technology Indicators; Eurostat.

In absolute terms, R&D expenditure in the government sector was on an upward trend for much of the past decade but the trend was reversed in 2009 (Figure 3.8). The distribution of R&D costs is similar to the distribution in the higher education sector, although with proportionately smaller capital costs. The expansion of 2005-08 was driven primarily by labour costs and other current costs.

While R&D personnel in the government sector seem better endowed with resources than their higher education counterparts (by about PPS EUR 5 000 annually in FTE terms), an international comparison highlights their resource constraints (Table 3.23). Among comparable countries, only government R&D personnel in Hungary were worse endowed in 2011, and Croatia's R&D personnel lagged the Slovak Republic, the least well-endowed of the other countries, by about PPS EUR 7 000 in FTE.

Figure 3.8. Government R&D expenditure by type of cost

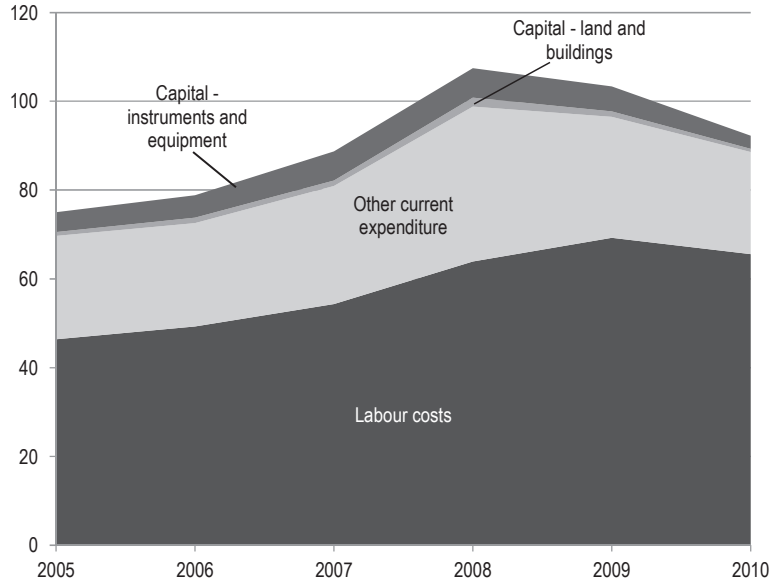


Table 3.23. R&D funding per R&D personnel (FTE) in the government sector

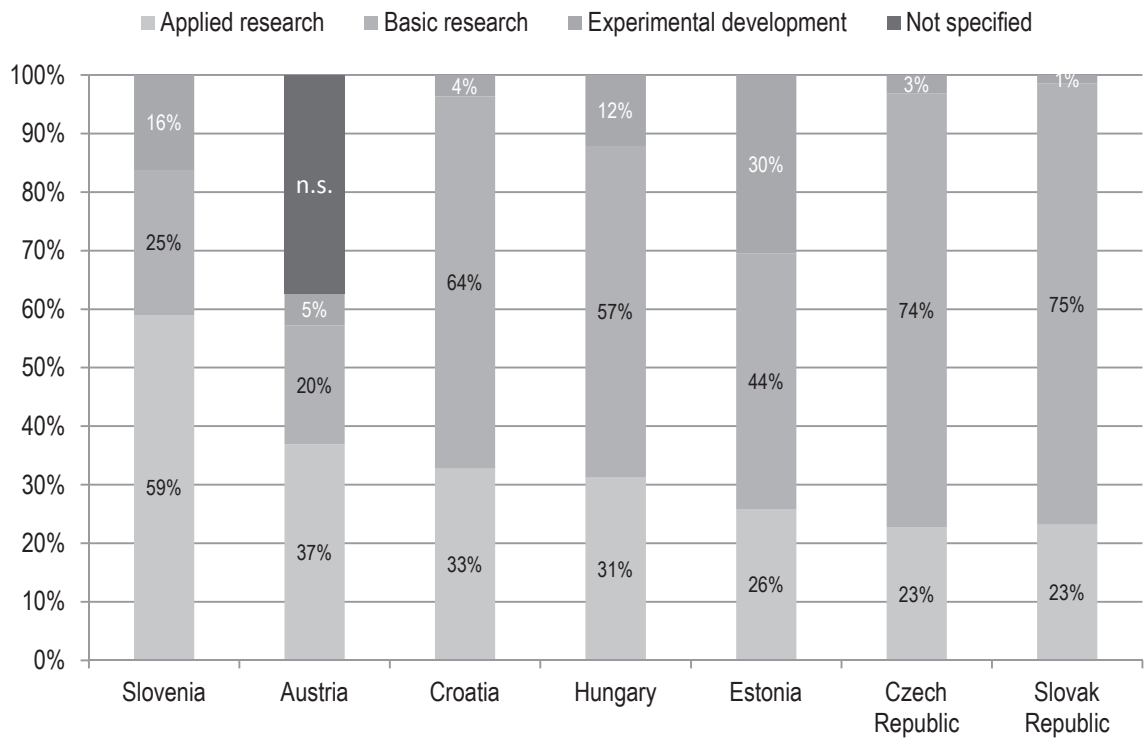
PPS EUR at 2000 prices

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Czech Republic	52 579	53 226	55 762	43 397	45 450	52 251	51 165	53 206	53 503	44 433
Estonia	20 417	20 931	21 353	25 072	37 933	23 543	38 064	35 563	37 185	45 530
Hungary	47 127	44 405	42 531	44 646	41 936	40 768	39 576	35 979	33 661	29 230
Austria	121 133		120 676	120 859	119 316	126 714	125 540	123 795	124 458	123 033
Poland	38 461	39 060	43 617	47 164	50 623	53 398	57 055	62 291	67 345	66 480
Slovenia	48 246	56 043	55 056	50 091	51 578	46 937	47 255	46 127	48 124	53 548
Slovak Republic	22 160	27 580	27 450	26 393	30 310	30 258	30 610	32 589	35 746	38 829
Finland	56 790	55 652	56 890	58 862	60 203	58 025	60 578	70 017	72 273	68 482
Croatia	32 224	31 138	30 147	34 487	34 247	35 247	39 644	34 679	30 650	30 694

Source: Eurostat (2013), Statistics Database.

In terms of the distribution between basic, applied and experimental research, the government sector conducts a relatively large share of basic research, as in the Slovak Republic, the Czech Republic and Hungary (Figure 3.9), whereas in EU members with developed innovation systems it carries out a larger share of applied research and experimental development. The dominance of basic research in the government sector contrasts with the substantial share of applied research and experimental development in the higher education sector; both patterns are exceptional in international comparisons. In the HEIs, the increasing share of market-oriented research could arguably be compatible with (and may even be a reflection of) an increasing alignment with the needs of business. It may however be a type of research that universities, not just in Croatia but everywhere, are less well prepared to deliver than PRIs. In the case of the government sector the dominance of basic research arguably corresponds to a persistent adherence to the traditional mission of PRIs.

Figure 3.9. Share of GOVERD by type of research, 2010



Note: 2009 for Austria.

Source: Eurostat (2013), Statistics Database.

Table 3.24. Publications by sector, 2010

	Total	Total (%)	Own	Others in country	Foreign	Foreign (%)
Business sector	849	8	562	192	95	2
Government sector	3 371	32	997	1 080	1 294	33
Higher education	6 161	59	1 400	2 196	2 565	65
Sectors - total	10 381	100	2 959	3 468	3 954	100

Source: Croatian Bureau of Statistics (2012b), Masters and Specailists, 2011", First Release no. 8.1.5, p. 34, www.dzs.hr/Hrv_Eng/publication/2012/08-01-05_01_2012.htm, accessed April 2012.

The government and higher education sectors are evenly matched in terms of the overall amount of R&D funding and also share a similar governance framework (see below). However, the government sector devotes twice as many resources to basic R&D, relies even less on business funding and possesses a higher resource endowment per FTE R&D personnel. This might suggest stronger performance in terms of scientific publications, yet the government sector's performance in this respect lags considerably that of the HEIs (Table 3.24). The government sector's scientific output is smaller by a factor of two in foreign publications and by a factor of 1.8 overall. However, the observable performance deficit of the PRIs is likely affected, first, by differences in numbers of individual researchers in the two sectors, which implies that PRIs are potentially missing

efficiency gains from collaboration: although overall human resources in terms of FTE are similar, according to Eurostat, in 2010 the government sector employed 3 123 researchers and the higher education sector employed 8 003 (headcounts). Second, observable performance may be lower due to the national character of the research performed in PRIs, which may not be of interest to an international audience. The lower degree of internationalisation in PRIs versus HEI, is compatible with this explanation (Table 3.26), however it accounts for only a small part of the difference in the performance deficit, as HEI are 1.7 times more prolific in national publications too. Third, and more importantly, the share of contract research performed by PRIs may be underestimated, as an unspecified part of their activity – insofar as it is not captured by formal R&D statistics – accounts for the provision of services to other parts of government[9]. This is in fact typical of PRIs across countries, and probably accounts for a substantial portion of the difference in performance.

Nevertheless, it is likely that the publication shortfall also reflects genuine efficiency problems[10] stemming from the governance and internal organisation of the sector as a whole, as well as the stimuli it receives from the external environment (the small share of competitive funding as a share of their budgets and the lack of internationalisation).

In terms of patenting, instead, PRIs perform much better than HEIs. In 2010 PRIs applied for 26 patents in Croatia and 8 abroad (versus 13 and 5 for HEIs, respectively). In the same year, two patents were granted in Croatia and one abroad (but none for HEIs). Although the absolute numbers of filed or granted patents are low by international standards, they have improved over time. However, given the PRIs' focus on basic research, this performance is promising and suggests a strategic focus on patenting in recent years.

This performance needs to be placed in the wider context of the functions of patenting in a public research setting. For PRIs and universities, patents are generally a means to ends such as the accumulation of market-relevant knowledge and capabilities and therefore of credibility in negotiations with industry or when applying for grants. In such a setting, income is a secondary consideration and is more likely to come from follow-on contracts than from licensing. Given the recent progress in patenting, it is reasonable to expect PRIs to capitalise on their new credentials through greater interaction with industry. Currently, as mentioned, the share of business contracts in PRIs' income (4.7%) is significantly below that of the higher education sector (10.0%).

The pattern is similar for PRI performance in FP7. While the higher education sector attracted EUR 11.26 million, the public research sector obtained EUR 4.85 million (EC, 2011b), of which the RBI accounted for EUR 2.99 million from 11 participations. Therefore, despite the close alignment of the sector's thematic profile with FP priorities, the government sector (RBI aside) attracted only EUR 1.86 million from FP7 over more than four years.

In a survey of 13 independent PRIs for the OECD Investment Compact, all respondents cited lack of funds as an important constraint on research activity, about half cited lack of personnel, and a third cited fragmentation of the research community and lack of adequate research equipment as important constraints.

Steering and funding of PRIs

PRIs share several aspects of the governance and steering of PRIs – in particular the relationship with the central government and its agencies – with the higher education sector, which have changed little in recent years. Various aspects of the configuration of Croatia's PRI system are not in line with current international good practice: the

predominance of government as a source of funding; the large share of institutional funding (and the very marginal role of competitive funding); and the lack of formal links between funding and performance (other than the minimum requirements for ASHE accreditation). As for HEIs, institutional funding is mainly determined by existing capacity; this can be an obstacle to the drastic overhaul that is periodically needed to respond to social demands. The internal management arrangements of PRIs have in fact been described as obsolete and in need of overhaul (Švarc and Račić, 2012, p. 5).

The fragmentation of PRIs takes a different form from the fragmentation of HEIs; it occurs largely between rather than within organisations. It is likely to have hindered large-scale, long-term projects, as reflected in the modest and capital investment-poor expansion of the last decade (Figure 3.10). The distribution of institutes across fields of research (Tables 3.22 and 3.23) shows a relatively large number of organisations in the humanities and social sciences as well as in engineering, health and agriculture. A multiplicity of actors in a given area can be positive inasmuch as it can foster competition, diversity of approaches and independence in the provision of scientific information. However, in the absence of either performance-based funding or of competitive project-based funding of substantial proportions the tendency to compete in terms of quality and relevance is weak. Moreover, the fragmentation of capacities among several organisations may hinder collaboration and prevent scale-critical activities. A move towards linking funding to performance and performance-based funding mechanisms would enable PRIs to pursue ambitious objectives with diversified sources of funding.

Given the wide range of disciplines and the diversity of orientations and missions, the structure of public research funding can serve as an indirect indicator of PRIs' role in the wider innovation system. Many "practical" disciplines are represented, particularly in engineering and agriculture (Brodarski Institute; KONCAR – The Electrical Engineering Institute; the Ruđer Bošković Institute to some extent; the Croatian Centre for Agriculture, Food and Rural Affairs; the Meteorological and Hydrological Service). This would suggest a substantial share of income from contract-based research and related services, especially since various measures to support PRIs' technology transfer capabilities have been implemented during the last years. There are also many entities with a more scientific orientation, which would suggest a higher share of government / institutional funding. As discussed earlier, government funding dominates in PRIs.

In fact, the strong reliance on government funding is partly a reflection of at least three main attributes of the current configuration of PRIs and their relationships with stakeholders. First, an unspecified part of the public funding of PRIs goes to the provision of services to other parts of government, and may thus be socially and economically relevant. Second, some PRIs were geared to serve industries that have declined in relative terms or been displaced by industries that make less use of PRI services. These PRIs did not adapt sufficiently to the changing environment because the steering and funding system gave them few incentives and resources to do so. Fragmentation and a mixture of budgetary unpredictability and inflexibility prevented long-term planning for skills accumulation and infrastructures. Third, the small size of the sector, its inter-organisational fragmentation and difficulty for reaching critical mass, and the strong orientation towards the provision of routine services of the public good type and of scientific evidence for public policy all limit the potential relevance to businesses.

As in the case of universities, an increase in competitive, project-based funding would help to raise the quality and relevance of PRI research. In contrast to universities, however, the poor performance of PRIs in FP7 suggests that they may be ill prepared for such a move, in part because the limited resources at their disposal are largely tied to routine service provision. A gradual but sustained transition to a more competitive funding regime would need to be accompanied by an increase in funding and capacity building.

Box 3.5. Funding and governance of public research institutes

Centres Recherche Publique (Luxembourg)

Since 2006, the four Luxembourg-based Centres Recherche Publique are governed by performance contracts (as a follow-up to a recommendation made by the *OECD Innovation Policy Review*). Every three years (from 2013, every four years), the government and the directors of the centres negotiate a small number of key performance indicators and agree on a budget. These key performance indicators are essentially number and quality of publications, PhDs completed, income from grants and income from contracts. The model is inherently static as it negotiates and determines the levels and shares of income from institutional funding, grants and contracts. Institutional funding ranges between 50% and 60%, and grants and contracts have equal shares. The essence of the performance contract can be written on a post card. The productivity of the system has improved significantly; managers and policy makers are not interested in a return to the former model.

Fraunhofer institutes (Germany)

Fraunhofer institutes' funding is equally divided among institutional funding, income from grants, and income from contracts. Its determination and the underlying model and strategic thinking, however, are tricky and less well known. It is essentially dynamic. Institutional funding is allocated on the basis of six parts and related budgeting components, calculated as follows:

1. A size-independent fixed amount of EUR 0.6 million
2. 12% of the operating costs
3. 15% of funding from EU subsidies (mainly FP)
4. 10% of income from contracts up 25% of total sales, followed by 40% to a 55% share of total sales, then again 10%
5. Internal projects
6. *Ad hoc* projects

Overall, about two-thirds of the institutional funding is determined by rules and accounts for about one-third of total income. Income from national grants is not rewarded but is substantial, not least due to the comparatively low barriers to access.

This model has contributed significantly to the dynamism and balanced development of the Fraunhofer institutes. The stability and familiarity of the model to project leaders, team leaders, heads of department and directors play an important role.

Box 3.5 provides two examples of how funding can be used to steer PRIs. Both models are simple, transparent and easy to implement. In the past, the interaction of Luxembourg's public research centres with the government was complex, with a multitude of funding schemes and a complex reporting system. Following the OECD review of Luxembourg's innovation policy (OECD, 2007b), Luxembourg implemented performance contracts and is now in the third iteration of the exercise. PRI management is now widely familiar with the functioning and implications of performance contracts.

Underlying the performance contracts is a negotiated formula that determines budgets and related outcomes. The steering of the German Fraunhofer Institutes does not entail specified outcomes but takes account of their success in the market for contracts and in European grants. The model is essentially dynamic and its effectiveness is widely recognised in the German innovation system. Both models require clear government ownership and continuing government commitment. Both models effectively determine the composition of funding.

Relations to society and stakeholders

There is considerable variation in the PRIs' view of their relations to society and stakeholders. Their mission statements state three relevant objectives: to provide scientific knowledge and other services of the public good type; to serve the business sector with contracts and other formal transactions; and to provide scientific evidence for public policy. Some PRIs perform mainly scientific research; others have a mixed portfolio that includes applied research and services particularly relevant to the business sector. Most, however, have a portfolio that is primarily shaped by the need for scientific evidence for policy making, such as public health, food safety, meteorology and hydrology, international relations, economics and public finance.

The scientific institutes are mainly justified by the need for a high degree of continuity in topics that are nationally sensitive, such as the study of Croatia's cultural heritage. They deal with subjects that cannot be transferred to universities, as they need stability, long-term orientation and accumulation of knowledge that universities may not be able to ensure. The humanities are a particular area of focus. These institutes are largely dependent on institutional funding; additional income from research grants mainly serves the purpose of quality assurance and allows some flexibility in terms of moving into new areas.

Institutes that deal in scientific evidence for public policy are by far the dominant group. They serve the public sector's need for scientific evidence in a large variety of government-related sectors: agriculture, fisheries, veterinary medicine and food; public health, social sciences and economic studies; and public services such as meteorology, geology or hydrology. In many respects, they are on-demand research service providers for the public sector or for the general public.

The key challenge for PRIs is a proper funding portfolio mix that combines institutional funding, income from contract research and research-based services, and income from grants. While institutional funding ensures continuity, income from contract-based activities mainly serves to keep in close contact with new and changing user needs. Research grants help to keep track of advances in methods and theory and of relevant knowledge communities.

The Meteorological and Hydrological Service is a good example. It combines all three strategic elements and benefits from well-balanced interaction. The public service character of weather forecasting requires institutional funding (continuity, independence, compliance with international contractual commitments). It has specialised services for customers (sea transport, fisheries) that will pay for advanced and tailored services that cannot be funded from the public budget. Grants serve mainly to develop methods, models and services further and to collaborate, particularly at international level.

A classification of each of the PRIs in Tables 3.22 and 3.23 into one or more of the above mission types permits a crude assessment of the distribution of capacities across the sector. Staff are divided relatively equally among the three types of mission. The even distribution of mission objectives is in keeping with the strong prevalence of government funding and the moderate interactions with the scientific community and the business sector.

The official websites for PRIs listed in Tables 3.22 and 3.23 reveal that over 50% (24 out of 43) have published neither an annual report nor a strategy. The situation is somewhat better for PRIs on MSES's Register of Scientific Organisation, for which only 36% (9 out of 25) did not make either document available. The absence of annual reports suggests poor accountability in general and in the extended sector in particular. Although PRIs receive 80% of their funding from public sources, they neither provide evidence about their past achievements nor do they present a strategy for the future.

Increasing the contribution of PRIs

Improving the interaction between HEIs and PRIs and between them and the economic and public environment has been on the policy agenda for at least ten years. Following international practice, a number of measures were implemented with the help of the European Commission (IPA IIIc) and the World Bank (Science and Technology Project). The focus has been on specialised infrastructures for technology transfer and incubation. In recent years, technology transfer offices (TTOs) were established across Croatia, at the universities of Zagreb, Split, Rijeka and Osijek and a similar effort at the Ruđer Bošković Institute.

Following the rejection of the laws on science, universities and higher education (see Box 3.3), MSES issued an amended version, which the academic community refused but the public institutes supported (METRIS, 2011, p. 7). This indicates at least a general openness to change in the public research sector. Among the key aims of future policy would be better accountability and performance; the ability to plan strategically and pool resources; integration into the wider innovation system; increased relevance to industry; and increased internationalisation.

As in the case of HEIs, the transition to a performance-based budgeting would be a precondition of greater autonomy. Procedurally would be quite simple to implement. In the first instance, the institutes would be invited to propose a list of outcomes or achievements and a corresponding multi-annual budget that includes all expenditures (salaries, overheads, investments). This proposal would form the basis for negotiations between representatives of the PRI and the government (see the Luxembourg model, Box 3.5). The PRI management should have a great deal of flexibility to use the funding, e.g. to increase the number of staff, increase salaries or make a larger investment in equipment or building. Negotiated performance contracts need not be straightjackets; they can allow for considerable customisation to the individual profile and long-term strategy of each institute. As noted above, however, it takes two to three iterations to learn the new system and to internalise the increased autonomy and responsibility for results.

Use of performance metrics needs to be coupled with an awareness of their limitations, however. Policy makers and PRI managers need to understand that indicators are not the same thing as the "true" quantity they are intended to proxy (whether performance or excellence). Additional sources of evidence and expert opinion (e.g. peer reviews) are needed in research assessment exercises, particularly at low levels of aggregation (institutes or research teams).

In addition to the considerable attention to and investments in "interface" measures, such as incubators and technology transfer offices, concerted efforts are needed in the direction of building capacity across all sectors. This entails, first and foremost, a sustained increase in the scale of resources for their core R&D and innovation activities as may legitimised by changes in governance and funding mechanisms. The Structural Funds offer the opportunity to accelerate this process even further. Capacity building may also be achieved via joint projects and the delivery of services between research providers (PRIs and HEIs) and research users (companies, public institutions) and the matching of requirements with solutions. PRIs should also partner with specialised agencies, such as Croatian Waters, the Croatian Food Agency, the Croatian Environment Agency, the Croatian Energy Agency, or the Croatian Agricultural Agency, and especially the Croatian Competition Agency. These agencies are often responsible for designing or implementing policies and need various kinds of help. PRIs can act as preferred partners for providing scientific support and obtain access to potential clients or partners.

Building capacity should include not only collaboration on joint projects but also consultancy, training or use of technical facilities. Synergies should be sought between contract research, consultancy, training of young researchers, creation of spin-offs, patenting. Both sides play an important role: while the research partners are better at providing solutions, companies or public institutions have a better awareness and knowledge of challenges, needs and requirements. Overall, it is about community building; single, one-off collaborations rarely pay off. The challenge is to find the right mix of type and level of performance.

The availability of EU Structural Funds is a historic opportunity. The use of Structural Funds for large-scale investments in research facilities will provide an opportunity to pioneer and support the implementation of performance-based budgeting and help achieve these goals. This will require more deliberate policy ownership and will give policy institutions (the ministries and their agencies) clearer roles. Coupled with a substantial rise in regular funding, the SF would make possible the establishment of various instruments and programmes to link PRIs, HEIs and the private and public sectors in their role as research users. Possible initiatives include:

- The establishment of joint PRI-HEI research facilities[11] with a clear profile and a range of research and research-based services for well-defined and well-understood target groups. This can be used as an opportunity to merge existing institutions (as has occurred in agricultural research through the merger of the Institute for Pomology, the Institute for Soil, the Institute for Plant Protection in Agriculture and Forestry, the Croatian Institute for Viticulture and Oenology, the Institute for Seeds and Seedlings, and the Station for Southern Cultivars Dubrovnik into the Croatian Centre for Agriculture, Food and Rural Affairs in 2009).
- The set-up of funding and consultancy services to contribute to community building between research producers and research users, particularly between PRIs and the business sector but also the public sector. These schemes should take into account the various types of interactions between PRIs and private and public users; they should focus not solely on research collaboration but also on consultancy, research-based services, training and wider skills development. Given the size of PRIs and their wide thematic coverage, low-threshold schemes such as innovation vouchers should be a high priority. Measures ranging from *ad hoc* collaborations on projects to long-term, strategically oriented research

partnerships should also be considered. They should aim not only, or even primarily, at advanced research content but also at proper management and appropriation of the collaboration and its results. Various kinds of intermediaries can and should help to set up such consortia, keep them productive and ensure sustainability.

Notes

1. Innovation is essentially about the introduction of economically useful novelty. The ability of companies to introduce such novelty hinges on distinct but highly complementary capacities. The capacity to adopt knowledge and technology originating outside the firm and adapt them to the firm's needs depends on the qualities of its workforce and of its organisation as well as on the ability and willingness of management to mobilise resources for investment. The systematic search for ideas and the development of products, services or forms of organisation which are new to the national, and especially, the global market usually calls for additional capacities in the form of formal research and development activity.

2. Croatia occupies the last position in the comparator group in the share of 25-64 olds participating in education and training (Figure 2.9).

3. ICT specialists are workers with the ability to develop, operate and maintain ICT systems. ICTs constitute the main part of their job (OECD, 2012, p. 14).

4. Croatia lags all countries in the comparator group with respect to the rate of employment of tertiary educated (ISCED 5 and 6). In addition, Croatia's share of employment in knowledge intensive sectors is low (Figure 2.6 in Chapter 2), behind most countries in the comparator group except Poland.

5. The purchasing power standard (PPS) is the name given by Eurostat to the artificial currency unit in which the purchasing power parities and real final expenditures for the EU are expressed. It is widely used to perform cross-country comparisons.

6. Interestingly, an econometric analysis of CIS data from 2001-03 by Aralica et al. (2008) finds that firm size was negatively associated with the share of sales revenue due to innovation. This counter-intuitive finding may be a reflection of the dynamism of the markets of large Croatian firms and of aspects of their international organisation.

7. There are some signs that such arrangements are being put in place. In 2011 ASHE prepared and co-ordinated two sessions of the Interdepartmental Working Body for Labour Market Monitoring tasked with examining and responding to labour market needs. The Agency for Vocational Education and Training and Adult Education is organising sector skills councils where skills gaps are discussed with employers, based on surveys (for more information see the forthcoming OECD Investment Compact study *Implementing Skills Gaps Analysis in the Western Balkans*).

8. According to the Croatian Bureau of Statistics (2012c, p. 8): "Government sector comprises institutions and other bodies that offer gratis common services to the community (except higher education) that otherwise, respecting market conditions cannot be secured, and which administer the economic and social policy of a community. Public enterprises are included in the business sector". In addition to the 25 organisations included in the Register of Scientific Organisations of the MSES, the Croatian Euraxess Portal lists 43 institutions (Euraxess, 2013) and the Croatian Bureau of Statistics accounted for 55 entities in 2010 (Croatian Bureau of Statistics, 2012c, p. 9).

9. A potential fourth factor is disciplinary specialisation. It is a well-established fact in bibliometrics that not all disciplines and fields of research publish at the same rate. For instance, the social sciences and especially the humanities have typically lower publication rates per researcher than the natural sciences and also tend to publish in a greater variety of outlets (e.g. books and monographs) than solely journal articles. PRIs and HEIs in Croatia share a strong slant towards the social sciences and the humanities, so the influence of this factor is likely marginal.

10. Comparative evidence on the quality of publications (e.g. based on citations) from the HEI and PRI sectors could be suggestive, but was not available at the time of the review.

11. The Czech Republic has chosen this option as their main priority (www.msmt.cz/areas-of-work/research-and-development-for-innovations-operational?lang=2, Ohler et al., 2011).

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Chapter 4

The role of government

The first section outlines the evolution of Croatia's post-independence innovation policy, from the transition period, the period of building infrastructure and initial transfer of approaches and solutions from more advanced countries, the 2000s up to the crisis which saw a move towards an articulated innovation policy and attempts to strategic planning, and the following phase lasting up to the present which was strongly shaped by preparations for EU accession. The second section describes the overall configuration and main actors of the STI governance system – primarily ministries, councils and agencies –with their respective roles. The next section discusses the innovation policy mix currently in place in Croatia, dealing with resource transfers in the form of direct public support and tax incentives for R&D and innovation, and the transfer of authority and institutional reconfigurations associated with an ongoing process of delegation of tasks and competences. The potential role of regulation and public procurement is also discussed. The fourth section focuses on international sources of funding for innovation which has played an important role in the past decade and is set to increase further in the wake of Croatia's recent accession to the EU, with full access to Structural Funds in addition to the already established full participation in the Framework Programmes. The final section summarises some major results of the review by discussing strategic tasks of Croatia's innovation policy from a functional assessment perspective.

4.1. The evolution of Croatia's science, technology and innovation policy[1]

The first phase (1991-93): economic downturn, transition to a market economy, privatisation, survival of a traditional science system

Immediately after independence, economic recovery, institution building and transition to a market-based economy, including privatisation and restructuring, were the major economic challenges. Particular problems arose from the combined effect of the economic downturn, the discontinuation of supplier-customer and innovation linkages, and a troublesome privatisation process, with severe consequences for the manufacturing industry (which had been a pillar of the Croatian economy) in terms of decline of incentives and capabilities for innovation. Public investment was mainly directed toward physical, and in particular road, infrastructure (Aralica and Redžepagić, 2012).

Science, technology and innovation (STI) policy was mainly understood as science policy: state-organised and state-budget-supported science aimed at extending the frontiers of knowledge. The scientific community, dominated by established interests, adopted an "ivory tower" approach in its relations with society; this had both positive and negative effects on the evolution of the system (Švarc, 2006, p. 152). The positive effect, and an important achievement, was the preservation of the academic community and related institutions, competences, equipment and skills. However, this approach had serious drawbacks, as it hampered recognising innovation and technological change as the driving force of economic growth, the roles of applied science and technology and of the interaction of science and industry (Švarc, 2006).

The second phase (1994-2000): building the infrastructure, transfer of ad hoc solutions from advanced innovation systems

The beginning of the second phase was marked by the first attempts to transfer methods and know-how from advanced innovation systems to Croatia, as the idea of a more comprehensive and systematic handling of STI matters gained ground. In 1994, the first steps were taken by transferring "best practices" from abroad, in particular from Germany and Italy, with a focus on science-industry co-operation and financial support for technology-based small and medium-sized enterprises (SMEs). Special attention was paid to knowledge and technology transfer from higher education institutions (HEIs) and public research institutes (PRIs) through the establishment of incubators, support of new technology-based firms, contract research, and the establishment of research labs. An agency was also established to implement functions formerly carried out by the ministry.

These actions led two years later to the National Scientific and Research Programme 1996–1998. Although the programme's name made no reference to "technology" or "innovation", it was used by the Ministry of Science and Technology (MoST) to implement two framework programmes that shaped the future of the innovation system (Švarc, 2006, p. 153). The first dealt with the establishment of a national network of institutions for the development, transfer, implementation and financing of new technologies. The second stressed the importance of government support measures for innovation and technology-based business. They were the source of several follow-up programmes and initiatives, such as the establishment of business innovation and technology centres, viewed as "interface institutions" between universities/public research and industry, with supporting institutions to assist companies through their start-up and expansion phases. In terms of building innovation *policy*, the centres were

expected to become reference points for future international and regional programmes (e.g. PHARE, INTERREG). However, while they were seriously considered at the time, the centres never materialised.

Between 1996 and 1998, three technology centres based in major cities and university centres were established and supported: the Centre of Technology Transfer, CTT, in Zagreb; the Technology Centre Split, TCS; and the Technology-Innovation Centre of Rijeka, TIC. All aimed to establish links between public-sector research and the private sector and to "develop innovation, know-how, technology, prototypes and to market preliminary products in as short a time span as possible" (ZSI, 2011).

In 1999, collaboration and transfer of know-how from Italy resulted in the establishment of Business Innovation Centre of Croatia (BICRO), with programming and implementation functions. It was the first operationally independent agency of its kind. BICRO's mission was to devise and implement financial models and instruments to support innovative or research-based entrepreneurship. At the same time, and much more important for the evolution of Croatia's innovation policy and innovation system, this was an opportunity to collect valuable practical experience and to learn about and assimilate new ideas about innovation management and policy delivery. It helped to build up and secure the human capital and networks formed by a core group of technology centre managers and relevant civil service officials. The decision to focus on technology transfer, interfaces, technology-based firms and start-ups was largely determined by a contemporary international drive to transfer best practices without much concern about their suitability to national settings (Tödtling and Trippl, 2005) and had a formative influence on the future policy trajectory.

The third phase (2001-08): towards an articulated innovation policy – HITRA, STP and attempts at strategic planning

The third phase in the development of innovation policy played a critical role in the evolution and shaping of the Croatian innovation system. In 2001, MoST established the Ministry of Crafts and Small and Medium Sized Enterprises (MOMSP) and HITRA, the Croatian Programme for Innovative Technological Development. These initiatives reflected a political intention to launch innovation and entrepreneurship.

The establishment of MOMSP signalled recognition of the need for an innovation policy in addition to science and research policy. HITRA was the first public policy programme to treat the national innovation system as a complex dynamic structure. Its main task was ambitiously defined: to restructure the wider R&D sector to meet the requirements of the knowledge economy. An increase in business R&D activities was perceived as a vital aspect of structural adaptation, and three activities were identified as core parts of HITRA: i) revitalisation of industrial R&D; ii) fostering science–industry co-operation; and iii) commercialisation of research results (Švarc, 2006).

As HITRA's aim was system-wide, it implicitly called for a change in the policy system, with co-operation across departmental boundaries and the alignment of departments' actions, not least through changes in legal and financial arrangements. To deal with potential frictions, an Inter-ministerial Control Group was established in 2001 to supervise HITRA's financial operations but also to be a "forum" for reaching consensus on conflicting policy issues. However, the Control Group never became fully operational. In the end, HITRA was forced to respect ministry borders and confined its policy measures and programmes to projects and companies that engaged in co-operation with the public R&D sector. It therefore became a programme targeting the clientele of

MoST: universities and PRIs, and its scope narrowed to the commercialisation of research results and stimulation of co-operation between companies and the public research sector (Švarc, 2006).

On this basis, HITRA established *de facto* a dominant policy design in the Croatian innovation policy community, and performed quite well within this narrow conceptual and institutional framework. However, this left vital areas of the innovation system unaddressed: the accumulation of R&D and innovation capacities in industry and related policies, such as intellectual property rights (IPRs), specialised financial instruments, science–industry researcher mobility, and the availability of qualified human resources.

Following HITRA's decline from a comprehensive to a rather narrowly defined programme, the World Bank's Science and Technology Project (2005-11) (STP) provided much needed funding and critical policy design support. STP was associated with more sophisticated support and with a push towards further delegation to operationally independent implementation agencies. As reported by the World Bank (2012), the project enabled R&D institutions to commercialise their research outputs and increased the ability of enterprises to develop, use and adapt technology by correcting the weaknesses of programmes to finance business R&D. Its main beneficiaries were the Ministry of Science, Education and Sports (MSES), two PRIs – Brodarski Institute Ltd and Ruđer Bošković Institute (RBI) – and the universities of Zagreb and Rijeka. The emergence of BICRO, founded some years earlier, as a central policy implementation agency was an important development during this period. MSES benefited from BICRO's development and implementation of innovation programmes and the implementation of the Unity through Knowledge Fund (UKF) in 2006. In terms of policy focus and the overall policy mix, the STP re-emphasised and amplified the existing focus on academia-industry interactions and the transfer of science from the public research sector to the economy.

A second stage in the evolution of the Croatian research and innovation system was the adoption in May 2006 of the Science and Technology Policy 2006-10 as Croatia's main strategic policy document. It aimed to stimulate scientific excellence and enable the transfer of knowledge and research results to the private sector in order to increase competitiveness and generate sustainable growth and productivity. Although it formally expired in 2010, no new major policy document has been adopted. A national innovation strategy is under preparation.

This phase created the foundation for further strengthening the overall STI policy infrastructure and for fostering science-industry co-operation. The Science-Technology Park in Rijeka and TERA in Osijek were established in 2007, followed by technology transfer offices at the universities and attempts to create spinoffs from PRIs (Ruđer Innovations at RBI). Greater attention was given to co-operation by the MSES and the former Ministry of Economy, Labour and Entrepreneurship (MELE). Because MELE recognised the importance of innovation for the economy, it started programmes to support investment in R&D and to develop science and business infrastructure and entrepreneurial education. These activities were included in the Programme for Supporting Small and Medium-Sized Entrepreneurship 2008-12.

While this phase commenced with the intention to move towards a comprehensive approach to research and innovation policy, this goal was not attained. Nevertheless, it had several notable achievements in terms of inter-ministerial co-ordination (MSES and MELE), delegation (BICRO and other executive agencies), and improvements in policy design and delivery. Co-operation between MSES and MELE constituted a significant step forward, at least in principle, because of its potential to address the co-ordination

failures that prevented more comprehensive treatment of innovation, especially the provision of meaningful support to the business sector. However, policy continued to focus on the public research sector, particularly its periphery.

The fourth phase (2008-present): institutional actions and plans, drawbacks and new opportunities

The current phase started in the second half of 2008 with preparations for EU accession and associated policies and plans. It has been affected by the global economic crisis and institutional funding problems. A total of more than 30 strategies and plans have been or are being developed. Most are under the responsibility of the Ministry of Economy and the Ministry of Entrepreneurship and Crafts. The efforts of these two ministries, the inclusion of a sectoral focus (e.g. energy, tourism) and the adoption of the cluster concept have the potential to lead to a more comprehensive approach to innovation. In the same period BICRO joined Enterprise Europe Network (EEN) and took a role of main partner for technology transfer and innovation, providing SMEs with educational events and tools on managing innovation, protecting Intellectual property and business models to enter new markets.

On the downside, the flurry of activity associated with the launch of the World Bank's STP and the Science and Technology Policy strategic document (Republic of Croatia, 2006) eventually slowed, and economic and political uncertainty led to the suspension of numerous measures and the winding down of public R&D budgets. In order to intensify inter-governmental co-operation for planning and monitoring science and innovation policy, the Strategic Council for Science and Technology (SVEZNATE) and the National Innovation System Council of MSES (VNIS) were established in 2008, the former presided by the prime minister. However, they did not become operational.

A major initiative of the previous government was the reform of the science and higher education system, with the Law on Science, the Law on Universities and the Law on Higher Education. The main intention of the proposed laws was to strengthen the functional and financial integration of universities (which are fragmented into faculties with a high degree of local autonomy) by changing the current models of financing, election of staff and the granting of licences. They also aimed to merge Croatia's two national councils (for science and for higher education) into a single body nominated by the government rather than parliament. The new laws would have increased institutions' autonomy but also their accountability. The scientific community strongly opposed the proposed laws and the delegation of power from the state to the institutions and they were withdrawn when the new government took office.

In July 2012 the amended Law on the Croatian Science Foundation (CSF) was adopted. It transfers funding of scientific research from MSES to CSF. This will have a positive impact on the quality of scientific research in the long term, provided practices such as the evaluation of proposals by peers from abroad are implemented. In parallel to the institutional empowerment of CSF, the Croatian Institute of Technology (HIT) merged with BICRO, in an attempt to strengthen coordination at the level of implementation. Moreover, BICRO is set to merge with HAMAG-INVEST, a business funding agency, as of 2014[2].

EU membership opens many opportunities to Croatia. Eligibility for the Structural Funds (SF) and greater participation in the next Framework Programme (FP), Horizon 2020, can help to transform the research and innovation system through unprecedented amounts of funds and opportunities for world-class collaboration. The planning and implementation challenges to be addressed are of a similar magnitude: past experience from the FP suggests that Croatia can expect one call for proposals a week. An important planning challenge is to develop a smart specialisation strategy as a precondition for the use of SF. An even greater challenge is the efficient and timely absorption of SF. To help Croatia meet this challenge, the World Bank recently launched STP II, with funding of USD 20 million, to support Croatia in applying for and implementing EU-funded projects.

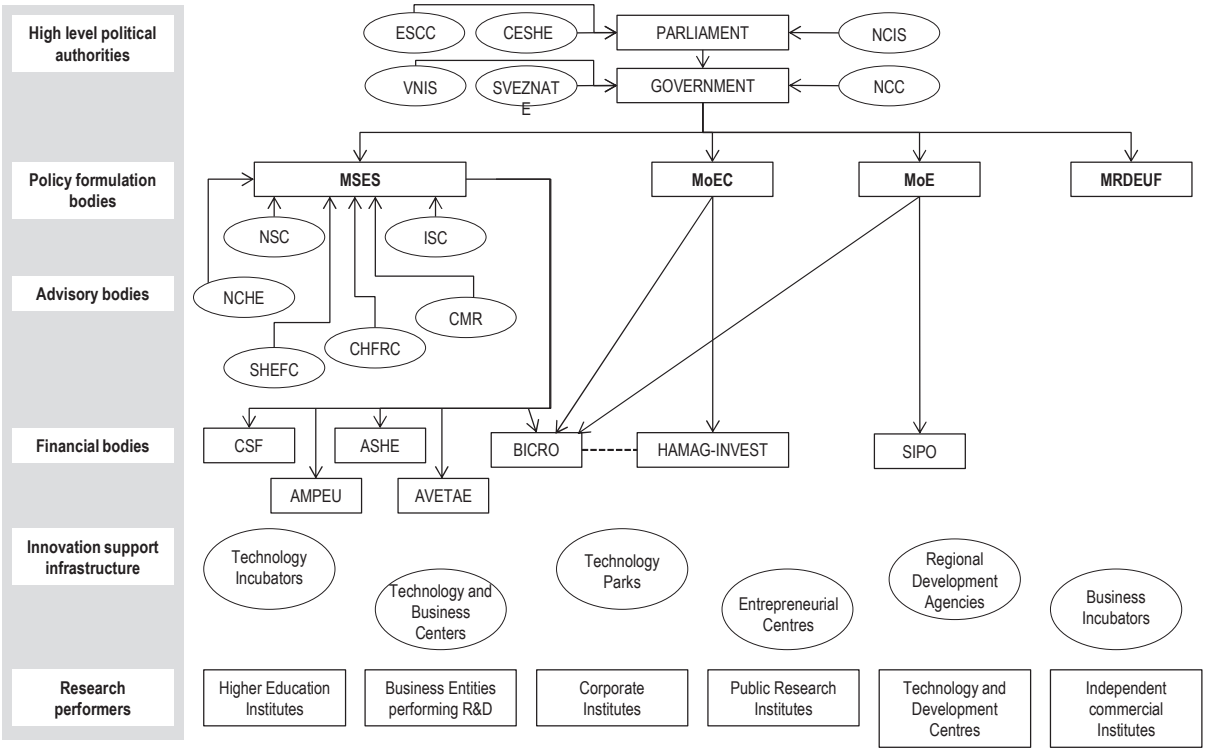
Over the long term the principal challenge will be to govern and manage the overall portfolio of EU instruments and develop and maintain a well-balanced national policy. It will be important to resist the temptation to use EU instruments and headline initiatives as substitutes for well-informed and well-articulated national planning that goes beyond the reach of these instruments.

4.2. The governance system: The main actors and their roles

Overview of the institutional configuration

The configuration of Croatian institutions in charge of governing STI shares many features with many other countries. As in many EU and OECD countries, higher levels of governance are in charge of orienting and programming policy. They include the parliament (in particular, the Parliamentary Committee for Education, Science and Culture in addition to the general body's say on changes in legislation) and four central government ministries: MSES, the Ministry of Economy (MoE), the Ministry of Entrepreneurship and Crafts (MoEC) (MoE and MoEC are the successors of MELE) and the Ministry of Regional Development and EU Funds (MRDEUF). This last ministry was established in anticipation of EU membership and motivated by an awareness of the opportunities and challenges arising from the implementation of Structural Funds across a wide array of ministries, agencies and beneficiaries. In addition, each ministry has a fairly distinct set of stakeholders. Lower-level implementation, monitoring and funding involve various intermediaries in the form of councils, committees and funding agencies, although some funding functions remain in the ministries (Figure 4.1). In common with comparable countries that have recently joined the EU, much of the institutional infrastructure for STI policy is relatively new – just over a decade old for most intermediaries – and in a state of flux.

Figure 4.1. The structure of the Croatian research and innovation system



Policy formulation bodies:
Ministry of Economy (MoE) Ministry of Science, Education and Sports (MSES) Ministry of Entrepreneurship and Crafts (MoEC) Ministry of Regional Development and EU Funds (MRDEUF)

High level political authorities:
Education, Science and Culture Committee (ESCC)
Committee for Ethics in Science and Higher Education(CESHE)
National Innovation System Council of MSES (VNIS)
Strategic Council for Science and Technology (SVEZNATE)
National Council for the Information Society (NCIS)
National Competitiveness Council (NCC)

Advisory bodies:
National Scientific Council (NSC)
International Scientific Council (ISC)
National Council for Higher Education (NCHE)
Science and Higher Education Funding Council (SHEFC)
Committee for the Hosting Foreign Researchers (CHFRC)
Committee for the Mobility of Researchers (CMR)

Financial bodies:
Croatian Science Foundation (CSF)
Agency for Science and HE (ASHE)
Business Innovation Centre of Croatia (BICRO)
Croatian Agency for Mobility and EU Programmes (AMPEU)
Agency Vocational Education and Training and Adult Education (AVETAE)
State Intellectual Property Office (SIPO)

Source: OECD based on ERAWATCH (2010a), "ERAWATCH Country Reports 2010: Croatia", European Commission, JRC-IPTS, erawatch.jrc.ec.europa.eu/erawatch/opencms/information/reports/country_rep/, p. 12, accessed June 2013.

The following section examines the characteristics, key activities and roles of the central government governance actors (MSES, MoE, MoEC, MRDEUF), the consultative and supervisory actors (councils), and the executive agencies (BICRO, CSF, the Agency for Science and Higher Education [ASHE], HAMAG-INVEST, the State Intellectual Property Organisation [SIPO]) with special reference to the extent and potential for interactions among them.

The central government

The Ministry of Science, Education and Sport

MSES is the government body most prominent in STI matters and is primarily responsible for programming, co-ordinating and monitoring science and education policies, in addition to its important role (although it shares some of the policy remit with the Ministry of Economy, see below) in shaping innovation policies. The part of its mission statement that relates to STI suggests that MSES exercises a high degree of control over the higher education and the public research sector. At the same time,

although MSES is the key orientation and programming ministry, as demonstrated by its role in drafting the 2006-10 policy agenda document (Republic of Croatia, 2006) and its role in the recent innovation strategy process, its mission does not explicitly include long-term planning or agenda setting. Moreover, some functions that appear to be an integral part of its mission have been delegated to agencies such as BICRO and CSF, but its mission does not specify any supervisory role. An indication of MSES' priorities is the absence of any explicit mention of support of innovation in the business sector, even though BICRO, the business innovation agency, fell under its exclusive remit until recently.

MSES' current situation is the result of its history and the challenges it has faced. Its scope for policy action has changed considerably over time and is partly reflected in its name. It began as the Ministry of Science, Technology and Informatics (1990-92) and evolved into the Ministry of Science and Technology (1992-2002) before obtaining its current title (in 2003). From 1990 to 2002, its focus was science and technology (and informatics for the first two years). From 2003 its mandate expanded to include education and sport; this coincided with a shift in rhetoric from technology to innovation. From 2006, the (former) Ministry of Economy, Labour and Entrepreneurship entered the field of innovation policy, its portfolio represented by the Ministry of Entrepreneurship and Crafts and the Ministry of Economy from 2011. In 2011, the Ministry of Regional Development and EU Funds also became active in the areas of skills and innovation. These changes took place against a background of rapid political change; MSES and its predecessors have had 13 ministers in 23 years. Such change is generally incompatible with planning, launching and implementing significant changes and creating sustainable impacts on the wider research system, especially if it is symptomatic of a weak political mandate and a lack of sufficient resources. It is therefore not surprising that planning has consisted mostly of incremental additions to the system and has stopped short of fundamental reform.

In parallel, MSES has seen increased institutional complexity, both internally and in the system of its stakeholders, some of which – notably BICRO (World Bank, 2012) and ASHE – have achieved more effective policy delivery. However, increases in complexity have also fostered inefficiencies and left room for functional consolidation and specialisation.

MSES is the leading funder of research in the public sector and covers the entire portfolio of science, education and sports. According to its Financial Department, its total budget in 2010 was EUR 1 571.6 million, or 9.8% (10.1% in 2009) of the state budget and 3.5% of GDP. The budget for R&D amounted to EUR 163.4 million in 2010 (1.02% of the state budget, 0.95% in 2009) (Švarc and Račić, 2012). Just under a third of MSES funding (according to Švarc and Račić, 2013) consists of institutional funding for public research-performing organisations (such as PRIs and HEIs), and about the same share is devoted to the rejuvenation and expansion of the research community through the Junior Researchers Programme. Most institutional funding goes towards the salaries of researchers. About a sixth of the total is spent on support programmes (including those administered by BICRO), co-financing of international projects, and research support overheads, such as assistance for publishing, conferences and association membership. Another sixth goes to support institutes of national interest. Only about 10% is used for competitive R&D project funding via the Z-Projects initiative.

The establishment of agencies has resulted in the delegation of an increasing number of MSES's responsibilities to an intermediary level between government and researchers. Among the most important of these agencies are: BICRO, which caters to support for business sector innovation; CSF, which caters to science, principally through the allocation of competitive funding; and ASHE, which caters to quality assurance in research and education, with a mandate to accredit universities and PRIs. Some of MSES's orientation and advisory functions for STI policy making have also been delegated to expert councils and committees.

MSES concluded its latest programming cycle in 2010 (Republic of Croatia, 2006); the drafting of a new planning document was delayed by the onset of the economic crisis and the uncertainty created by the changes of government in 2008, 2009 and 2011 and the protracted EU accession process. Important support measures for the purchase of research equipment and for the commercialisation of research, such as the Science and Innovation Investment Fund (SIIF) and the Unity through Knowledge Fund, were discontinued or interrupted. A new World Bank loan granted in May 2013 for STP II is now helping re-introduce some of these schemes. Following evaluation, about 10% of publicly funded projects were terminated and funding was reduced for over half of all projects. Budget reductions also threatened the training of young researchers, as scholarships were temporarily abolished and opportunities for their career progression reduced (Švarc and Račić, 2013). A major concern of MSES in recent years has been the process of reform in the public research system in general and HEIs in particular. An important part of this process stalled when the proposed Law on Science, Law on Universities and Law on Higher Education were withdrawn. A new effort is under way, but has backtracked from the original ambition to consolidate management in the four old universities (see section 3.2.5 in Chapter 3).

The Ministry of Economy

While MSES has been the principal actor for research and innovation policy, both in its own right and through ASHE, CSF and BICRO, other ministries have also become important stakeholders in research and innovation policy. Overall, their entry has completed the policy portfolio, mainly by expanding the remit of innovation policy (which had been closely linked to public research) and by catering to a wider range of target groups, notably the business sector.

The MoE's policy scope covers economic development, competitiveness, industrial policy, energy policy, public procurement, the implementation of directives, standards and regulations for the EU internal market, and intellectual and industrial property rights (MoE, 2013). Innovation is also an explicit part of its mandate, both as a current policy concern and as a potential dimension of many of its other activities: For instance, the creative use of public procurement (see section 4.3.3), coupled with the mobilisation of international resources in the field of energy, present useful opportunities for stimulating innovation. The use of standards and regulation (see section 4.3.2 and Table 4.10) as a vehicle for innovation is another promising area for innovation policy development (EC, 2012a; Stewart, 2010; Blind, 2012).

The MoE (and its predecessor, MELE) have been quite active in developing and launching strategies and plans. Since 2010, they have (co-)launched at least 20 strategies, programmes and plans (Table 4.1). The innovation strategy and the cluster programmes are co-owned with other ministries, in particular MoEC and MSES.

Table 4.1. Policies, strategies, programmes, and actions plans launched by the Ministry of Economy or its predecessors since 2010

	Field of strategy or action plan	Collaborating ministry	Year of launch
1.	Women entrepreneurship development strategy in the Republic of Croatia 2010-13		2010
2.	Action plan for the implementation of the strategy female entrepreneurship 2010-13		2010
3.	Entrepreneurial learning strategy 2010-14		2010
4.	Operational plan, encouraging SME for 2011		2011
5.	Cluster development strategy in the Republic of Croatia 2011-20		2011
6.	Innovation strategy	MSES, MoEC	(in preparation)
7.	Economic development strategy		2012
8.	Energy development strategy		2012
9.	Investment promotion strategy		2012
10.	Industrial development strategy		(in preparation)
11.	Development strategy for food processing industry	MoEC	2012
12.	Development strategy for wood processing industry	MoEC	2012
13.	Development strategy for metal processing and production industry	MoEC	2012
14.	Development strategy for creative industry	MoEC	2012
15.	Development strategy for ICT industry	MoEC	2012
16.	Development strategy for defence industry	MoEC	2012
17.	Development strategy for textile industry	MoEC	2012
18.	Development strategy for building and construction industry	MoEC	2012
19.	Development strategy for pharmaceutical industry	MoEC	2012
20.	Smart specialisation strategy		2013

Source: Ministry of Economy.

The large number of strategies and plans led by MoE is indicative of a broad agenda serving a wide range of stakeholders. MoE is particularly active in developing sectoral policies and criteria for cluster formation in collaboration with MoEC.[3] Alignment with policies that are popular among EU members appears to be well advanced both in terms of themes (smart specialisation, clusters, entrepreneurship) and policy approaches and instruments (industrial policy, competitiveness, operational plans). The extent of inter-ministerial collaboration appears mostly confined to MoEC (MoE and MoEC were formerly parts of MELE). More extensive coordination would be in keeping with MoE's central place in economic policy.

The Ministry of Entrepreneurship and Crafts

MoEC's stakeholders are similar to those of MoE, focusing on SMEs and the drafting of concrete support measures. MoEC is in charge of a wide range of issues ranging from entrepreneurship, trade and foreign direct investment (FDI), to competitiveness, balanced regional development and innovation (MoEC, 2013).

Institutions such as regional development agencies and business centres initiated by local governments and MELE are now under MoEC. It was estimated that Croatia has 27 regional development agencies, 44 entrepreneurial centres, 23 business incubators (most

attached to regional development agencies) and 8 technology parks, including those of the Technology Infrastructure Programme (TEHCRO) (WBC-INCO.NET, 2011).

The Ministry of Regional Development and EU Funds

MRDEUF was founded to meet the challenges of effective and efficient absorption of the Structural Funds. In addition to its responsibility for EU funds, it is in charge of regional development and sustainable development of the Adriatic Sea islands and coastal areas. In this dual role MRDEUF has the opportunity to act as a showcase for aligning policies and related programmes and actions. MRDEUF's portfolio includes the full range of programming, funding and implementation functions relating to EU funds (Table 4.2).

Table 4.2. Portfolio of the Ministry of Regional Development and EU funds

	Planning	Implementation	Coordination	Policy intelligence
1. Planning and implementing of regional development policy and establishment of an integrated system for planning, programming, management and financing of regional development	x	x		x
2. Co-ordination of participants and of planning, programming, implementation, monitoring and evaluation of the annual and perennial regional development programmes and projects			x	x
3. Preparation of priorities and annual and perennial strategic and operational documents for the use of EU funds and other international sources of funding for regional development initiatives	x			
4. Co-ordination and management of interdepartmental working groups concerning the regional development and co-ordination of all activities for harmonisation with EU in the field of regional policy and structural instruments management			x	
5. Co-ordination of activities to ensure effective co-ordination with the units of local/regional self-government and with other stakeholders in drafting, organisation and implementation of regional development programmes and projects			x	
6. Sustainable development of the Adriatic Sea, islands and coastal areas; development of policy proposals and establishment of an integral system of planning, programming, management and financing the development of islands and coastal areas; planning, drafting and implementation of strategic documents and projects for the development of transport, utility and social infrastructure on the islands and in the coastal areas; commencement, co-ordination and supervision of activities pursuant to legislation that regulates the development of islands and coastal areas	x	x	x	x

Source: Adapted from www.mrrfeu.hr/default.aspx?id=866.

Croatia has become eligible for the full range of Structural Funds upon EU membership in 2013 and has already benefited from the Instrument for Pre-accession Assistance (IPA). The European Funds managed by MRDEUF cover a wide range (MRDEUF, 2013): institution building, transport, environmental protection, regional competitiveness, agriculture and rural development, and cross-border co-operation. Examples of MRDEUF's contributions include the preparation of a project pipeline and setting up the inter-ministerial thematic working groups to decide on priorities for the SF.

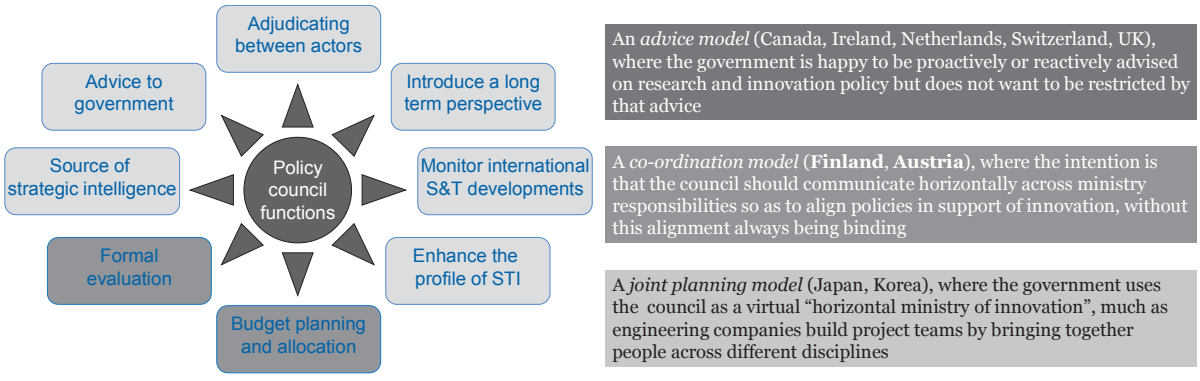
MRDEUF already has experience in planning, co-ordination and application of policy intelligence. While this experience and these capacities can be redeployed for the SF, staffing needs for implementation - including the required coordination with other ministries - will be at least an order of magnitude greater and will pose real challenges for

effective absorption. It is therefore critical to address this issue in time, both within MRDEUF and in the regions and to explore scope for collaboration with implementation agencies in the research and innovation policy area (BICRO, CSF, HAMAG-INVEST).

The councils

The last decade has seen a delegation of policy functions to operationally independent units. While ministries have maintained control over programming decisions, there has been a drive to delegate a considerable share of implementation to agencies and to give councils and committees an increasing say in orientation, long-term planning, co-ordination and monitoring. Such delegation is common in other countries and is motivated in part by the need to professionalise the delivery of these functions and foster learning. In the case of the councils, further reasons include the need to foster inter-ministerial co-ordination, to take a long-term outlook and strategic approach, and to strengthen high-level monitoring of and commitment to research and innovation. Councils can also serve as aggregators of the viewpoints and interests of various stakeholders and can play a crucial role in mediating between principals (society, represented by the government in its various forms) and agents (scientists and other knowledge workers). This can lead to a better-accepted form of governance than command-and-control steering (Rip and van der Meulen, 1996). The functions and types of councils vary among countries in response to national conditions (Figure 4.2).

Figure 4.2. Functions and types of high-level STI policy councils



Source:OECD (2012c), *OECD Science, Technology and Industry Outlook 2012*, OECD Publishing, doi: 10.1787/sti_outlook-2012-en.

The *National Council for Science (NCS)* is a strategic advisory body established in 1994 to develop and maintain overall scientific quality in Croatia. It has a wide range of functions (Table 4.3).

Table 4.3. The tasks of the National Council for Science

Task	Advice	Operation	Decision making
Discusses issues important for improving scientific activity in Croatia	x		
Monitors and evaluates the quality of scientific organisations		x	
Proposes budgets for scientific activities	x		
Organises the evaluation of scientific projects and programmes		x	
Submits annual budget proposals for science and higher education to the government	x		
Determines scientific fields, areas and discipline, as well as interdisciplinary fields of science and arts			x
Determines detailed requirements for appointment to science ranks			x
Determines detailed requirements for attaining authority to conduct a procedure for appointment to science ranks			x
Appoints the members of its own scientific field councils, art councils and peer review groups for scientific evaluation projects			x
Proposes the proclamation of the scientific centres of excellence and monitors their quality	x	x	
Provides its opinion on establishing technology and science parks.	x		

Source: www.nvz.hr/index.php?option=com_content&view=article&id=114&Itemid=27.

The tasks of the NCS are a mixture of standard research council tasks (classification of scientific fields, requirements for appointment to science ranks), advisory tasks (on budgets or on investments such as science parks) and more operative tasks (monitoring and evaluating scientific organisations, evaluation of scientific projects and programmes). Some of its tasks throw light on some perceived problems in the wider innovation system. For example it provides its opinion on establishing technology and science parks. The NCS does not have own operative capacity. Instead, it relies on the expertise of the six scientific and arts councils (natural science, technical, biomedical, bio-technical, social sciences, humanities) and the 22 scientific field committees. ASHE serves as a base for its operations.

The *National Council for Higher Education (NCHE)* is an expert advisory body established in 2004 and is responsible for the development and quality of higher education. It examines the evaluations of HEIs and their study programmes and provides a platform for networking the public HEIs. Its operations are carried out in co-operation with ASHE. NCHE submits, in co-ordination with the NCS, annual proposals on the allocation of budget resources for science and higher education to the Croatian government. To help in this task, the *Science and Higher Education Funding Council (SHEFC)* was established in 2005 to provide the councils with expertise and professional assistance. Its task is to develop the criteria for public funding for higher education and research which still poses important challenges.

The *Committee for Ethics in Science and Higher Education (CESHE)* was included in the Law on Scientific Activity and Higher Education 2003. Its nine members are proposed by the NCS and the NCHE. Its objective is to promote ethical principles and values in science and higher education, in relation with social stakeholders, as regards the application of technologies and the protection of the environment.

The *Strategic Council for Science and Technology (SVEZNATE)*, founded in 2008, is a high-level government body, responsible for co-ordinating and harmonising the government's efforts on science and technology development and is presided by the

prime minister. While SVEZNATE has been established, it is not operational. This is particularly unfortunate, because high level councils, chaired by the head of government, have been instrumental in raising the profile of innovation policy in other countries, and raising the profile of innovation policy within government is a key obstacle to the development of the Croatian innovation system.

The *National Innovation System Council (VNIS)* was founded in 2008 and is a high-level government body responsible for the development of the Croatian innovation system. Like the SVEZNATE, it has been established but is not operational.

The *Education, Science and Culture Committee (ESCC)* is appointed by parliament. It monitors the implementation of policies that are under the authority of MSES: pre-school education; primary, secondary and higher education; science culture and technical culture; international scientific and technical and technological co-operation; protection and use of cultural resources, historical materials and heritage; archives and archival materials, and the commemoration of historical events and persons; co-operation with religious communities; information technology; and other matters of education, science and culture.

After the parliamentary election in December 2011, the new minister of science, education and sports named the *International Scientific Council (ISC)* in January 2012. It consists of three prominent scientists from abroad whose main task is to provide advice and technical assistance to improve the efficiency of the science and higher education system.

The *Committee for the Hosting of Foreign Researchers in Croatia (CHFRC)* was established in 2009. Its purpose is to facilitate the hosting of foreign researchers participating in research projects in Croatia. The Code of Procedures for the Approval of Temporary Stay permits foreign researchers to work in private and public research and education institutions without a work permit. Moreover, to strengthen co-operation of Croatian researchers with their international peers, the *Committee for the Mobility of Researchers (CMR)* was also established in 2009 and prepared the action plan for researcher mobility (Švarc and Račić, 2012).

The *National Competitiveness Council (NCC)* was established in 2002 to improve Croatia's competitiveness and prepare its entry into the EU. It is an independent advisory body with 26 members and includes representatives of the government, business and academic sectors, and trade unions. Its recommendations have covered a wide array of policy issues, including education, market regulation, cost competitiveness, innovation, development of SMEs and regional development.

The *National Council for the Information Society (NCIS)* provides advice on proposed strategic and policy documents, laws and projects relating to the information society and also initiates and co-ordinates the activities of various stakeholders. The council has 14 members, with representatives from government, civil society, academia and the business sector.

Other policy advice mechanisms include the hiring of national and international experts either directly or by setting up *ad hoc* advisory groups or task forces of experts and scientists to assist in the drafting of policy documents; the expert advice provided through EU- and World Bank-funded projects; and the participation of middle-management policy makers in international policy discussion forums (e.g. EU, OECD, UNESCO-based working groups) (Švarc and Račić, 2012).

The agencies

The most significant expression of the central government's broader process of delegation of policy functions is the delegation of part of programming and especially implementation to specialised agencies. This process of "agencification", inspired by the "new public management" model, has been carried out in many OECD countries over the past three decades. Overall, despite some downsides, the ensuing reorganisation has had a positive impact on performance (OECD, 2010, Chapter 4). Operationally independent implementation agencies improve policy effectiveness by employing professionals who combine experience in specific funding and other financing instruments (including co-funding and the leveraging of complex financial instruments) with an understanding of the needs of target groups. By virtue of their independence, they can be shielded from occasional political interference in operational decisions and may be better able to maintain the long-term outlook. Independent agencies can also help overcome problems arising from ministerial compartmentalisation and seek synergies across issues that span portfolio boundaries.

The Business Innovation Centre of Croatia

BICRO was established by the Croatian government in 1998 as a public limited liability company to support innovation in the business sector. It is the most visible outcome of Croatia's first comprehensive research and innovation policy programme, the National Scientific and Research Programme 1996-98 and it was the first operationally independent agency to be entrusted with the implementation of research and innovation policy. At its inception its mission and approach to the support of industry were influenced by collaboration with the Business Innovation Centre Friuli-Venezia Giulia in Italy. BICRO developed the current range of its activities thanks to funding from the World Bank STP (2005-11). In addition to its operational independence in terms of implementation, BICRO has considerable discretion for parts of programming, specifically the design of instruments. Over time it has experimented with and accumulated significant experience with various support instruments (Table 4.4).

BICRO places strong emphasis on the commercialisation of science and the support of technology-based start-ups. As a result, its efforts have focused on the interface of public research and the business sector with a view to greater collaboration between these sectors and the commercialisation of public research. This focus is evident in the overall balance between types of instruments employed and their relative funding shares, i.e. the dominance of incubators and technology transfer, mainly from public research and higher education to the private sector, with a focus on promising technological areas such as the life sciences, nanotechnology and information and communication technology (ICT).

Table 4.4. BICRO programmes

Programme	Description	Status
Development of knowledge-based firms, academic spin-offs (RAZUM)	RAZUM aims at the development of new technology-based firms and academic entrepreneurship. It provides support for the commercialisation of products and services whose market value is primarily based on the results of R&D. It provides funding to start-ups or established SMEs that undertake applied research leading to new or improved products or services. Subsidies are only available for projects at the pre-commercial stage. Projects that already include investment in manufacturing or service facilities are evaluated by RAZUM, but can only be financed by the Croatian Bank for Reconstruction and Development. Over 2007-10, 31 projects were approved and 22 were contracted, and six commercial projects were directed to the Croatian Bank for Reconstruction and Development.	Started in 2007
Technology infrastructure programme (TEHCRO)	TEHCRO provides financial support to establish organisations that provide facilities, advisory services, and overall support to technology transfer and commercialisation of research results. It provides support to establish technology transfer centres, business incubators and R&D centres. This includes: setting up specialised technology incubators for life sciences, including nanotechnology and information and communications technology (ICT); setting up technology transfer centres; providing equipment for the aquaculture R&D centre founded by the University of Dubrovnik and co-financed by the International Bank for Reconstruction and Development. Applicants to TEHCRO are consortia that must include a public body (e.g. a regional development agency) and an R&D partner (public or private). Other private partners may also be included. Subsidies provided through TEHCRO may last up to five years. The company is then expected to become self-sufficient. The projects are: • Technology Park Varaždin Ltd. • Science and Technology Park of the University of Rijeka Ltd. (STeP Ri) • Technology and Business Innovation Centre for mariculture MARIBIC d.o.o. in Dubrovnik • Industrial Park Nova Gradiška Ltd. • Regional Development Agency Međimurje REDEA Ltd. • TERA Tehnopolis Ltd. in Osijek	Started in 2007
Venture capital industry (VENCRO)	This programme is not fully operational owing to a lack of financial resources and interest from potential private partners.	Started in 2008
R&D services for companies (IRCRO)	It aims at encouraging SMEs to establish R&D activities. It intends in particular to encourage and stimulate demand for the services of HEI/PRIs. Projects under IRCRO involve co-operation between industrial firms and HEI/PRIs and are jointly funded by IRCRO and the company using a 50/50 matching grant scheme.	Started in 2007
Business competitiveness upgrading programme (KONCRO)	Provides support to high-technology SMEs that want to hire consultants in order to acquire technology and management competences, develop new products and processes, enhance productivity and quality or invest in environmental protection. Applicants are obliged to hire consultants that have been pre-approved by BICRO.	Closed in 2010
Proof of Concept programme (PoC)	Aims to ensure pre-commercial capital for technical and commercial testing of innovation concepts. The activities eligible for funding (max. EUR 47 000) include: protection of intellectual property, demonstration of feasibility, development of prototype. Funds can also be used for market analysis, business planning, concept/strategy development. PoC was introduced in 2010 and is implemented with the help of first 11 and later 17 recognised centres that provide support for the preparation of project applications. A total of four calls have been launched so far, with the number of applications growing each time. In 2010, a total of 284 pre-applications and 159 full applications were received, of which a total of 46 were approved and funded. In 2011, 33 projects were approved. During the fourth call (published in 2012), a total of 241 project applications were received, for almost EUR 8 million, with private-sector participation of an additional EUR 4 million. Overall, the requested amount was around 12 times higher than the total programme budget.	Started in 2007
EUREKA	EUREKA is a European network that supports businesses performing close-to-market R&D projects. Croatia has been involved in EUREKA as a full member as of 23 June 2000. In February 2009 MSES transferred operative implementation of EUREKA programme to BICRO. Since then BICRO became the National EUREKA Office for Croatia, responsible body for the whole implementation including financial management and contracting.	Started in 2010

.../...,

Table 4.4. BICRO programmes *(continued)*

Programme	Description	Status
Eurostars	Eurostars Programme is a European Joint Programme dedicated to the R&D performing SMEs, and co-funded by the European Union and 33 EUREKA member countries. Eurostars aims to stimulate these SMEs to lead international collaborative research and innovation projects by easing access to support and funding. It is fine-tuned to focus on the needs of SMEs, and specifically targets the development of new products, processes and services and the access to transnational and international markets.	Started in 2011
Enterprise Europe Network (EEN)	BICRO is one of seven Croatian members of EEN. BICRO is the co-ordinator of technology transfer, innovation and joint research activities.	Started in 2009
Technology projects programme (TEST)	TEST, operated by the former *Croatian Institute of Technology* provides funding for pre-commercial research to develop new technologies (products/ processes/ services) through the development of original solutions (prototypes/pilots), as well as research linking basic science and its technological application to the development of industry sectors. During 2001-09 EUR 6.3 million was spent for the TEST programme.	2007-2012
National technology foresight platform and business intelligence system	HIT was also in charge of developing the national technology foresight platform and business intelligence system, and was supposed to take over the consolidation of the administrative structure of the national focal points of the EU Framework Research and Technology Development Programmes from MSES.	

Source: BICRO (2009, 2010, 2011), Annual Reports, www.bicro.hr/en/; Švarc and Račić (2012), "ERAWATCH Country Report 2011: Croatia", European Commission, Brussels.

BICRO manages half a dozen programmes which have been introduced during the last five years (Table 4.5). Over this period it has evaluated 455 pre-applications and 219 applications and funds 160 projects (89 if Proof of Concept is not included). Some programmes are oversubscribed, particularly Proof of Concept (332%), RAZUM (345%) and EUREKA (375%), mainly owing to limited resources for funding. Given the scale of resources and the number of projects involved, BICRO has so far nurtured a small sector, essentially hedging its bets on a few contenders, each of which has an uncertain probability of successful employment creation and long-term sustainability. This approach can be useful for capturing serendipitous and radical ideas and has a non-negligible probability of a reasonably strong economic impact if pursued vigorously over a sufficiently long period. However it cannot be the main basis of support for business-sector innovation as a whole. Addressing a much larger part of the business sector would inevitably involve nurturing the accumulation of a wide range of in-house innovation capabilities in firms, including in R&D, but also in engineering, design, IT and marketing (Bell, 2009), which would require a much wider range of policy instruments and a different approach and mindset. The BIOCentre project (funded under the Regional Competitiveness Operational Programme 2007-2011) is somewhat of an exception within BICRO's portfolio, in terms of the wide range of services offered, though the focus on the research-intensive end of the spectrum of possible innovation modes is evident there too.

Nevertheless, within the rather narrow focus of its past activities, BICRO has already achieved some notable results in terms of new products and processes, IPR generation[4] and support of knowledge-intensive employment (BICRO, 2011). Moreover, BICRO appears well respected, especially by the business sector.

Table 4.5. BICRO programmes and total funding

	Number of pre-applications	Number of applications	Number of projects	Over-subscription	Contracted funds EUR
PoC	364	236	71	332%	1 638 587
RAZUM	154	76	22	345%	13 977 380
IRCRO		61	22	277%	2 020 127
EUREKA		30	8	375%	1 075 253
TEHCRO		19	14	136%	9 333 580
KONCRO		32	22	145%	155 539
BIOCENTRE (IPA IIIc)		1	1		16 376 410
Total		455	160		44 421 337
Total national					28 044 927

Source: BICRO (2009, 2010, 2011), Annual Reports, www.bicro.hr/en/.

BICRO's mandate and operational scope expanded in 2012 when it absorbed the former Croatian Institute of Technology. HIT had been established primarily to create the pre-conditions for accelerated application of new knowledge and technologies by providing services, expertise and project funding. The merger of HIT with BICRO was motivated by concerns over the efficient absorption of EU funds and possible overlap of responsibilities for innovation and policy measures.

BICRO – just as the general innovation policy debate in Croatia – considered the binding constraint on the development of the innovation system to be the weak interface between science and industry. The contrast between perceptions of a strong science base and the evident absence of strong economic impact may have contributed to the emergence of this view. As indicated in Chapter 2, however, Croatia's performance in science actually trails that of comparable countries. Crucially, as shown in Chapter 3, various dimensions of business-sector innovation activity and capacities are also weak. Therefore, the balance of available evidence – the quantity and quality of scientific output, the lack of requisite skills in the business sector and the weak commitment of businesses to R&D and other knowledge-intensive activities –supports the view that the binding constraint is not at the interface but at the core of public-sector and, especially, business-sector innovation capacities.

In any case, international experience (see section 3.1, especially discussion around Table 3.9 and references therein) demonstrates that among the possible types of economically useful innovation, the science-driven variety has been dominant in only a few places and only some of the time. Even in advanced innovation systems, companies that innovate tend to do so on their own. When they collaborate they tend to do so primarily with other companies rather than HEIs or PRIs, and when they collaborate with HEIs or PRIs they tend to do so on their own initiative.[5] Therefore, even under optimal conditions, overemphasis on a "science-push" model, while potentially useful for a small part of the business sector, would not reach the majority of firms.

BICRO's current portfolio caters to new-to-the-world innovators. It offers little that is likely to encourage non-innovators and new-to-the-firm or new-to-the-country innovators to upgrade capacities, develop activities and change innovation behaviour. From an international perspective, BICRO's relatively meagre resources are striking given the task it performs. BICRO's annual statements emphasise the design of instruments tailored to condition incentives and leverage additional funding and focuses on a few issues identified as priorities. This seems a sensible response.

Despite its focus on the interface with science rather than the core of business innovation capacities, its pronounced resource constraints and their temporary deterioration, and the well-documented inflexibilities of HEIs and PRIs, BICRO's performance is positive and is a credit to the competence and dedication of its staff. In moving BICRO's agenda closer to that of a fully-fledged innovation agency, it would be useful to consider ways to cater to the needs of the majority of Croatian firms, including large ones, by rebalancing its objectives and delivery instruments (see section 4.3.1, especially the parts 'Direct and fiscal support for business-sector innovation' and 'Funding skill development'). Recent developments, including the merger with HAMAG-INVEST and the joint supervision of the enlarged BICRO by MSES, MoE and MoEC seem compatible with the direction proposed.

Croatian Agency for SMEs and investment (HAMAG-INVEST)

HAMAG-INVEST draws on a network of certified consultants to provide support to SMEs through financial incentives and business advisory services. Originally, HAMAG-INVEST was the agency for credit guarantee schemes, while MELE implemented non-financial measures directly. In 2007, HAMAG-INVEST began to take over some MELE programmes that dealt with the improvement of business support infrastructure, such as business centres, regional development agencies, entrepreneurship of target groups (youth, start-ups, disabled persons), and support for student co-operatives and student enterprises.

HAMAG-INVEST is in charge of public guarantee funds and grants guarantees for loans by commercial banks and other creditors that focus on financing fixed assets and working capital. Its grant capital is EUR 65 million. It encourages small business creation, growth and investments, provides loans, issues guarantees for small business loans, and provides financial support to reduce the cost of loans. It also supports high-growth, export-oriented businesses ("gazelles"), subsidises participation in international fairs and exhibitions, marketing, certification, introduction of new technologies and protection of intellectual property, and develops women and youth entrepreneurship. Finally, it has developed an accreditation system for trainers and has started a project for the Accreditation of Business Consultants, based upon regular participation by Croatian consultants in tailored training programmes for business service providers.

HAMAG-INVEST and BICRO both address SMEs, but do not appear to have co-ordinated their activities in the past and seem to have rather different cultures. However, there are a number of possible synergies, including the design of financial instruments tailored to the needs of innovating companies and the exchange of experience about their common target groups. For example, they might set up a one-stop clearinghouse for clients and possibly a learning platform. The creation of clusters, and even more, the planning of operational programmes for the EU Structural Funds would be an ideal point of departure. HAMAG-INVEST's experience in leveraging complex financial instruments may help address certain aspects of BICRO's underfunding. The merger of BICRO and HAMAG-INVEST in 2014 will be an important step in the direction of supporting the accumulation of innovation capacities in a greater number and variety of firms as well as supporting a greater variety of modes and types of innovation.

The Croatian Science Foundation

The CSF was established in 2001 and currently has 11 staff. Its mission is "to promote science, higher education and technological development in Croatia in order to ensure the development of [the] economy and to support employment" (CSF, undated).

There is no doubt that science should remain relevant to social and economic concerns. However, the emphasis on economic impact in the mission of the main science policy implementation agency seems too strong, especially in a short to medium-term context. In OECD countries, especially those with strong innovation systems, such organisations[6] typically aim, above all, to foster scientific rigour and a culture of constructive scepticism. This is generally achieved by encouraging within-country competition and international collaboration, dimensions apparently lacking so far in the Croatian innovation system. Of course, this should not stop CSF from seriously considering ways to strengthen the economic and social relevance of the high-quality research it funds.

As Table 4.6 indicates, CSF has launched almost two dozen programmes since its inception, only a few of which are still active. The suspended or terminated programmes and funding schemes generally ran for only a few years. Among those suspended in 2010 and 2011, lack of funds appears to be a more common cause of suspension than a change in priorities or their perceived (lack of) success.

Table 4.6. Programmes of the Croatian Science Foundation

Programme	Description	Status
PROGRAMMES		
Research Projects	The basic aim is to create new or enhance existing knowledge. The main support instrument for international co-operation but also for developing and promoting Croatia's strategic priorities. Support for research groups working on internationally competitive issues, whose leaders have been recognised for their scientific achievements. The ultimate goal is to create a critical mass of research groups, competitive on the international level. Criteria: Proposal must fit the priorities of CSF. Internationally competitive issues. Coherence of project proposals with the strategy of the applicant institution. Project leader must be an active researcher with internationally recognised achievements, employed at the institution at which the project is to be carried out, permanently or during the project period.	On-going
Collaborative Research Programmes	Carried out by universities, faculties or public institutes and involving a number of content-related research projects – minimum of three groups of which at least two from different legal entities. The programme has to be approved by the Senate or Academic Council of the scientific institutions and comply with the priorities of the home institution. Project leader has to be an internationally recognised, qualified and productive researcher. The ultimate goal is to encourage the development and strengthen co-operation by research groups to create internationally competitive programmes and provide conditions for centres of excellence. Criteria: Proposal must fit one of the themes of the call and the strategy of the institutions. Programme leader and research group leaders must hold a doctoral degree, be active researchers employed at the Croatian research institution that submits or carries out the programme. Institution must provide support (adequate space, infrastructure, equipment).	On-going
HIGHER EDUCATION REFORM		
Learning Outcomes-Based Higher Education	To encourage Croatian educational institutions to develop institutional strategies for the introduction of learning outcomes; adjust regulation and development of institutional guidelines for the definition of learning outcomes; train teachers and academic staff, reform programmes of study and disseminate experiences and good practices.	Closed in 2008
Integrated University And Integrated Tertiary Education System	To study organisational and legal models of integration of universities and tertiary education as a model for the effective use of human resources, jobs, promotion and realisation of labour rights.	Closed in 2006

…/…

Table 4.6. Programmes of the Croatian Science Foundation *(continued)*

Programme	Description	Status
Development of Institutional Quality Assurance Units	To support the establishment of quality assurance units, the spreading of the culture of quality in the academic and non-academic society and collaboration between the institutions	Closed in 2007
Development of Joint Studies	To support the development of joint studies and joint degrees and co-operation among universities, particularly with universities in the European Union, to develop programmes of study, research and development of human resources.	Closed in 2005
Development of PhD Programmes	To support the development of doctoral studies in the tertiary cycle of higher education, and to encourage co-operation between universities, to co-operate with the public and private sectors to build doctoral programmes.	Closed in 2004
BRAIN GAIN		
Homing Programme	To enable research activities in Croatia for researchers who have built an independent research career abroad.	Closed in 2008
Postdoc	To improve the professional competencies of young researchers holding a PhD and to support their early scientific independence.	Closed in 2011
Visitor	To enable researchers from abroad to carry out research projects in Croatia.	Closed in 2009
Senior	To provide employment for researchers from abroad, enable them to carry out research projects and train young researchers at Croatian universities and institutes.	Closed in 2009
HRZZ Installation Grant	To help scientists with two to five years of postdoctoral experience to set up their research in Croatia and rapidly establish a reputation in the European scientific community.	Closed in 2011
TRAINING OF DOCTORAL STUDENTS		
National Training Courses and Summer Schools for Doctoral Students	To improve the quality of doctoral studies via training courses and summer schools.	Closed in 2010
Fellowships for Doctoral Students	To improve the research standards and quality of doctoral studies and to promote international mobility of young researchers during their doctoral studies.	Closed in 2011
Partnership in Research	To improve co-operation between research institutions, industry and entrepreneurship and increase budgetary investments in research.	Closed in 2010
INTERNATIONAL PROGRAMMES		
Support for Joining European Science Foundation programmes	To integrate Croatian scientists into the European Research Area via scientific and EUROCORES programmes of the European Science Foundation (ESF).	
EMBO Installation Grant	To help leading life scientists to set up labs in Croatia and rapidly establish a reputation in the European scientific community.	Closed in 2010
European Social Survey	Facilitate the involvement of Croatian scientists in European social research in order to gain better insight into social change in Croatia and facilitate comparison with other European countries.	Closed in 2010
International Collaborative Workshops	To foster and strengthen co-operation between Croatian and foreign research groups in preparation for joint projects and research co-operation.	Closed in 2009
AWARDS		
Science Award	To recognise, reward and promote scientific research in undergraduate and graduate courses. Tender is invited in September each year.	On-going
Science Award Sculpture Solutions	Awarding sculpture solutions to students and alumni from the Academy of Arts of the University of Osijek, the Academy of Applied Arts in Rijeka, the Art Academy in Split and the Academy of Fine Arts, University of Zagreb.	Closed in 2009
SOCIOCULTURAL TRANSITION FROM INDUSTRIAL INTO THE KNOWLEDGE BASED SOCIETY		
Development of Croatian Professional Terminology	To foster the development, systematisation and unification of Croatian professional terminology, to organise terminology workshops and educate experts to take care of Croatian terminology.	Closed in 2011

Source: www.hrzz.hr/index.php?option=com_content&view=article&id=3&Itemid=7&lang=en.

Many of the terminated programmes were devoted to specific higher education issues such as implementation of quality assurance systems, development of joint studies or of PhD programmes and training of doctoral students, mobility schemes (with a focus on "brain gain"), summer schools, scientific workshops, links to international programmes such as the European Science Foundation (ESF) and EMBO, and participation in the European Social Survey.

Given the status of the Croatian innovation system, much of CSF's effort so far has had to deal with "system failures" as regards systematic internal quality assurance, training of young researchers, and use of international programmes and research infrastructures. At the same time, owing to the number and diversity of these failures and its limited budget, CSF's responses have been less than comprehensive. It has supported participation in EMBO and ESS but not other supra-national research infrastructures. Likewise, it has supported ESF and EUROCORES but not participation in the FP. The suspension of initiatives for young researchers contrasts with the practice of the increasing number of European countries that are putting doctoral schools in place and attempting to expand their capacity (European University Association, 2005).

A cursory overview of the funding allocated to the programmes over their duration highlights the small numbers of projects and volumes of funding, less than EUR 10 million over a period of about a decade (Table 4.7). In recent times, CSF has undergone a streamlining of its portfolio of activities and has only a small number of funding schemes.

Table 4.7. Total funding provided by the Croatian Science Foundation

Programme	No. of projects	Allocated funds EUR
Research Projects	9	1 089 117
Collaborative Research Programmes	4	744 598
Learning Outcomes-Based Higher Education	6	156 963
Integrated University and Integrated Tertiary Education System	1	39 521
Development of Institutional Quality Assurance Units	8	188 320
Development of Joint Studies	4	107 358
Development of PhD Programmes	9	183 476
Homing Programme	6	547 453
Postdoc	76	785 336
Visitor	11	370 769
Senior	3	224 250
HRZZ Installation Grant	12	1 434 943
National Training Courses and Summer Schools for Doctoral Students	11	135 958
Fellowships for Doctoral Students	129	732 178
Partnership in research	19	1 771 090
Support for Joining European Science Foundation Programmes	1	435 490
EMBO Installation Grant	2	300 000
European Social Survey	1	38 994
International Collaborative Workshops	16	176 500
Science Award	15	27 665
Science Award Sculpture Solutions	4	2 635
Development of Croatian Professional Terminology	1+27	26 347+217 485
Total		9 736 446

Source: www.hrzz.hr/index.php?option=com_content&view=article&id=3&Itemid=7&lang=en.

In 2012, the MSES shifted its Z-Projects funding scheme to the CSF following the Law amending the Law on National Science. This is an important step towards integration of science programming and implementation in a single specialised organisation. However, even the Z-Projects scheme is too small to rebalance overall public research in the direction of competitive funding. Resource constraints therefore appear to be the main binding constraint for realising the potential of CSF.

More broadly, the Croatian science system needs to move beyond ASHE's "bare minimum" criteria for accreditation and other *ex post* quality assurance processes towards the proactive pursuit of excellence. CSF will be crucial for bringing about a major shift in the balance of HEI/PRI funding towards competitive funding and for supporting a concerted, system-wide drive to internationalise. The success of this wider process will also depend on factors beyond CSF's mandate, notably a meaningful reform of HEIs and PRIs and reliance on performance-based principles in the allocation of funding, the proper functioning of the advisory councils, and full exploitation of the opportunities presented by EU membership, especially with respect to the FP and the European Research Council (ERC).

The Agency for Science and Higher Education

The beginnings of quality assurance in science and higher education in Croatia date back to 1993 when the NCS and NCHE were established. ASHE, founded in 2005, now has the external quality assurance competences of the two national councils and is in charge of initial accreditation/reaccreditation, thematic evaluation and audit, and recognition of foreign educational qualifications. ASHE has grown rapidly and employs a total of 64 people (ERAWATCH, 2010b).

ASHE is in charge of setting up a national network for quality assurance in higher education and providing professional assistance to the NSC, NCHE, SHEFC and CESHE. Within ASHE, the National ENIC/NARIC (European Network of Information Centres-National Academic Recognition Information Centres) office operates as a reporting centre for academic mobility and the recognition of higher education qualifications. ASHE's willingness and ability to respect its mandate was demonstrated in 2008 when, following the evaluation of a number of PRIs, it recommended the removal from the Registry of Scientific Institutions of more than ten of these organisations (ENQA, 2011). Since 2009, ASHE is also responsible for collecting information on Croatian higher education and research developments, for providing support for the implementation of the state *matura* (a secondary-level graduation examination linked to access to university) and for administering the centralised applications and admissions to higher education.

ASHE acts as a link to the international and European higher education policy and regulatory community. It is a member of relevant international associations, such as the International Network for Quality Assurance Agencies in Higher Education and the Network of Central and Eastern European Quality Assurance Agencies in Higher Education; it is an associate of the European Association for Quality Assurance in Higher Education (ENQA) (ERAWATCH, 2010). Membership in such bodies serves to transfer international standards, both to ASHE and to the Croatian higher education system. On its own initiative, ASHE has been evaluated for its compliance with the European Standards and Guidelines (ESG) for external quality assurance agencies and thus with the membership criteria of ENQA. An external peer review, conducted in 2011, rated ASHE's overall performance very highly against ESG standards and found that ASHE is well managed at both executive and board levels (ENQA, 2011).

ASHE works to foster quality at the level of organisations, and the accreditation and evaluation process acts as a powerful instrument in this regard. However, raising the quality of scientific research in Croatia will require additional effort, with more proactive approaches and instruments at CSF and reform of HEIs and PRIs coupled with systematic monitoring and evaluation of policy support measures.

Agency for Vocational Education and Training and Adult Education

Vocational education is the responsibility of the Agency for Vocational Education and Training and Adult Education. AVETAE's activities are defined by the Vocational Education and Training Act. One of its primary tasks is to develop a modern vocational education and training (VET) system, as outlined in the Vocational Education and Training System Development Strategy of the Republic of Croatia 2008-2013. Another of the Agency's tasks is the development of adult learning to facilitate labour market inclusiveness. Its actions are mostly funded by IPA Component IV: Human Resources Development and were previously funded by the CARDS (Community Assistance for Reconstruction, Development and Stabilisation) programme. To reform education by taking into account aspects such as creativity, critical thinking or teamwork, the Croatian National Educational Standard was created and has been implemented since 2005 in elementary schools. Entrepreneurship training is still not widely included in curricula. At the level of university education, initial steps have been taken through the TEMPUS project FoSEntHE, which focuses on development of teaching programmes for enterprises and entrepreneurship.

Agency for Mobility and EU Programmes

AMPEU has implemented EU programmes on lifelong learning since 2009. Its portfolio includes: Comenius (pre-school and school education), Erasmus (higher education), Leonardo da Vinci (vocational education and training), Grundtvig (adult education) and the Transversal Programme Jean Monnet (European integration in the area of lifelong learning).

The State Intellectual Property Office

SIPO is the administrative body with responsibilities for IPR protection. It carries out the procedures for granting industrial property rights (patents, trademarks, industrial designs, geographical indications and designations of origin, topographies of semi-conductor products) and performs the accompanying professional and legislative activity. In addition to its legislative and professional activities, a significant part of SIPO's activities involves provision of information and services relating to intellectual property (IP), co-operation with other institutions to support innovation activity, and co-operation with economic and R&D entities.

SIPO has concluded co-operation and non-disclosure agreements (NDAs) on IP information services and other services as part of its regular activities with HIT/BICRO, Ruder Innovations and the CSF. Co-operation agreements on IP education, according to the IP4INNO methodology, were concluded with BICRO and TERA Tehnopolis. Through its Information Centre (INCENTIV), SIPO provides intellectual property pre-diagnostic services to SMEs (following the methodology of France's INPI), which include estimating the company's innovative and IP potential. SIPO also provides information on various aspects of IP to universities, PRIs, public-private research and technology organisations, and SMEs. Compared to the findings of an international study

of good practices for the support of SMEs in the field of IP covering Australia, Japan, the United States and the EU27 (Radauer et al., 2007), SIPO's approaches in this area appear to be satisfactory while SIPO's collaboration and engagement with the innovation and research agencies and their communities could be strengthened.

Policy intelligence: agenda setting, monitoring and evaluation

The governance of Croatia's innovation system is in flux: the stakeholders have expanded from one to four ministries, four new agencies have been established within six years, funding schemes have been consolidated over the past five years and there is an impending shift from scarcity to abundance owing to the availability of the European Structural Funds. In such a setting, the effective delivery of the functions of government depends on the quality of policy intelligence, effective analysis, and the quality of agenda setting and policy evaluation.

For policy intelligence, the picture is mixed. While there are extensive STI statistics, and the Croatian Bureau of Statistics (CBS) produces regular bulletins on matters of relevance to innovation policy, such as R&D, firm-level innovation, education, the labour market, and the state of various industrial sectors, policy evaluations are infrequent and are not always made public. Whereas BICRO and CSF have systematic *ex ante* evaluation and monitoring of their projects, *ex post* evaluations, particularly at the aggregate level of programmes, including assessment of impacts, are generally lacking. The procedures of BICRO and CSF have not been externally evaluated. ASHE appears to be the only agency to have done this. Nevertheless, there are some advances: the first publicly available evaluation of several programmes (RAZUM, IRCRO and UKF) was performed by the Institute of Economics (2011). In addition, the World Bank conducted a rigorous evaluation of its loan (World Bank, 2012), which may also provide a useful template for future evaluations at the level of programmes.

With respect to the use that is made of policy intelligence information, there is little indication that the detailed statistics produced by CBS are methodically analysed and in some cases that they affect policy at all. The general lack of mention to past evaluations in policy rationales suggests that evaluations do not feed back into policy design. Strategic planning documents (such as the Science and Technology Policy 2006-10 or the Strategic Development Framework for 2006-13) give a cursory overview of headline indicators but do not provide an evidence-based rationale for the identification and selection of priorities. In the absence of such a rationale, priorities are likely to be the outcome of political processes that reflect ministerial and departmental portfolios more than the constraints that prevent the system from achieving its potential. Moreover, orientation and planning documents display a tendency to borrow from internationally popular approaches and instruments that may not be appropriate for Croatia –the most notable example of which has been emphasis on various interface and science-push measures. The result has been a proliferation of objectives all with seemingly equal priority; the magnitude of the challenges is not adequately estimated and the expectations raised cannot be achieved with the modest resources available. For research performance, three types of regular evaluation processes are in place: the evaluation of research projects, the evaluation of individual researchers, and the evaluation of HEIs and PRIs (Švarc and Račić, 2012). Evaluation of individual researchers is linked with their workplace promotion procedures. Judgements are mainly based on bibliometric indicators: the number of scientific papers in relevant journals and the number of citations received. Income from grants or contracts is not considered a performance indicator, nor is the number of patents.

ASHE evaluates the universities, in particular their study programmes, and PRIs. Individual study programmes are evaluated by a combination of national and international evaluators (METRIS, 2011). In addition ASHE evaluates PRIs and HEIs on the basis of self-evaluation reports and follow-on on-site visits by experts appointed by the NCS and NCHE. Typically, only domestic experts take part in these evaluations. However, international experts are involved in the evaluations of the Ruđer Bošković Institute, the Brodarski Institute and the University of Zagreb. As the results of these evaluations are not linked to the amount of institutional funding received, they do not give these organisations incentives to perform.

In the past ten years Croatia's innovation system has undergone changes that would have challenged even countries with more mature monitoring and evaluation mechanisms. Overall, the information base for supporting policies, tracking implementation and measuring outputs and their impact is fragmented. While many positive steps have been taken, including some quantitative evaluations, these are are not, on their own, sufficient for ascertaining the impact of policy and the needs for change.

The establishment of effective evaluation mechanisms (for producing a useful evidence base for policy making and creating incentives for performance) is a long-term process involving not just rules, routines and implementation agencies but also the emergence of a domestic community of evaluators. Linking domestic evaluation exercises and developing common evidence bases would be important for ensuring consistency and continuity in the system. It is important for the effectiveness, legitimacy and credibility of policy for interventions to be, as much as possible, evidence-based.

Monitoring and evaluation should be integrated into policy, particularly the funding cycle. This is presently not the case, particularly for institutional evaluations. The implementation of performance-based contracts can also be linked to evaluation. The proposed shift to address the funding organisations rather than just projects would also benefit from a stronger evaluation culture. The idea would be to examine the goals and strategies of organisations (company, institute, team) and to see how well their projects support the organisation's goals and strategies. This would have an impact on the organisations and their future development, would encourage them to differentiate their missions and would for that reason facilitate coherence in the system.

EU membership will entail a strong demand for reporting, monitoring and related studies. The use of Structural Funds for research and innovation can support the development of policy intelligence systems in line with European standards. To maximise the benefits from the development of such systems, it would be important that they exceed simple reporting requirements and are sufficiently tailored to national needs.

Finally, it would make sense to nurture the development of a strong community of domestic and international experts. In addition to classical peer-based evaluation of grant applications, informed peer-based evaluations are an effective approach to evaluation of institutions. Agencies such as BICRO, CSF and ASHE could jointly develop and maintain a community of experts and contribute to the internationalisation of Croatian research evaluation as regards standards and the building of communities and networks. The Structural Funds can be used to finance such activities and as an opportunity to gain experience with evaluation in practice.

4.3. The policy mix: portfolio and balance of instruments

The following sections examine the policy instruments used and the balance between them. Several types of interventions are typically found across several areas of public policy, including in innovation policy (Bemelmans-Videc et al., 1998; Woodside, 1986; McDonnell and Elmore, 1987): resource transfers (distinguishing between direct funding and taxation and their variations); legislation, regulation and standards; public procurement; transfers of authority and institutional reconfiguration (e.g. creation of new institutions, delegation of responsibilities, nationalisation/privatisation); provision of information (including awareness-raising measures, information platforms, data-gathering and dissemination processes such as systematic audits, peer reviews, statistics and policy intelligence). In assessing the extent to which the policy mix fits the system and deals with its binding constraints, the balance of types of innovation, purposes and target groups is also considered.

Resource transfers: direct funding and tax incentives

The transfer of public resources, typically in the form of direct funding, is one of the most potent instruments at the policy maker's disposal. It is certainly among the most widely used instruments of innovation policy. This is understandable considering the absence of markets for certain types of R&D, the incompleteness of markets for knowledge more broadly, and the pervasiveness of systemic failures. Useful distinctions within the class of funding instruments include the mode of allocation (institutional/competitive), the types of beneficiaries (organisations, individuals, teams or projects), the ownership of beneficiaries (public/private, national/foreign) and the types of costs (human resources, buildings, equipment). Finally, of increasing relevance in recent years is a distinction between direct funding and tax incentives, the latter typically in the form of tax credits or allowances for R&D. Such distinctions can facilitate an assessment of the adequacy of these instruments in dealing with the system's binding constraints.

Funding public research and innovation

As mentioned in Chapter 3 public R&D-performing organisations (HEIs and PRIs) operate under considerable resource constraints. Public-sector researchers in Croatia have relatively fewer resources than researchers in comparable countries. Institutional funding is by far the dominant mode of allocation, and block grants are the primary source of financing of HEIs and PRIs. Block grants cover gross salaries and the material costs of the institutions. In addition, institutions submit investment plans to MSES each year in order to finance additional requirements. Grants are provided for research projects and for junior researchers. The system has limited flexibility for redirecting funds across funding streams for salaries, investment and consumables. There is little competitive funding in both absolute and relative terms and it has been volatile, especially during the crisis. Not only is competitive funding a small share of total funding for HEIs and PRIs[7], the boundaries between institutional and competitive funding are blurred. Even the share that is nominally competitive is not very selective. For a long time, competitive funds (research projects, grants for young researchers and support programmes for scientific publication, etc.) had an acceptance rate of around 90%. In recent years, the acceptance rate has declined to 70% (Švarc and Račić, 2012).

The current funding regime therefore has a number of weaknesses. First, the dominance of non-negotiated institutional funding, and its allocation more or less in terms of HEI or PRI staffing needs, implies the absence of any significant relationship between funding and performance. Yet the legal basis for linking funding to performance and quality exists (EACEA, 2010). Second, systems in which predictable institutional funding

dominates are, in principle, potentially better positioned in terms of the long-term accumulation of human resource capacities, research infrastructures, the funding of stable research teams, centres, etc. In Croatia, these potential advantages have not materialised owing to a combination of limited flexibility for using institutional funding for different purposes and the inability to steer the fragmented HEIs/PRIs (within-organisations and between-organisations, respectively). Third, the small share of competitive funding in the financing of HEIs/PRIs and the high acceptance rate has meant that it has not been possible to exert much leverage and induce a change in behaviour. The competitive funding allocated to scientists and teams has been seen as an occasional addition to regular streams and does not fulfil its purpose of raising quality standards.

In terms of the types of costs supported (human resources, buildings, equipment), attention has focused on increasing the number of researchers. Relatively little attention has been paid to the development of other types of human resources important for innovation (such as professional/vocational skills, master's education) and to investments in infrastructure.

The lack of support for equipment and infrastructure can create important problems for capital-intensive disciplines, such as engineering, physics and chemistry. Specific measures taken by MSES have led to some improvement over the last decade, as reflected in the amounts of R&D funding per R&D personnel. A Register of Capital Equipment (above EUR 30 000) was established to open facilities and equipment to sharing (Švarc and Račić, 2012), in response to the fragmentation of HEIs/PRIs. However, comparisons of resource endowments per R&D personnel with countries of similar income per capita suggest that the deficit remains. Indeed, a majority of participants in TEST were motivated to apply in order to purchase equipment for scientific and education purposes, the second most-cited reason for applying after gaining experience of collaboration with industry (Švarc et al., 2011). In addition, the onset of the crisis had the strongest impact on capital expenditures (see Chapter 3). Opportunities to address current deficiencies in infrastructures, equipment and new buildings will be available in the coming programming period for the Structural Funds (see below).

In many disciplines, the costs of research infrastructures are often too high for individual countries to support. This makes international resource pooling for new infrastructures and the opening up and mutual sharing of existing ones increasingly attractive. The EU's European Strategy Forum on Research Infrastructures (ESFRI) initiative, for instance, aims to facilitate multilateral co-ordination for better use and development of research infrastructures, by providing a forum for national delegates to meet and seek synergies. Some of its activities are reported in the Roadmap for Pan-European Research Infrastructures. To make the best use of limited resources, Croatia should develop systematic means of identifying suitable international initiatives and performing cost-benefit analyses of participation in international infrastructures. This would require wide stakeholder participation and consideration of the extent to which they substitute or complement existing and foreseen projects in Croatia.

The stalling of capacity expansion in capital-intensive infrastructures in HEIs, the suspension of measures for training young researchers, and the insufficiently strategic use of resources by PRIs have all constrained the systematic mobilisation of resources and are symptomatic of the volatility of STI budgets and their dependence on funding from the World Bank and the EU. While EU funding is bound to increase by an order of magnitude, it will not continue indefinitely and its use for sustained capacity building remains a challenge. Ultimately, regular national streams of funding will prove crucial to the long-term development of the system.

Direct and fiscal support for business-sector innovation

Many governments opt to support R&D in the business sector with resource transfers either directly in the form of grants for R&D and related investments or indirectly in the form of tax incentives (see also section on fiscal measures below). Though in the national setting such funding is often relatively small in terms of relative magnitudes, it can make an important difference to individual companies, especially those at critical stages of their growth and development (e.g. when entering formal research activities). Box 4.1 shows government-funded BERD in Croatia and the comparator group, with its magnitude and calculations on the distribution of funding across sectors. Direct government funding of business R&D is low by international standards, in both absolute (EUR 3.26 million) and relative terms (0.86% of GERD). This puts Croatia at the bottom of the comparator group. When one also considers state support via tax incentives, about EUR 18 million of total state funds (or 5.5% of GBAORD) (CBS, 2012) were directed to the business sector. This suggests a somewhat more positive picture, yet Croatia is still a long way from what most countries in the comparator group spend on direct funding alone. The concentration of public funding to a few industrial sectors contrasts with the high sectoral dispersion of BERD and is another indication of its limited relevance.

Box 4.1. Magnitude and distribution of government funded BERD in Croatia in international perspective

A natural response to the limited availability of funding would be to concentrate funding as much as possible. In fact, public support for private R&D in Croatia is already quite concentrated. In terms of the distribution of government funding of business R&D across NACE sectors, calculations on the number of "equally sized" sectors (derived from a Herfindahl index[8]) are suggestive (table below). Unlike unitless summary measures of concentration or dispersion, the number of equally sized sectors can be interpreted intuitively; the greater (smaller) the number of sectors the more equal (concentrated) the distribution. Estimated at about three and a half equally sized sectors, only Estonia had a distribution of public R&D support concentrated on fewer sectors. Moreover, this high degree of concentration contrasts directly with the broad spread of overall BERD across industrial sectors. As no explicit sectoral criteria are applied to the disbursal of direct funding, the discordance between the dispersion of BERD and the concentration of direct funding may indicate the uneven appeal of direct public funding instruments across sectors. Despite the high degree of concentration and because of the small amount of overall funds, funding per sector is around EUR 1 million. This is not only the smallest amount among the countries considered but also four times smaller than that of the second-smallest, again, Estonia.

	Government-funded BERD 2009 in current prices, EUR millions (% of GERD)	Number of "equally sized" sectors receiving government funding (=1/HHI) over 2008-09	Government-funded BERD per equally sized sector in 2009 (current prices, EUR million)	Proportion of innovating enterprises receiving public support (Sixth Community Innovation Survey, 2008)
Czech Republic	185.79 (8.87%)	6.2	29.9	17%
Estonia	9.71 (4.92%)	2.3	4.1	13%
Hungary	94.52 (8.86%)	12.9	7.3	27%
Austria	558.72 (7.47%)	5.3	104.5	40%
Poland	73.46 (3.5%)	3.5	21.0	18%
Slovenia	49.97 (7.61%)	6.4	7.8	24%
Slovak Republic	8.793 (2.9%)	n/a	n/a	14%
Finland	119.78 (1.77%)	9.0	13.4	35%
Croatia	3.26 (0.86%)	3.4	1.0	28%

Source: OECD, based on Eurostat (2012), Statistics Database.

Direct support

BICRO is the main source of support for the business sector; its instruments, as mentioned, are strongly oriented towards technology-based start-ups, transfer centres, incubators and R&D centres, contract research with HEIs/PRIs, support of the proof-of-concept phase and of participation in EUREKA. There is also a small-scale grant scheme operated by MoEC. While these instruments are still operational, consultancy for high-technology SMEs and subsidies for pre-commercial R&D have been terminated. Venture capital (VENCRO) was considered but has not been implemented, mainly owing to the lack of sources of finance and of interest among potential private partners.

The portfolio of funding schemes and services provided by BICRO intends to "unlock" the innovation potential of public-sector research by supporting interface-type measures. BICRO's programmes have been largely co-financed by a World Bank loan, and this has conditioned their continuity. Despite the resource constraints, BICRO's business support seems to have obtained a number of successes in terms of firm and employment creation and leveraging private co-funding. However, these successes have not sufficed to raise the national innovation capacity, as they address a narrow set of stakeholders. The innovation grants of MoEC have so far addressed this gap in policy coverage only very partially as they have been too small, though current plans to increase their size may change this. HAMAG-INVEST also focuses on SMEs and operates loan guarantee schemes and, more recently, support for general consultancy services. In recent years it has increasingly used regional development agencies or business centres to deliver its services. Innovation is at best an implicit issue on HAMAG-INVEST's agenda and there is no evidence of its impact on raising innovation capacity.

Various sources (see Chapters 1 and 3) attest that business funding in general and for innovation in particular is hard to come by. The prevailing policy approaches have been shaped by a rather narrow view of innovation that emphasises specific modes: research-based innovation, the commercial exploitation of public sector research, and a preference for high-technology SMEs. National innovation policy has not yet adopted a broader notion of innovation and has not extended its instruments to address challenges such as the absorptive capacity of firms. As a consequence, the majority of business firms that account for most economic activity in Croatia have not been addressed sufficiently, including less knowledge-intensive firms, firms performing non-research-based innovation and established and/or larger companies.

As is common in many smaller EU countries, funding for intermediate and later stages of business growth (such as mezzanine and equity capital) are largely absent, and there may be too few local investors to create a sustainable venture capital community. Past efforts to provide funds for economic cooperation (co-financed by HBOR) have not addressed this. There are some positive developments though, such as the emergence of a Croatian Business Angel Network (CRANE) and of active start-up communities in urban centres such as Zagreb, Osijek and Rijeka. Notably, a regional fund for the Western Balkans has been established by the European Investment Fund (EIF), the European Commission (EC) and the European Bank for Reconstruction and Development (EBRD), under the name Enterprise Development and Innovation Fund (see www.wbedif.eu). In the near future, the SF can be mobilised to support familiarisation with novel financial instruments.

Support for business innovation – especially the long-term accumulation of in-house innovation capabilities in a much greater number and variety of firms – cannot rely exclusively on international funding but will have to come to a substantial extent from

national budgets. They will have to increase by at least an order of magnitude just to match the commitments of other new EU member states. There are good reasons for channelling such support principally through a specialised agency with a proven track record and for making much more use of direct funding while ensuring adequate monitoring and rigorous evaluation.

Support for innovation in large firms, including the subsidiaries of multinational enterprises (MNEs), would have to be usefully linked to the broader support initiatives of the newly established Agency for Investment and Competitiveness, a potential candidate for collaboration with BICRO. The experience of Ireland's IDA with customising instruments to specific target groups (high-technology and other knowledge-intensive multinationals in particular) may be usefully drawn upon as a model for attracting more knowledge-intensive employment (see Ó Riain, 2004; Collins and Pontikakis, 2006). In expanding its mission beyond R&D and commercialisation of science, BICRO can better support innovators' efforts to reach new international markets. Co-ordination with the State Office for Trade Policy may reveal opportunities for synergies.

There are some indications that Croatia possesses higher shares of knowledge-intensive employment in services than in manufacturing (see Chapter 1). Policy makers increasingly recognise that these sectors are more innovative than previously thought. In contrast to manufacturing, most innovations in services seem to be non-technical and result from incremental changes in processes and procedures that do not require much formal R&D (OECD, 2005). This indicates the need for differentiated policy approaches. Services innovation can be significant in Croatia, especially in its burgeoning tourism sector, but also in sectors connected to ICTs, such as software and communication, as well as business consultancy services, retail and the utilities sectors. In extending the innovation policy mix to support innovation in services more broadly, it may be worth considering embedding service innovation in generic innovation policies, such as R&D tax credits or grants (e.g. in the Netherlands the R&D tax credit now covers the development of software), and integrating service innovation in support measures (commercialisation policies) aimed at science-industry interactions (OECD, 2012b).

There are many policy gaps in support for the business sector, including support for low-capability firms, for non-research driven innovation of various kinds (e.g. in services, notably in the tourism sector), for the adoption of process innovation (such as standards and regulations or other processes with notable productivity improvements), for skills and training and for the employment of skilled human resources, and for facilitation of firm-firm networks to take advantage of the capabilities and leveraging ability of larger firms and affiliates of MNEs (each considered below).

Fiscal measures

Fiscal measures to promote private investments in R&D include tax relief and the exemption of custom duties for importing research equipment. The regulations on reduced taxation of profits for R&D in companies are formulated in the Law on the Amendments and Supplements to the Scientific Activity and Higher Education Law (Official Gazette No. 46/2007). These regulations harmonise the regulations on the taxation of R&D with EU rules. They allow companies to reduce the tax base for eligible costs of scientific and developmental research projects by 150% for fundamental research, 125% for industrial research and 100% for development research (provided the total amount of relief is equal to or lower than 100%, 50% and 25%, respectively). The terms are even more generous for SMEs (Aralica et al., 2011). Eligible costs include

(insofar as they are incurred in the course of/are deployed exclusively for) personnel, equipment and property, costs of obtaining technical know-how and licensing patents, consultancy and additional overheads and operating costs (Aralica et al., 2011).

R&D tax incentives are significantly larger than the respective direct resource transfers in the form of grants and other funding measures. For example, in 2009 direct subsidies amounted to less than a third of the aid granted by the tax incentives (Table 4.8). However, the overall scale of resource transfers to support R&D in the business sector, including tax incentives, is still exceptionally low by international standards (see table in Box 4.1, col. 1).

Table 4.8. State aid for research and development and innovation, 2007-09

	2007		2008		2009	
	HRK millions	EUR millions	HRK millions	EUR millions	HRK millions	EUR millions
A1 grants	4.9	0.7	46.9	6.5	31.6	4.3
A2 tax advantages	156.0	21.3	162.6	22.5	107.5	14.6
Total	160.9	21.9	209.5	29.0	139.1	19.0
- % of horizontal aid	24.1		31.6		21.1	
- % of total state aid (less agriculture and fisheries)	2.0		3.5		2.8	
- % of total state aid	1.4		2.2		1.6	
- % of GDP	0.05		0.06		0.04	

Source: Aralica et al. (2011) "Evaluation of tax incentives aimed at stimulating R&D Projects in the business sector: Preliminary results", Institute of Economics, Zagreb, p. 8, originally from Croatian Competition Agency.

The current tax incentives for R&D seem to benefit a small number[9] of medium-sized to larger firms, providing support for maintaining or increasing their R&D investment in Croatia (Aralica et al., 2011). They provide much less support for smaller, less R&D-oriented firms and innovation more broadly. This may be partly due to the complexity of the application procedure in Croatia or may reflect similar difficulties that smaller firms have in benefiting from such instruments in other countries too. A better understanding of the reasons for their uneven appeal seems necessary and can be the topic of a dedicated study.

The Act on Investment Promotion and Development of Investment Climate which came into force in September 2012 foresees a variety of tax incentives for investments in tangible and intangible assets, many of which are of direct relevance to innovation activity such as purchase and modernisation of equipment, training costs, business support services as well as the development of product and process innovations. The minimum investment threshold covered by the Act is EUR 150 000. Reductions in the corporate profit tax rate by 50%, 75% and 100% are foreseen for investments of up to EUR 1 million, 3 million and 3 million, provided that the investments also lead to the generation of employment (5, 10, and 15 new posts respectively).

In the recent past, OECD and EU countries have increasingly employed tax incentives to support innovation in the business sector. Like direct funding, they address the tendency of the market to devote fewer resources to innovation than would be socially desirable. It is often thought that they are more advantageous than direct funding in that they allow firms, rather than government, to decide which R&D projects to finance

(OECD, 2012c). Tax incentives may also influence the location of internationally mobile R&D. While public support to business R&D via tax credits therefore has specific advantages, it is not necessarily allocated where they are likely to have the greatest social return. Tax incentives for R&D can have drawbacks which may be more pronounced in countries with nascent innovation systems.

- A key issue for policy for emerging innovation systems is how to design and customise support to the different needs of various segments of a developing business sector in order to encourage more firms to innovate, and support more of the innovating firms in their efforts to upgrade their capabilities and become internationally competitive. Tax incentives for R&D may not be the best way to perform these tasks as they are more difficult to target.
- Pure R&D tax incentives correspond to a rather narrow subset of inputs to a specific type of innovation. They do not cover non-R&D-based forms of innovation and downstream parts of the process linked to commercialisation and widespread use. The current framework for fiscal incentives in Croatia is somewhat broader in its coverage of inputs, but like the rest of innovation support, was mostly concerned with R&D-based innovation. In that respect, the introduction of tax incentives for wider innovation investments, as foreseen in the recent Act on Investment Promotion and Development of Investment Climate could provide valuable experience.
- R&D tax incentives are much less relevant to start-ups, which typically have few or no profits to be taxed. For companies with liquidity constraints, tax incentives may not have a timely impact. In terms of tax incentives, SMEs are generally at a disadvantage as they often perform non-R&D-based forms of innovation and even those that perform R&D are unlikely to meet the requirement of *exclusive* use of eligible personnel, buildings and equipment for R&D. OECD analysis has shown that tax credits may favour less dynamic incumbents at the expense of dynamic young firms (OECD, 2013b).
- R&D tax incentives may not bring about a meaningful and lasting change in the innovation behaviour of firms as some companies may simply claim tax credit for activities that they would do in any case.

In light of the above, there may be a need to reconsider tax incentives, based on an overall appreciation of their opportunity cost and other possible impacts. In their current form they may not be equally relevant to parts of the business sector (such as non-R&D innovators of all kinds and start-ups) and may not fully exploit the potential for spillovers in the commercialisation and production stages.

Funding skill development

Skills are a relatively neglected area in terms of the use of resources to support the business sector. This is an area of direct relevance to the business sector and one of the main barriers to innovation according to the latest CIS. A recent OECD survey found that it was cited as a greater barrier than the availability of external funds (see Chapter 3). The current partial conceptualisation of innovation has also affected support for the provision of relevant skills. BICRO and HAMAG-INVEST do not engage in skills upgrading within firms, except indirectly through accreditation of consultants and support for companies to hire accredited consultants. By virtue of CSF's mission, it focuses support on research skills and international scientific mobility, which are more relevant to the

public than to the business sector. Some potential for relevant skills provision exists in AMPEU, notably the initiatives connected to lifelong learning and to vocational education such as the Leonardo da Vinci programme and Grundtvig. The current impact of these programmes is not known. Some TEMPUS projects attempt to fill gaps in the provision of entrepreneurship and other business education at universities, and some also cover skills in professional and vocational education. Given the low budgets involved and the focus of these projects on curriculum development, it is doubtful that they would be sustainable in the absence of a steady supply of national funding.

A supply-push approach to skills may not work if the business sector's demand for such skills is dampened by a lack of in-house activities (in design, architecture, engineering, marketing, ICTs and R&D) that could make use of such skills or even the inability of management to appreciate the potential benefits from innovation in a business environment that emphasises other sources of profitability. One way to kick-start such activities and stimulate demand is to provide public support for knowledge-intensive employment (e.g. the insertion of a "first engineer", an "innovation assistant", etc., into SMEs). The aim would be to sustain such employment in business firms long enough for the initiation of the kinds of knowledge-intensive activities (in design, engineering, marketing, information technology) that can lead to profitable innovation or at least demonstrate its potential to do so. This would be especially relevant for firms that have systematically engaged in new-to-the-firm innovation (e.g. adopted international quality standards such as ISO qualifications or upgraded their information gathering and logistics operations with ICTs) and wish to engage in new-to-the-market innovation but lack the necessary in-house capabilities. This appears to be the case of a substantial proportion of the Croatian business sector. Public support for the employment of graduates with the needed skills could be a first step in that direction. For companies with more developed innovation capacities, employment of researchers can be crucial for developing internationally appealing products and services. Slovenia's experience with programmes to support the employment of young postgraduates in industry may be useful. These include a dual mentorship (an academic and an industry-based researcher) by the Slovenian Technology Agency (TIA) and, for more established researchers, the "Co-financing of employment of researchers in enterprises" scheme of the former Public Agency for Entrepreneurship and Foreign Investments (JAPTI) (OECD, 2012a, p. 163).

Strengthening professional and vocational education, addressing evident short-comings in the supply of specialised graduates (see Chapter 3) as well as promoting on-the-job training and lifelong learning for those already in employment would increase the pool of qualified human resources. Extending the scope and duration of industrial placements would be one way to improve the economic relevance of tertiary education. However, as the ability of companies to absorb students is limited, extending the length of placements may also imply rationing them to the better-performing students, which may, on the long-run, help improve the attractiveness of such initiatives to companies. Other examples of instruments to support the development of business-relevant skills include job shadowing and service learning (Box 4.2).

Box 4.2. Different forms of workplace learning

Workplace learning includes a diverse set of practices ranging from brief periods for observing a workplace to structured, long-term apprenticeships leading to a qualification or diploma.

- Job shadowing involves very short periods of time – usually days – in which students follow a worker to learn about a job. This often involves younger students and serves the purpose of exploring possible careers. In Canada, ninth-grade students shadow an adult close to them in real-life work settings ("Take Our Kids to Work", www.thelearningpartnership.ca/page.aspx?pid=250). In Italy, vocational education and training (VET) secondary schools team up with local enterprises to set up "simulated learning enterprises" on school premises to encourage students to acquire the skills needed by those enterprises.
- Service learning involves voluntary work by students, usually in non-profit organisations, to provide a service and learn as well. In the Flemish Community of Belgium, for example, some students in part-time VET programmes participate in such learning.
- Internships are short periods of time during which students work in actual workplaces, usually for no or nominal wages. They may be governed by a special contract. In Austria, the Flemish Community of Belgium, Chile, Hungary, Italy and Mexico, students in school-based upper secondary VET programmes may participate in internships, although not all do so.
- Apprenticeships are a more structured, dual-track approach, combining part-time, workplace-based training in a company with classroom instruction in a vocational school, usually over a period of years, leading to a qualification. Germanophone countries (Austria, Germany, Luxembourg and Switzerland) have well-developed apprenticeship systems They also exist in Australia, the Flemish Community of Belgium, Denmark and the Netherlands.

Source: OECD (2012d), *Better Skills, Better Jobs, Better Lives: A Strategic Approach to Skills Policies*, OECD Publishing, doi: 10.1787/9789264177338-en.

Funding of linkages

Croatian research and innovation policy has emphasised the commercialisation of public research and the creation of interface structures at the periphery of HEIs/PRIs. Accordingly funding measures have been directed at the science-industry interface: technology transfer offices, incubators, technology parks, research centres, science-industry co-operation and technology-based companies. TEHCRO has focused on technology infrastructures and incubators, including the Biosciences Technology Commercialisation and Incubation Centre (BIOCentre), RAZUM on stimulating and supporting academic spin-offs, and IRCRO on funding collaborative R&D projects between firms and HEIs/PRIs.

However, Croatia lacks instruments to support larger-scale, more systematic science-industry collaborations. Many countries have such instruments. These include competence centres (Austria, Estonia, Sweden), collaborative research centres (Australia), centres of excellence and regional research centres (Czech Republic), open access centres (Lithuania) or top institutes (the Netherlands). While their missions vary, all have a long-term orientation based on a coherent research agenda and systematic involvement of research partners from industry, the public sector and academia. Such facilities offer Croatia a number of opportunities and should be considered an option for EU Structural Funds investment to achieve a stronger and more systematic link between HEIs and PRIs, by making use of their respective advantages (training of young researchers, access to

research infrastructures), and involve companies operating on international markets, such as subsidiaries of MNEs.

The spatial and/or thematic concentration of research and innovation activity in cluster-type arrangements (whether called 'clusters' as in the recent past or under the guise of triple helix, regional smart specialisation strategies or in the context of public-private partnerships) is likely to play an important role in the future policy mix. Clusters typically act as a low-threshold, flexible instrument for capacity building, by providing access and supporting networking mainly at regional level. The kinds of activities promoted by clusters and related instruments support science-industry interaction mainly by co-ordinating and leveraging existing structures and resources. As clusters are inherently co-ordinating and facilitating mechanisms, their role and impact very much depends on their embeddedness into existing networks and their access to major actors. Existing institutional infrastructure at the policy implementation level (BICRO and HAMAG-INVEST) and at the institutes themselves in the form of various intermediaries (technology centres/parks, development agencies, incubators) seems receptive to such approaches. However, clusters sometimes tend to duplicate rather than complement existing structures. Managers of incubators as well as managers of technology and transfer centres and parks engage in networking within their own realm. One reason is that they compete for the same, limited, mainly public resources. It will be important to ensure that the activities of clusters are complementary and have strong institutional backing.

International evidence from the CIS suggests that when firms collaborate in their innovation activities they do so primarily with other firms. The promotion of inter-firm (or firm-firm) networks can have a lasting influence on demand for knowledge-intensive employment and can stimulate innovation activity. While the EU FP does this to some extent and will do so more upon EU membership, this may not be enough in the absence of complementary national policy instruments. First, the FP focuses on pre-competitive research and not on marketable products or services. Second, it requires companies to engage in R&D that is typically close to the global frontier, which contrasts to the current needs of most Croatian SMEs for new-to-the-firm and new-to-the-industry innovation. These firms will require national support measures (possibly co-funded by the SF) to create and sustain collaborative linkages to develop intermediate products, marketable products, and supplier-client joint processes. Large subsidiaries of MNEs operating in high-technology industries or large domestic, sometimes state-owned enterprises with good innovation records have in some cases pulled networks of suppliers and clients into more knowledge-intensive activities by fine-tuning their intermediate product procurement procedures and by engaging in joint training and other forms of collaboration. International experience suggests that MNEs' affiliates (see examples in OECD, 2007) may sometimes find inter-firm network relationships with local suppliers profitable in terms of long-term cost reductions and may be willing to partly finance schemes for developing them.

Sectoral support

Croatia provides a considerable amount of sectoral support to industry, primarily to sectors that are deemed socially significant (e.g. owing to their contribution to employment) or strategically significant as areas of current or future national comparative advantage. However, this support is insufficiently linked to innovation.

An overview of state aid during 2008-10 (Table 4.9) by sectors and/or social objectives, shows that public support for business research, development and innovation (RDI) represents only 1.6-2.1% of total public support for the business sector. By comparison, agriculture and fisheries (42.71%, 2010), transport (16.25%, 2010) and shipbuilding (13.26%, 2010), taken together, account for almost three-quarters.

In the EU framework (including for competition), now fully applicable to Croatia, R&D and innovation policy will become a major channel of support to industry, including to sectors that have been seen as nationally important in Croatia for various reasons. In addition, EU membership means that new sources of support to the business sector will become available through the Structural Funds, albeit less directly.

Table 4.9. State aid by aid categories, 2008-10

Sectors	2008		2009		2010	
	EUR millions	Share (%)	EUR millions	Share (%)	EUR millions	Share (%)
Agriculture and fisheries	500.5	37.81	500.2	42.24	549.9	42.71
Industry and services	823.3	62.19	684.1	57.76	737.6	57.29
Horizontal objectives	91.8	6.93	89.7	7.58	87.3	6.78
RDI	29.0	2.19	19.0	1.60	23.0	1.79
Environmental protection and energy saving	5.2	0.39	8.8	0.74	3.7	0.29
SMEs	23.9	1.80	31.1	2.63	23.5	1.82
Training	9.5	0.72	7.3	0.62	66	0,51
Employment	18.9	1.43	5.8	0.49	12.8	0.99
Culture	5.3	0.40	5.0	0.42	7.1	0.55
Support to access to finance during financial and economic crisis			12.8	1.08	10.7	0.83
Specific sectors	663.8	50.14	521.0	44.00	568.9	44.18
Steel production			0.3	0.03		
Transport	201.1	15.19	178.4	15.06	209.2	16.25
Shipbuilding	261.9	19.79	157.1	13.26	170.7	13.26
Tourism	23.7	1.79	22.4	1.89	21.6	1.68
Public service broadcasting	147.9	11.17	154.4	13.04	162.3	12.60
Other sectors	18.6	1.41	8.1	0.68	1.2	0.09
Rescue and restructuring	10.4	0.78	0.4	0.03	3.8	0.30
Regional aid	43.0	3.25	43.5	3.67	42.4	3.30
Aid at local level	24.7	1.87	29.8	2.52	39.0	3.03
Total	1.323.8	100.00	1.184.2	100.00	1.287.6	100.00

Source: Republic of Croatia (2011), Croatian Competition Agency, *Annual Report on State Aid for 2010*, December.

Many countries are using innovation policy as part of a wider "directional" industrial policy to build strengths in sectors considered especially attractive. Pre-eminent among such tendencies in the EU context is the "smart specialisation" approach, which envisages the use of STI instruments to develop national or regional comparative advantages. Central to the approach is an "entrepreneurial process of discovery", a multi-stakeholder identification of unique STI niches to specialise in. The intention is to promote innovation in the direction of scientific, technological and industrial change.

The EU's smart specialisation strategy allows considerable room for manoeuvre and may be useful in achieving greater coherence in the use of Structural Funds for STI expenditures. In any case, economically profitable diversification will require policies that increase the structural flexibility of the system as a whole and allow it to develop innovative capacities in sectors of high global demand. The challenge is to provide the market (domestic competition, internationalisation) and non-market (regulation, public procurement) stimuli and framework conditions to facilitate diversification and avoid lock-in into sectors of low value added and adverse terms of trade over the long term (such as certain types of tourism and some primary sectors). In light of the obvious limits of long-term industrial planning, policy makers should balance the selection of priority areas or sectors *ex ante* with increased attention to the flow of signals for profitable internationally tradable activities and to the responsiveness of the system to these signals.

Innovation in the tourism sector

Environmental sustainability has been central to Croatian strategic planning on tourism for over two decades (Ministry of Tourism, 2003; Ministry of Tourism, 2013), but innovation does not appear to have been an integral part of this agenda. Despite greater attention to innovation in more recent planning, there is still no visible inter-ministerial co-operation between innovation policy stakeholders and their tourism policy counterparts.

There are good reasons to believe that both the environmental and the economic sustainability of tourism depends on innovation. Tourism has relatively low costs of entry and therefore tends to become a sector of considerable proportions (in terms of contribution to exports, employment, value added) in countries with favourable natural endowments, such as Croatia's EU partners in the Mediterranean area. As few countries possess such natural advantages, the sector can be highly profitable. However, without continued innovation tourism can be subject to rapid demand swings owing to a combination of changes in consumer tastes over time and, as more countries overcome the low barriers to entry, the emergence of lower-cost locations. Moreover, excessive dependence on tourism may result in adverse effects like those in countries rich in mineral exports such as oil and gas. There is some evidence that small countries or regions that depend heavily on tourism have suffered adverse demand shocks, a decline in manufacturing (as its comparative advantage deteriorates and the currency appreciates), and even increases in rent-seeking and institutional deterioration (Capó et al., 2007; Sheng, 2011; Shong et al., 2012). There are some tentative indications – especially with respect to currency appreciation and an associated industrial decline (Broz and Dubravčić, 2011) – that this could pose a challenge for Croatia. The above underscore the crucial need, and role of innovation policy, to foster more balanced structural change through diversification to higher value added economic activities across the services sector and across manufacturing.

Within the tourism sector, given these considerations, a focus on innovation becomes an economic imperative. Innovation may also help to reduce the strong seasonality of current demand for tourism, which, among EU countries, is greatest in Croatia and Greece (Eurostat, 2010). Policy could usefully focus on the existing momentum of environmentally sustainable tourism. A concerted drive towards innovation in tourism, with a further focus on environmental sustainability (green innovation), could also have other long-term positive impacts, notably in the areas of energy, water, waste and biodiversity (OECD, 2013a).

Essential parts of a drive for green innovation in tourism services would include: increasing industry engagement to showcase the benefits of innovation in tourism, greener destination planning and co-ordination with fiscal and government investment policies, including facilitation measures for private finance (OECD, 2013a). A key policy challenge is to convince industry stakeholders, in a sector that is highly profitable at present (partly owing to heavy investments in the past that are now written off) that investment in innovation is necessary for long-term sustainability and not just for environmental reasons. An important part of such an effort in Croatia would expand the agenda of innovation implementation agencies and their funding instruments to cover innovation in services and identify specific opportunities for collaboration with businesses in other sectors as well as HEIs/PRIs, in terms of marketing, design and R&D (see examples in Box 4.3). Green innovation in tourism may also be a profitable sectoral focus for a possible competence centre.

Box 4.3. Examples of policy initiatives to promote green innovation in tourism

Switzerland: Federal Act on the Promotion of Innovation and Co-operation in Tourism

Switzerland has supported innovative and sustainable tourism projects for over ten years under the Federal Act on the Promotion of Innovation and Co-operation in Tourism (1997 Innotour Act). The Act was recently reviewed and came into force in a revised form in February 2012. It now stipulates the project requirements in relation to sustainability and only projects that contribute to the improvement of resource efficiency will be supported. The medium- to long-term goal is the separation of economic growth due to tourism from the amount of resources consumed. Under the new Act the Confederation can also specify topics and spearhead certain projects, thereby expanding the possibilities of national tourism policy to promote sustainable tourism.

Portugal: network of co-operation on tourism R&D

Turismo de Portugal has recently launched a project to establish a network of co-operation on tourism R&D, running from 2011 to 2013, in order to mobilise the tourism research capacity of universities. It is the first instrument of tourism policy developed specifically to promote innovation, and in particular green innovation, in tourism. This project will be upstream of innovation processes, producing knowledge on critical issues for green innovation in tourism, in the following areas:

- ICTs: processes with a focus on market access, network management and virtualisation of the value chain, optimisation of management processes, enrichment and / or creation of new proposals for consumption / experience, intelligence, etc.
- Architecture, technology and construction materials, with particular emphasis on the adaptation of creative design, integrated environmental solutions, building energy optimisation, etc.
- Water management and energy management, particularly research solutions for profitable production and consumption and reduced environmental impact for businesses and entertainment equipment.

The network's mission will be to develop partnership projects between the national scientific and technological system and enterprises able to create green innovation.

Source: OECD (2013a), "Green Innovation in Tourism Services", *OECD Tourism Papers*, No. 2013/01, OECD Publishing, doi: 10.1787/5k4bxkt1cjd2-en.

Legislation and regulation

As discussed in Chapter 1, framework conditions are critical for the performance of innovation systems. The legal framework for innovation[10] consists, among others, on the provision and enforcement of IPR, the competition framework and binding regulations. These are complemented by (voluntary) standards (see Table 4.10 below).

IPR play an important role in modern innovation systems. Owing to the public good features of knowledge, innovators are unlikely, in the absence of government intervention, to reap enough of the benefits of their efforts, which are largely captured by society at large (including competitors). This can dampen or destroy potential innovators' motivation to invest in innovation. With property rights for knowledge and a system of enforcement, innovators can recoup more of the benefits of innovation and are thus encouraged to innovate. Patents, copyright (and related instruments such as trademarks and industrial designs) bestow innovators with a temporary monopoly on the economic exploitation of their innovation. In doing so, they inhibit the diffusion and widespread use of the innovation by adding to its cost for potential imitators and users alike. Partly due to considerations on the appropriate balance between the benefits and costs of IPR, countries vary widely in the scope and quality of their IPR legislation and the effectiveness of enforcement. Countries that enforce IPR better have stronger innovation systems, in terms of generating higher shares of economic growth from total factor productivity (Furman et al., 2002; Furman and Hayes, 2004).

Croatian IPR legislation has been aligned with that of the EU for some time (EC, 2006). However, recent European Commission reports highlight the need for better enforcement, for sufficient funding for the Board of Appeals (first instance), and for increasing public awareness of IPR (EC, 2011a, pp. 30-31). Nevertheless, there is little uptake of IPR instruments in Croatia (see Chapter 2), an indication that the domestic market for formally traded innovation is small. The lack of an upsurge in the registration of foreign-owned patents on the eve of EU accession (WIPO, 2013) suggests low expectations for the market's medium-term development.

A strong IPR system needs to be accompanied by a legislative and operational infrastructure that supports market competition (see Chapter 1). Historically, the Croatian business landscape was dominated by state-owned and collectively managed enterprises, some of which were large. Privatisation and the transition to a mixed market economy generally reduced industrial concentration and competition policy has had success in some areas. However, pockets of strong concentration persist in some sectors still dominated by old incumbents (such as utilities where, with the exception of telecommunications, the top firms have maintained their market share). In a small number of new sectors that have attracted MNEs (such as computers and related services, manufacture of tobacco products and retail), concentration has increased over the past decade (Tipurić and Pejić Bach, 2009). The establishment of the Croatian Competition Agency (CCA) and the recent extension of its powers under the Competition Act of 2010 are important steps in securing and maintaining a level field. CCA appears to have sufficient administrative capacity and is monitoring and adjudicating some three dozen cases a year (EC, 2011a). CCA is also monitoring the implementation of state aid (e.g. to the shipbuilding industry) for compliance with EU rules. Greater co-operation between CCA and BICRO/MoE will probably be necessary to ensure that more direct support to business innovation does not contravene EU rules.

An obligation arising from Croatia's EU membership will be the adoption of EU regulations that will affect product characteristics, industrial processes and consumers. From the perspective of innovation and related policies and support measures, this enforced adaptation can spur extensive new-to-the-firm and new-to-the-industry innovation. However, legislation alone does not ensure the correct implementation of regulations. Effective implementation requires mobilising all stakeholders through awareness-raising campaigns, provision of information on specifications, brokerage with specific service providers, and perhaps the direct provision of coaching and advice by specialised government agencies. SMEs face particular challenges for the timely adoption of standards, owing to lack of awareness and of human and financial resources.

In the Pre-accession Economic Programme 2012-14, the Croatian authorities prepared an extensive action plan (Republic of Croatia, 2011). Its Annex III (Structural Reforms Agenda and Achievements) envisages more than 220 regulatory reforms and adaptations in a wide range of policy areas (Republic of Croatia, 2012). Implementation of the requirements of the Floods Directive provides an example of the magnitude of the effort required. The preparation of flood hazard maps and flood risk maps,[11] including the installation of the relevant software and training, will take at least 1.5 years and requires a budget of EUR 1.1 million and the support of the ministries and specialised agencies of a consortium of three EU members. The training of specialists in the Croatian professional community will take another year before the first adaptations and new investments can be made, a process likely to take several years.

It is clear that the large number of regulations to be introduced creates a considerable co-ordination challenge and will require the mobilisation not only of MRDEUF and the MoE (as the relevant sectoral ministry) but also the implementation agencies, including BICRO, HAMAG-INVEST and CCA. The SF can support the implementation of standards, associated infrastructure and the process of extensive adaptation that will accompany them. Expertise from the European Commission, selected national authorities from other EU member states but also standardisation bodies can also be mobilised. Special attention will have to be paid to SMEs and to the regionally balanced implementation of the standards across Croatia (EC, 2012a). Synergies will need to be sought between large-scale projects (e.g. physical infrastructures) financed by the SF and the introduction of associated regulations, in order to maximise the return on the limited administrative capacities.

Public procurement

Public procurement, together with (binding) regulation and (voluntary) standards, address the demand side of innovation (Table 4.10). The preferences of discerning consumers in a large and sympathetic market are vital for the development of an innovative and internationally competitive business sector (Georghiou, 2007). A ground-gaining argument in recent years is that the public sector can use expenditure for its procurement needs creatively to emulate a "lead market", typically a market with demanding early adopters, whose needs and preferences can influence the development of innovations that later come to enjoy general acceptance. In this way, public procurement may stimulate innovation[12]. It may increase the productivity and effectiveness of the public sector; leverage its purchasing power to induce lasting behaviour change in the business sector (e.g. by encouraging non-innovating firms to innovate); and provide a focal point for the development of activities within companies that thrive on innovation, such as design, engineering, marketing, various forms of IT and of course R&D. Employing public procurement for this purpose is frequently spurred by or occurs with

the introduction of binding regulations and voluntary standards. It is therefore important to consider the possibility of interactions between these three demand-side instruments.

Table 4.10. Key features of demand-side innovation policy instruments

Demand-side policy	Procurement	Regulation	Standards
Objective	New product or service	Market uptake, increased competition and social goals	Market uptake, interoperability, transparency
Input	Finance, performance requirements, skills	Legal process, need to co-ordinate	Participation of standards agencies, co-ordination of participants in the standards development process
Participatory incentive	Sales, risk reduction, preferential treatment (e.g. SMEs), attraction of additional private-sector finance	Mandatory	Voluntary
Effects of success	Improved and less costly public services, stimulation of innovation	Reduced market risk, transparency, stimulation of innovation	Reduced market risk, transparency, increased interoperability, increased trade
Possible risks	Insufficient skills in the public sector, lack of co-ordination across government, idiosyncratic demand	Conflicting goals, length of the process	Technology lock-in, inadequate attention to consumer needs (with industry-driven standards)

Source: OECD, based on Aschoff and Sofka (2008), "Innovation on Demand: Can Public Procurement Drive Market Success of Innovations?", *ZEW Discussion Papers*, 08-052, Zentrum für Europäische Wirtschaftforschung/Centre for European Economic Research.

A number of countries already use public procurement as an innovation policy instrument and others are considering it. There are also the EU Lead Market Initiative (covering eHealth, protective textiles, sustainable construction, recycling, bio-based products and renewable energies) and a new action plan of the European Commission for boosting demand for European innovations (EC, 2012b).

There are trade-offs as using public procurement for innovation may not be the most cost-effective way to fulfil the public sector's procurement needs. Indeed, one of the characteristics of lead markets is the willingness and ability of their consumers to pay a premium for innovation (Izsak and Edler, 2011). In practice this means that public procurement for innovation carries costs, which include a potential efficiency penalty in the delivery of public services if the solution is inferior to the best in the market (or the cost of mitigating the penalty with additional procurement). The overall transaction costs (planning, negotiation, co-ordination, monitoring and evaluation) may also be substantial. The short-term efficiency penalty may be more than offset by long-term gains from innovation, provided the instrument remains in place for a sufficiently long period.

To support innovation, government may use its procurement needs in two distinct but complementary ways: it may use directional procurement targeted at specific technologies/sectors, e.g. for the IT industry and services; for recurrent procurement, it may demand changes to achieve persistently higher standards of quality and efficiency through innovation, employment of the highly skilled and demand for knowledge-intensive services such as engineering and design activities, e.g. in ICT and related services. This can be done by specifying the functional requirement of the procured goods and services rather than committing contractors to specific solutions.

There is a range of opportunities for experimentation, not only in Croatia, but also in many EU and OECD countries. General-purpose technologies, such as ICTs and biotechnology, can be supported through specific technologically and/or sectorally focused procurement plans. Process innovations in logistics, training and even planning can be supported through increasingly demanding specifications in terms of the ratio of output to input. Finland and the United Kingdom are using public procurement to support innovation in services, Korea to address social challenges, such as services for an ageing population, and Stockholm's Royal Seaport to create a sustainable city (OECD, 2012b).

Demand for innovation can be stimulated by so-called co-operative procurement, whereby government and the private sector co-finance a large-scale sectoral innovation programme. Such an approach may make sense when the needs of the public and private sectors overlap, as in the case of energy-efficient or environmentally sustainable office equipment. Firms gain from cost-efficiency improvements and government achieves the social goal of environmental sustainability (Georghiou, 2007).

Given the weight of the public sector in the Croatian economy, the foremost objective of public procurement should be to foster competition on the basis of efficiency and quality. Capacity building in less capable actors may be a result of this use of public procurement – and may strengthen competition in the long run – but it should not be the primary policy objective. As part of the income of the PRI sector depends on government procurement contracts, such an approach could foster competition in the sector and raise the quality bar.

However, precisely because of the size of the government sector, the use of public procurement for innovation also poses risks. Policy making in this area should be mindful of the potential for efficiency penalties stemming from e.g. corruption and closed markets, as well as the inability of the central government administration and specialised procurement agencies to manage innovative contracts, with delays, cost spirals and missed performance targets (Georghiou, 2007). To minimise such risks and use public procurement as a vehicle for the creation of competitive markets, several things should be kept in mind:

- The use of procurement for innovation should be linked to other long-term, large-scale national goals, such as national sectoral strategies and major infrastructure projects, including urban infrastructure, environmental projects (wastewater plants, landfills) and transport infrastructure (ports, airports).
- The amount of funding mobilised by procurement must be large enough to overcome the "indivisibilities" associated with R&D-based innovation and the considerable production and follow-on operating costs, such as service and support (Georghiou, 2007).
- The scope of government procurement needs – from ICT and capital-intensive infrastructure to construction and support for service provision – is wide. It will only be possible to fulfil a small part of public procurement needs by individual corporate or other providers. A necessary part of any policy in the area will be the facilitation of competitive consortia of national and international partners from the business sector, PRIs and HEIs.
- A major task of innovation policy is to strengthen the competitiveness of Croatian businesses in an internationally more open domestic procurement market and to facilitate their participation in the much larger European market for (innovative) public procurement, i.e. fulfilling the procurement needs not just of the Croatian

public sector, but of public sectors in other EU states. Enabling businesses to participate in international tenders for innovative products and services can be an objective of general public support measures for R&D and innovation. The possibility of joining European public procurement initiatives (as they materialise) of relevance to the Croatian public sector should also be considered.

- Information exchange and co-ordination between MoE, which has direct responsibility for public procurement, agencies such as BICRO, CSF and HAMAG-INVEST and business firms should be ensured.
- It is of paramount importance to safeguard the integrity of the process with appropriate management of tenders that minimise the risk of mismanagement and define clear penalties all parties that attempt to pervert the process.

Transfers of authority and institutional reconfiguration

The transfer of authority for decision making to other parts of government or outside it has considerable potential to affect the efficiency and effectiveness of policy. Importantly, transfers of authority represent opportunities to enhance the innovation system without necessarily implying a budget burden. Decisions on transfers of authority take a wide variety of forms and intensities, ranging from the complete transfer of executive powers to different organisations to arm's-length co-ordination on a voluntary and *ad hoc* basis. This may also involve the setting up of distinct organisations or their integration (e.g. as in a merger) and the transfer of ownership (e.g. privatisation or nationalisation). Among other considerations, decisions on transfers of authority have to take into account the relevant parties and the nature of the co-ordination[13], as well as its frequency and intensity. International experience shows that specific configurations within the government – such as delegation of executive funding decisions or an advisory role to an intermediate level – can improve the efficiency and effectiveness of policy.

The most significant transfers of authority in Croatia involve the delegation of parts of the orientation, implementation and policy advice functions to operationally independent councils, expert committees and, above all, executive agencies. The most important agencies that now incorporate (parts of) functions that previously belonged to MSES are BICRO, CSF and ASHE. In 2012, the Z-Projects for PRIs/HEIs and initiatives for technology programmes and related activities, particularly science-industry co-operation and commercialisation of research results, were transferred to CSF. This was a major step towards making CSF a more mainstream science funding agency. The current situation is the result of a long process of delegation that has facilitated a better understanding of each agency's target groups, policy learning from leading international practice, and the greater efficiency that comes with specialisation. There is some evidence that it has had a positive impact on the governance of Croatia' research and innovation.

Nevertheless, ministries have maintained strong control over programming decisions and in some cases over implementation. The MoEC for instance still operates an innovation grants scheme separate from BICRO. While decisions on programming, insofar as they are non-routine (e.g. rebalancing the policy mix), are for good reasons kept within ministries, implementation tasks are usually more routine and benefit from being carried out by operationally independent agencies. Likewise, ministries are the natural place for the orientation function as they are the part of government that is most closely aligned with the democratic expression of social interests and most directly subject to parliamentary scrutiny. Councils can have an important say on orientation, in

their expert advisory role, and on implementation in terms of monitoring and suggestion, but otherwise their presence implies a transfer of only "soft" authority.

The establishment of the Strategic Council for Science and Technology (SVEZNATE), to be chaired by the prime minister, appeared a promising way of raising the profile of STI policy making in Croatia and contributing to some long-term stability. However, both SVEZNATE and the National Innovation System Council of MSES (VNIS) are not operational (Švarc and Račić, 2012). In principle, the delegation of part of the orientation and monitoring functions to operationally independent councils of experts is a positive step towards the effective conception and delivery of policy. Some of the councils examined perform functions that are essential in any advanced research system (NCS, SHEFC, CESHE), while others have a more contingent origin and rationale (CHRFC, NCIS).

Their impact depends on the extent to which they are linked to high-level policy-making processes and on how well the boundaries of their roles are defined and understood. The fact that SVEZNATE and VNIS are not yet operational may suggest a lack of political commitment to science and innovation. The present demarcation of their boundaries may also leave room for overlap. In view of the relatively large number of councils and committees and the uncertainty associated with a rapidly changing political and economic landscape it would seem necessary to review the entire system of policy advice to clarify the division of policy functions among the councils and between the councils and other parts of government.

As in many countries with a similar configuration there is considerable scope to extend co-ordination between MSES and other ministries. For example, MSES could co-operate with MoE on policy responses to the challenges raised by regulations, the implementation of which will also require the involvement of BICRO. Moreover, synergies can be sought with measures that promote the adoption of organisational and process innovations. The effective implementation of MoE's many sectoral strategies (energy, food processing, wood processing, metal processing, ICT, etc.) depends on well-conceived and delivered policies regarding education and training as well as R&D and innovation, which requires the co-ordination with relevant ministries and agencies such as MSES and BICRO. Addressing service innovation will require inter-ministerial co-operation between the innovation ministries and agencies and a range of services-sector ministries, such as the Ministry of Tourism, the Ministry of Sea Transport and Infrastructure, the Ministry of Health, and the Ministry of Culture. The councils may also participate. To be meaningful co-ordination needs to span policy functions and take place primarily during the policy programming and implementation phases. At present, where co-ordination exists (e.g. between MSES, MoE and MoEC) it is often confined to the early stages of orientation (drafting of strategies) and/or programming (drafting of measures). There is much scope to extend interactions between ministries (MoE, MoEC and MRDEUF) and agencies (BICRO, HAMAG-INVEST and CSF). The recent merger of BICRO with HIT and the future merger of BICRO and HAMAG-INVEST may help consolidate the portfolio and provide economies of scale and scope in administrative capacities at the intermediary level.

Both BICRO and CSF are considerably underfunded. Raising the profile of BICRO and CSF in the national policy-making community will be a necessary first step towards their fuller empowerment. Both organisations would be well served by an international evaluation / peer review of their organisational structure, relation to government and other agencies, management systems and procedures, evaluation criteria and procedures, and their efforts at and systems for policy learning (monitoring, evaluation of their

programmes and services). ASHE can be seen as a role model for these agencies, given its systematic efforts to evaluate its procedures externally and engage with international peers.

The many sectoral agencies (Croatian Waters, the Croatian Food Agency, the Croatian Environment Agency, the Croatian Energy Agency, or the Croatian Agricultural Agency) have had no obvious innovation mandate though in principle the opportunities are many. They can act as strategic partners of innovation agencies and other innovation-related intermediaries in identifying synergies and developing joint activities including in internationalisation.

At the level of research performance, various attempts have been made to reform universities and to bring about the functional integration of the older universities (see Chapter 3). These attempts have failed and the HEI/PRI sector is held back by considerable fragmentation (within and between organisations, respectively). The inability to deal with these issues compromises the long-term potential of public research in Croatia. The successful implementation of a host of policy initiatives in the public-research sector, including the move towards more competitive funding, the linking of institutional funding to performance, internationalisation and social relevance, all depend on progress in the process of HEI and PRI reform.

Provision of information

A well-functioning innovation system requires a seamless flow of information. The government plays an important role as provider and disseminator of information. For example, awareness of the role of science and technology may help legitimise an increase in resources for research and can encourage the take-up of science, technology and engineering education; publicising the results of evaluations serves a signalling function and may facilitate the allocation of resources to more efficient actors; online databases of individual researchers, research groups and innovating firms help increase visibility and opportunities for interaction.

The views of Croatian society on science offer an indirect impression of the effectiveness of general communication channels. Evidence from the EU Eurobarometer opinion polls suggests that Croatia is relatively sympathetic to science, even if not optimistic about its potential. Overall trust in science increased in Croatia over 2005-10 and is above the EU average (74% and 66%, respectively) (EC, 2011b, p. 455). However, Croatians feel that the capacity of science to improve the environment is not very good (43%, against an EU average of 54%) (EC, 2011b, p. 462).

The goal of raising public awareness of science and technology featured prominently in the last strategic document (Republic of Croatia, 2006), which proposed a number of possible events and inter-ministerial collaborations. Raising awareness is again one of the objectives of the National Strategy for the Development of the Intellectual Property System of the Republic of Croatia 2010-12. Nevertheless, awareness-raising activities do not appear to be frequent, either as stand-alone measures or as part of measures with a different main focus. The European Commission's ERAWATCH and TrendChart joint inventory of support measures lists only one such measure, the CSF's annual Science Award (*Nagrada za znanost*). This award offers national publicity and public recognition for the research activities of undergraduate students and a small monetary prize. Other innovation prizes include the innovation prize offered by the MoEC and the Union of Croatian Innovators.

Croatia provides fewer digital public services than EU countries. It has nevertheless made progress in this area and particularly in the establishment of dissemination infrastructure for research and innovation. By 2010 some 65% of public services were fully available on line (over 80% in the EU), but were less sophisticated than in the EU. In a composite index of the level of sophistication of digital service delivery that takes into account the degree of interaction, the ability to conduct transactions and the degree of customisation and automation, Croatia ranked 28th out of 32 European countries (Capgemini et al., 2011).

In terms of information for research and innovation, Croatia's pioneering SVIBOR platform contained information on projects financed during 1990-95. It was followed by the web-based dissemination platform for Z-Projects. Perhaps the most notable initiative of relevance to research and innovation is the Croatian Scientific Portal (*Hrvatski znanstveni* portal); it has a database of Croatian scientists, a database of Croatian scientific bibliography and online access to Croatian scientific journals and publications. Also noteworthy is the web-based provision of undergraduate student services by the Higher Education Institutions Information System (ISVU), which has extensive national coverage. To attract foreign researchers and facilitate Croatia's participation in the ERA, the Croatian Mobility Centre (EURAXESS) assists foreign researchers engaged in research projects at Croatian universities and PRIs.

In addition to the benefits of digitisation and better service provision in the wider public sector, there are opportunities to improve the sharing of scientific information within the public research system. The outcomes of publicly funded research are often not readily available to the general public or even to other scientists. The result is unexploited opportunities to form links and to transfer insights across different areas of inquiry; it may also limit the public's understanding of science. A related problem is the underutilisation of scientific data, as the lack of established models for sharing means that opportunities to find new uses for old data are not fully exploited and that wasteful duplication may occur. The barriers to access range from administrative barriers (arising from organisational or institutional boundaries that merely retard the rate of transmission) to legal and privacy concerns that raise serious obstacles to the sharing of scientific information. New barriers have also appeared, such as the rising cost of scientific research,[14] the pressure on PRIs to make greater use of IPRs in order to diversify their sources of income, and the reluctance of scientific publishers to permit public access. The situation is not helped by developments in the use of public procurement to stimulate innovation, which include conditions that allow the transfer of IP to suppliers.

At international level there are attempts to promote more "open science" (OECD, 2012c). Policy efforts in this area include transnational initiatives for common data interchange structures as well as the establishment and maintenance of international information infrastructures, which are essential for addressing contemporary social challenges (such as achieving a better understanding of global climate change). Participation in international data infrastructures should be a priority among Croatia's future internationalisation measures. Moreover, within Croatia, efforts are needed to encourage inter-institutional co-ordination and the adoption of commonly understood protocols for the sharing of information. This may require legislation to overcome administrative barriers. Central to efforts to promote openness would be investments in digital storage and dissemination infrastructure and permission to share licences, datasets, designs, software.

Several other areas of research and innovation policy could benefit from awareness raising actions and better dissemination of the results of existing interventions. In particular, the results of evaluations of programmes and measures should always be made public. This would facilitate policy and stakeholder learning.

Related areas that have not so far attracted sufficient attention of Croatia's policy makers include networking, information sharing and co-ordination across a broad range of stakeholders. For instance, when setting up long-term research and innovation priorities and eliciting agreement from a range of industry and other stakeholders, technology platforms may be useful. These are industry-led multi-stakeholder forums that aim to define research priorities, agree on action plans and mobilise funding in a broad range of technologies deemed important for national or regional competitiveness (OECD, 2011b). Technology platforms could help to identify sectoral innovation bottlenecks at an early stage, including the need for associated services (e.g. competence centres, research infrastructures), education, training, standards and government regulation. They could play an important role for Structural Funds programming in light of the need for "smart specialisation" strategies. Examples of additional priority actions, include support for EU Framework Programme and European Research Council applications, support for a national inventory of marketable R&D services offered by HEIs and PRIs, market information services, export brokerage and the provision of technology matching services (OECD, 2013c).

Finally, it would be important to engage in a concerted effort to improve the profile of STI throughout Croatian society. There are notable cases of research and innovation success within HEIs and PRIs and in small and larger companies. Showcasing their successes and highlighting their impact on Croatian society and the economy would raise awareness of current and potential benefits. Recognition of Croatia as a country in which relevant scientific research of high quality takes place and noteworthy innovations are developed would help inspire participation from all segments of society, improve confidence, attract resources and strengthen the standing of STI in the national policy mix. This is particularly important at present, as all indications are that, in Croatia, STI has not yet attained its rightful place at the highest political level, whereas most EU and OECD countries recognise STI as the main motor of sustainable economic growth.

Overall assessment of the policy mix

Croatia has made considerable progress in constructing a research and innovation policy governance apparatus and a variety of modern policy instruments. However, the short history of Croatian research and innovation policy means that the portfolio of instruments is incomplete in some respects. There is also a considerable lack of balance in the instruments, in the emphasis on specific forms of innovation and associated policy approaches. The public research system's inertia, coupled with significant resource constraints, have conditioned the long-term evolution of policy and contributed to these imbalances. Because of the delay of necessary reforms of HEIs and PRIs, the challenges raised by a changing national and global environment have been dealt with by introducing new organisational structures at the periphery of institutions and through a patchwork of *ad hoc* interventions. Progress has been made in spurts, largely owing to external funding (from the World Bank and, more recently, the EU), rather than through a steady and gradual evolution. This has contributed to the lack of a long-term policy outlook and continuity.

The policy imbalance is heightened by a strong emphasis on R&D-based forms of innovation, and more specifically on the commercialisation of public research and support for high-technology projects and high-technology start-ups. While a "science-push" and "frontier-focused" policy approach has been useful for parts of the business sector, it has been less relevant to the needs of the majority of firms. Meanwhile, a number of opportunities to stimulate collaboration with the business sector in terms of skills development, the provision of services and sharing of competences have been missed. Many firms in Croatia appear to be at the critical transition point between no innovation and new-to-the-firm innovation, while the innovating minority lack the resources and in-house capabilities (in engineering, design,[15] marketing, information technology and R&D) needed to move to new-to-the-market and new-to-the-world innovation. There is little in the current policy mix that appeals to non-innovating firms and entices them to change behaviour. Overall the policy mix has not been well suited to the accumulation of wider innovation capabilities within the public and business sectors.

Principal among the issues with the policy mix is a poor endowment. Funds allocated to BICRO and to other relevant institutions, programmes and instruments, even including tax incentives, are exceptionally low by international standards. For its part, CSF has far too small an endowment to have a profound impact on the scientific research community. Fortunately this is likely to be addressed in the future. The Structural Funds can play a crucial role in securing long-term funding for STI, both by contributing directly to STI projects and by freeing up resources previously tied up in other areas, if the planning, coordination and implementation challenges they pose are resolved in time.

In terms of balance between types of instruments, in spite of the lack of public resources, the national policy effort concentrates on resource transfers. While some resources have been devoted to the training of researchers, other types of specialised human resources important for innovation and investments in infrastructure have received relatively little attention. Project-based competitive funding is too low to compensate for the absence of a link between funding and performance in public research. Reform in HEIs and PRIs has not been possible which constrains their ability to develop.

The remaining policy instruments available to policy makers are unevenly utilised. There have been no attempts to use legislation and regulation or to adjust public procurement practices to stimulate innovation. Understandably, considerable policy attention has been paid to transfers of authority, with the creation of councils and executive agencies as a generally suitable intermediary policy-making level. Except for the continuing efforts needed to combat fragmentation in the public research sector and some overlapping responsibilities, the system's institutional configuration is nearly complete. It is now opportune to focus policy attention (and freed administrative capacities in ministries as the result of delegation) on the task of rebalancing the policy portfolio to support the business sector more directly, forcefully and pervasively (aiming at wider capability accumulation rather than just R&D, without downplaying the role of the latter), of making more extensive use of policy instruments (including neglected ones such as regulation and public procurement) and developing synergies among them.

While national policy makers were receptive to international policy approaches and instruments, it appears that these were not always well adapted to the Croatian context. This is likely a reflection of shortcomings in the functioning of the councils and of the ministries' lack of a long-term orientation. In the future, the transfer of internationally popular policy approaches should be accompanied by a critical and detailed evaluation of their suitability to the national context and current needs. Croatia is fortunate and rather

unusual among smaller countries in possessing systemic assessment capacities, a testament to its strong tradition in the social sciences and economics at the Institute of Economics Zagreb, the Ivo Pilar Institute of Social Sciences, and even in the private sector. However, these capacities are not systematically utilised to inform the design of the national policy mix.

4.4. International sources of funding for innovation

Overview

Over the past decade a substantial amount of public funding for innovation in Croatia has come from international sources. The principal sources have been the World Bank and the European Union. World Bank funding has been embedded in national support measures (see the preceding section) and is not dealt with here.

Although Croatia was not yet a full member of the European Union in the period covered by the latest figures, the share of direct funding from the European Commission is roughly equal to funding from national sources. The EU funding mainly concerns participation in FP6 and FP7, which represents a third of total funding; funding from the precursor of the Structural Funds, IPA IIIc / Priority Axis "Research and Development", represents another sixth.

Croatia's ability to accumulate research and innovation capacities in the core actors, to assist the business sector to innovate (in all forms and modes), and to steer the system towards larger-scale or networking projects and long-term research programmes is weak. Such joint activities could raise much more interest in the research-intensive business sector than the current funding programmes, which mainly aim at the creation of technology-based firms and technology transfer from the public to the business sector.

EU Framework Programmes

Croatia participated as a "third country" in the 6th Framework Programme for Research and Technological Development (FP6) in the period 1 January 2002-1 January 2006. In the given period, institutions from Croatia participated in FP6 projects amounting to a total value of EUR 6 million. As of 1 January 2006, Croatia became associated to FP6, paying a share to the overall budget and having the same rights and access to funding as the member states. According to MSES, under the entire FP6 (spanning the period 1 January 2002 - 31 December 2006), Croatian-based institutions were parties to project agreements of a total value of EUR 15.1 million. The agreements involved a total of 134 projects and participation of 154 partners from Croatia.

The Republic of Croatia has been participating in FP7 as an associated country since its beginning in 2007. According to MSES, by 18 October 2012, 273 Croatian partners contracted 218 projects with co-financing by the European Commission of EUR 53.9 million. The success rate of projects with Croatian partners stood at 17.32 per cent, while in the case of EU Member States it equalled 21.86 per cent. The area with the largest number of projects (30) with Croatian partners is "Research for the Benefit of SMEs", whose aim is to strengthen the innovation capacity of small and medium-sized enterprises and their contribution to the development of new technology-based products and markets.

The next framework programme, Horizon 2020, differs from its predecessors in a variety of respects, mainly a larger budget, a strong focus on research excellence, and the explicit adoption of "societal challenges" as a strong thematic orientation. Its budget will

increase from about EUR 50 billion to EUR 75 billion and will be allocated according to three major pillars: i) excellent science (EUR 24.6 billion, of which EUR 13.3 billion is earmarked for the European Research Council, ERC); ii) industrial leadership (EUR 17.9 billion); and iii) societal challenges (EUR 31.7 billion). There is also about EUR 5 billion for the European Institute of Innovation and Technology, the Joint Research Centre and Euratom Regulation.

Although the FP accounts for a significant portion of public R&D expenditure in the EU, new member states (the post-2004 entrants, referred as EU12) receive relatively little FP funding. Evidence suggests that the new EU member states receive five to ten times more funding of R&D from the Structural Funds than from FP7 (EC 2011b, p. 255). Moreover, as regards the FP, the EU12 typically suffer from several related problems: a relatively small number of world-class research actors, the existence of established networks ("clubs") with high entry barriers, and a certain reluctance on the part of institutes to enter international collaborations for fear of brain drain, particularly to better-endowed EU member states in north-western Europe (EC, 2010).

Croatian participation to Horizon 2020 will also depend on the responsiveness of national policy. National coaching seminars to assist in the development of Croatian-led Horizon 2020 project applications, the provision of guidance and support to their successful submission can make a difference in combating the abovementioned participation deficit common to new EU members. Ultimately though, the benefits that Croatia can expect to derive from Horizon 2020 will depend on improvements across the system notably the increased integration into international scientific networks and improvements in the quality of public research.

Other European programmes and intergovernmental research organisations

Croatia has participated in the EUREKA programme since 2000. So far, Croatian organisations have participated in ten completed and seven running projects (www.eurekanetwork.org/croatia/about). The total funding of Croatian participation is EUR 1 075 million from national sources (BICRO Annual Report 2011). In 1992 Croatia became a full member of COST. It has participated in over 250 projects and is currently involved in 70.

With regard to intergovernmental research organisations, Croatia officially joined the European Molecular Biology Laboratory (EMBL) in 2006 as the organisation's 19th member. In co-operation with EMBO and with the support of a grant from the CSF (EUR 300 000), Croatian life scientists have set up a research laboratory. In the very early days of Croatia's research policy (1991), it signed a co-operation agreement with CERN. It renewed it in 1998. A separate memorandum defines the participation of Croatian scientists. Co-financing of participation is on a functional basis, that is, MSES's financial contribution is provided only for specific experiments. These conditions are considered very favourable because Croatia pays only for actual work. MSES allocated around EUR 70 000 in 2003. The funds are intended for the travel costs of scientists from Croatia and for minor equipment. The main collaborating institutions are the Ruđer Bošković Institute, which plays a co-ordinating role, and the Technical University of Split.

Harnessing opportunities from EU Structural Funds

The Structural Funds form part of the EU's so-called Cohesion Policy instruments, whose main long-term objective is the convergence of incomes between and within member states. In practice this is done through resource transfers, which, following some

alignment with general EU orientation, are usually programmed at the national level and carried out at the regional level. Historically the SF has given lower priority to STI investments. Most EU member states have shown a strong preference for investment in transport, environmental and other capital-intensive infrastructure, as well as funds to mitigate the effects of industrial restructuring, including support for re-training and urban regeneration.

Partly because of the SF's stated objectives and partly because of its past focus, the magnitude of the opportunity it presents for STI policy is often not fully appreciated. Even if the development of STI capacities is a secondary objective, the SF allocations invariably constitute sizeable amounts of public funding for innovation. In terms of R&D funding, for example, over 10% of public funds across the EU27 can be traced back to the SF and 20% comes from EU sources if FP funding is included (Barré et al., 2013). In terms of broader innovation expenditures, SF may rival (or for less well-off EU member states, eclipse) national STI funding. The share of SF devoted to research, development and innovation represents about 160% of the national public R&D budget (GBAORD) in Latvia and Lithuania, about 120% in Estonia, Poland and the Slovak Republic, and 60-80% in Bulgaria, the Czech Republic, Hungary and Slovenia (EC, 2011b).

In the recent past, Croatia's research and innovation policy has been very unstable, in terms both of funding and implementation. Structural Funds can help to increase budgetary stability as they cover a lengthy period of up to ten years: one to two years for preparation, seven years for implementation and up to two more years for finalisation. By their nature the SF should mainly address systemic aspects of the national innovation system (such as capacity accumulation up to the threshold of self-sustainability) rather than short-term tasks. In other EU countries they have been used to support reforms that would otherwise not have been feasible, such as the implementation of structures or systems with long lead times.

The SF present an unparalleled opportunity to overcome indivisibilities, spur institutional reform and foster sustainable capacity building. It is therefore important to identify long-standing problems in the wider research and innovation system that require a long-term perspective and would benefit from additional support. With reference to the earlier examination of major gaps and bottlenecks in the Croatian STI policy mix, the following areas seem especially profitable targets for SF planning:

- *Addressing the evident need to increase investment for research infrastructure and equipment.* The challenge will be to identify investments of wide appeal and complementarity and to support only investments that form part of coherent long-term research programmes. Research facilities jointly operated by HEIs and PRIs and wherever feasible, business enterprises, could provide a wide range of associated business support services in design, prototyping, marketing, IT and logistics, along the lines of competence centres. At present, only the BIOcentre comes close in terms of the requisite scale. Such facilities can be viable candidates for investment, but will have to be carefully tailored to the Croatian context. There are indications that at least some R&D-performing enterprises would be interested in using specialised research infrastructures, and there may be unexploited opportunities for cost-sharing with the private sector in both existing and planned infrastructures. It will be important to integrate research centres, infrastructures and related programmes as much as possible into the innovation system.

- *Redressing the imbalances in human resources for innovation* (in favour of science, technology, engineering and mathematics; in favour of professional undergraduate education in polytechnics and master's programmes at universities) by strengthening the capacity of education providers to set up study programmes and develop funding models that ensure sustainability. SF programmes addressing these issues should be linked with relevant developments in the higher education sector, including reform of governance and implementation of performance-based contracts.
- *Introducing an explicit innovation dimension in the various sectoral and regional development strategies/initiatives*, including the development of the islands and coastal areas (i.e. green tourism innovation, discussed earlier) and others possibly related to energy policy. Ensure that innovation policy stakeholders such as BICRO are among the institutional "owners" of such programmes, and co-operate with sectoral agencies such as Croatian Waters, the Croatian Food Agency, the Croatian Environment Agency, the Croatian Energy Agency, or the Croatian Agricultural Agency. Collaboration should go beyond the drafting of plans to include a say in monitoring and evaluation and the development of joint activities, including internationalisation. The success of such a pervasive approach will hinge on the identification of project managers who can collaborate with those who represent and operate the sectoral policies.
- *Providing support for service innovation with a dedicated competence centre*. A possible focus on green innovation in tourism can be considered. Alternatives include themes recognised as contemporary social challenges in Europe such as changing demographics, sustainable mobility and energy efficiency. A thematic focus may strengthen the centre's social relevance and its profile, not only in Croatia but eventually internationally.
- Seeking synergies between SF investments in large infrastructures, the introduction of binding regulations and associated firm-level innovation. The SF could finance related needs for training, coaching and the development of information platforms. Mobilise SF to familiarise users with novel financial instruments in collaboration with BICRO and HAMAG-INVEST.

Experience with the use of Structural Funds for STI investments in other new EU member states (particularly the Czech Republic, see Box 4.4) suggests that the following are important sources of success:

- Give policy ownership to innovation policy makers and implementation agencies. This is crucial for several reasons. Clear ownership can be linked to accountability and the delivery of specific outcomes within a given time. SF may also be used to strengthen the administrative capacities of innovation agencies, and can support recruitment, training and the accumulation of experience that may also prove valuable in national programmes. The agenda addressed by the Structural Funds should be aligned with that of national programmes and actions. The relevant actors (or "policy owners") should interact.
- Seek commitment to achievements that performers can directly influence by proper management, but do not expect them to agree on the impacts on the economy or society (which they are mostly unable to manage). Balance financial rewards for good performance with corresponding penalties.

- Be mindful of the tendency of open consultation exercises to generate long wish lists that are difficult to implement. If they are used, their input should not be binding. Use such exercises as an information-gathering mechanism and one of the many types of input to long-term planning and prioritisation based on a holistic assessment of the system's binding constraints.
- Frame the discussion on the need for infrastructure around possible outcomes from their use in terms of the concrete impact on research, innovation, education and business (rather than vaguely on the economy) and a clear identification of likely users. Make such investments conditional on long-term, credible research and innovation programmes of wide stakeholder appeal.
- In strategic planning, take two complementary levels into account: one is interventions and the intended improvement of the research and innovation system. The second is active planning for policy learning. Policy learning requires a rigorous system of policy intelligence, including rules and procedures for planning, monitoring and evaluation. The evaluation of all kinds of proposals will create a demand for field experts. If the recruitment and involvement of these experts is well managed, it will create a community of potential partners for collaboration.
- Seek to have more proposals than it is possible to fund and encourage competition to improve the quality of ideas. The criteria for selection should give greater weight to the quality of the proposal (including qualifications and performance, in particular the entrepreneurship of key staff) than to cover a set of pre-determined priority areas. As a general principle, keeping the number of decision-making criteria small and focusing on well-understood target groups can help improve the efficiency of delivery.
- Pay attention to the establishment of appropriate management structures. There should be clear responsibility for the execution of the research programme and the achievement of results, and a clear set-up of supervisory and advisory bodies committed to quality and performance through supervision and advice. Inter-ministerial co-ordination should not lead to diffusion of responsibility.

Box 4.4. The Czech operational programme research and development for innovation

The Czech government decided to focus on innovation and established a special operational programme for research and development for innovation (OP R&DfI) for 2007-13. The programme is based on a SWOT analysis of the Czech innovation system and is embedded in a number of relevant planning documents, including the National Development Plan 2007-13, the National Strategic Reference Framework and various innovation policy frameworks.

OP R&DfI runs from 2007 to 2013, with operational spending until 2015. The overall budget is nearly EUR 2.44 billion, 85% of which from the Structural Funds. Two-thirds are allocated for upgrading the Czech research landscape within Priority Axis 1 (Centres of Excellence) and Priority Axis 2 (Regional Research Centres), each with EUR 800 million and covering the whole country except the capital city of Prague.

PA 1 supports the creation of a few large centres of excellence. It aims at funding a small number of internationally competitive centres to put Czech science more firmly on the international map but also to strengthen ties to local and international users of their research. In one competitive call in 2010, 8 proposals out of 15 were selected and are currently being implemented. Some centres of excellence are very large and will be employing up to 900 staff, such as the Brno-based CEITEC in life sciences and material sciences and the European Research Infrastructure Project ELI (Extreme Light Infrastructure). …/…

Box 4.4. The Czech operational programme research and development for innovation
(continued)

PA 2 funds comparatively smaller regional R&D centres, with a mainly sector-specific, application-oriented and demand-driven mission. These centres help local firms and other users to innovate strategically and to perform their mission better. In successive rounds in 2009 and 2010, 37 initiatives were selected from 96 proposals. The centres are now starting their operational activities.

Both kinds of centres are being established at existing universities and PRIs, primarily the Czech Academy of Sciences, preferably in the form of co-operation between institutions. They are not distinct legal entities but have their own management, rules and procedures. The use of Structural Funds is therefore expected to lead to a physical and organisational restructuring of the Czech university and public research landscape. New buildings and scientific equipment receive about one-third of the money each; another third goes to new research staff, graduate schools and mechanisms to strengthen governance and research management.

The process of selection and implementation was highly structured:

- Applicants had to present an attractive research agenda, supported by the credibility and track record of key staff and a clear understanding of and access to their target groups (academia, industry, public institutions, etc.). Investment in infrastructure had to be justified in terms of the research agenda.
- An evaluation was performed by national experts (20% of weight) and international experts (80%) and included a consensus meeting and an evaluation report of about ten pages. There were essentially six criteria: quality of the research agenda; credibility of the key staff; attractiveness for and access to the target group; management; human resource policy (esp. regarding young researchers) and budget and funding.
- Recommendations were made by a combined national and international panel. The government adopted the recommendations in all cases.
- After a green light from the evaluation panel and adoption by the government performance contracts were negotiated for the period ending in 2018 at the earliest. A very important aspect in these performance contracts is that the performance indicators exclusively cover the types of outcomes that can be managed directly by the centres.
- The negotiation of performance contracts led to savings of a total of EUR 200 million out of EUR 1.6 billion owing to the cancellation of equipment that was not justified by the research programmes. These savings were re-invested in other research centres that were considered "good enough" in the evaluation process. At the same time, the volume of performance increased by about 30% in terms of numbers of publications, income from contracts and grants, and completed PhDs.
- In addition to regular audits each centre will be evaluated two to three years after its start, mainly to identify bottlenecks, adjust parts of the research agenda and performance indicator levels, but particularly to inject additional motivation and advice.
- For the five largest centres the scientific/executive director was recruited with the help of search committees, composed of national and international members. The search process provided many valuable insights into the international scientific community's perception of the Czech research system. A number of expatriates could be motivated to return.

Source: Fritz Ohler, Technopolis Austria.

4.5. Strategic tasks of innovation policy – a functional assessment

Croatia does not yet have a mature innovation system. Its notable progress in putting together elements of such a system, important though they are, has not yet resulted in substantial economic benefits. The realisation of such benefits will hinge on simultaneous efforts across the various interdependent components of Croatia's innovation system: the framework conditions for innovation, the absorptive capacity of firms, the governance and funding of public research, mechanisms to facilitate the emergence of critical mass, and internationalisation. These efforts will have the anticipated impact only if they are implemented in a co-ordinated fashion.

Improving framework conditions for innovation

International experience shows that economies and societies that thrive on innovation have some common characteristics: a stable macroeconomic environment favourable to investment, dependable legal institutions, and an efficient public sector that facilitates the functioning of markets. In the years before the global financial and economic crisis, Croatia had a comparatively good macroeconomic environment, with solid growth, contained inflation and stable exchange rates. Returning the economy to a stable state is a necessary first step in restoring conditions favourable to the required long-term horizon of innovation policy.

Trends in trade and FDI suggest that the Croatian economy is less open than comparable economies. While this will change as a result of EU membership, it will be important to foster further internationalisation and prepare the economy for the effects of increased international competition. Industrial planners will need to anticipate structural change, while regulators will need to ensure a level playing field at home as a stepping stone to an internationally competitive business sector. At the same time, improvements in the investment climate and in public-sector efficiency will be needed to encourage knowledge-intensive investments and reduce transaction costs. A concerted push towards the online delivery of public services would do much in that respect and would increase transparency and, over the long term, trust in the system.

Strengthening the human resource base for innovation

Croatia has a well-educated population, with a secondary education attainment above the EU27 average. HEIs in Croatia have pronounced strengths in social sciences, law and humanities, as reflected both in the structure of tertiary graduates and in scientific output by discipline. However, the skills profile of the Croatian workforce may limit its potential for innovation in the business sector. Businesses find the lack of qualified personnel an important barrier to innovation. Compared to similar countries, Croatia has few students and graduates in mathematics, science and engineering and low levels of on-the-job training and lifelong learning. There are also indications that the quality of science and mathematics education trails that of comparable countries.

Education in HEIs will need to be further aligned with the needs of the labour market. The recent establishment of the Interdepartmental Working Body for Labour Market Monitoring with help from the European Training Foundation, is therefore a positive development. Systematic skills needs analysis and coordination with industry will be needed. A specific policy task will be to identify the skills constraints that hinder innovation in the Croatian business sector. The relative increase over time in the share of

services firms suggests that these needs may be changing, and it will be important to align the education and training system in a timely fashion.

Traditional strengths in the social sciences, law and the humanities could be mobilised by reinforcing the economic relevance of study programmes and increasing the intensity and diversity of links with industry. Strengthening professional and vocational education and addressing evident shortcomings in the supply of master's and other specialised graduates will be necessary. In addition, current efforts to promote entrepreneurship throughout secondary and tertiary education should be continued.

Greater emphasis would need to be placed on the alignment of tertiary education with the need for innovation in the business sector. Strengthening technical disciplines and improving the economic relevance of the social sciences and humanities (by seeking to link them with entrepreneurship, marketing, logistics, and IPR in both education and service provision) would be important steps. More broadly, public-private co-funding of postgraduates, the development of application-oriented curricula, the introduction of new types of formal education such as sandwich courses (with placements of up to a year), more effective industrial placements and professional doctorates (with distinct criteria for advancement) may also be helpful.

An important means of strengthening human resources for innovation will be to capitalise on the unique design, engineering, production and logistics capabilities of MNEs. Facilitating mobility between sectors, extending the scope and duration of industrial placements and forming long-term arrangements for the joint provision of training and education between MNEs and HEIs seem sensible courses of action.

International researcher mobility is low and will need to be encouraged. At the same time, provisions and incentives are needed to encourage the return of researchers to Croatia and attract international talent.

Improving the governance of the innovation system

Overall governance

Aspects of innovation policy governance have improved over time, notably with the drive towards "agencification" (ASHE stands out as a positive example) and efforts to install evaluation mechanisms. However, overall governance suffers from limited co-ordination, piecemeal programming and lack of continuity. The need for improved co-ordination has become more pressing with the increase in the number of innovation policy actors, as the portfolio is currently spread across three ministries (MSES, MoE and MoEC) and several agencies. Limited co-ordination has affected the quality of programming, which has been further hampered by a lack of functional specialisation (incomplete "agencification") and an inability to plan over longer horizons owing to weak political commitment and volatile budgets. The volatility of R&D budgets was especially pronounced over the last decade, seemingly on a biennial cycle of double-digit growth followed by sharp contractions of the same magnitude, linked to the weak position of STI in the government's budget portfolio and the consequent dependence on external funds to fulfil even basic functions. Policy intelligence is weakly developed both in reach and in quality (a lack of evidence-based systemic analysis and consequent prioritisation).

Because of the imbalance between the proliferation of initiatives with ambitious targets and the low level of resources, policy effectiveness has been low. This has arguably damaged the credibility of STI policy, raising doubts about its true economic

promise. EU accession is a historic opportunity to upgrade the role and position of STI policy in the government's portfolio, as it will *de facto*, become the preferred channel for support to the business sector. Institutional reconfiguration to place STI policy at the highest levels of political authority will be necessary however. It will be crucial to address the gap left by the non-operation of key councils.

EU accession will also provide much needed budgetary stability through the SF but will need to be complemented by a rise in national funding. In the forthcoming programming period, the long-term orientation of the SF programmes will need to be adequately linked with national programmes for sectoral support and innovation. Better co-ordination may also reveal opportunities to use novel instruments to stimulate innovation including public procurement, regulations and standards.

"Agencification" can help to improve policy effectiveness by professionalising the delivery of policy. The completion of this process should have high priority to ensure a clear division of labour, stability, operational independence and ministerial governance mechanisms.

Policy mix and specific instruments

Despite the lack of public resources, the national policy effort has concentrated on resource transfer instruments and has placed strong emphasis on "bridging" public and private research, while falling short as regards resource mobilisation at the core of either public or business research. The limited project funding has been under conditions that do not stimulate competition. This policy focus has been conditioned by a rather narrow view of innovation as science-driven, frontier-shifting R&D. This view contrasts with the true potential of innovation as a pervasive activity that applies to all types of companies and all parts of society.

Overall, the range of policy instruments available to policy makers remains underutilised. No attempts have been made to use legislation and regulation or public procurement as triggers of innovation. The preoccupation with institutional reconfiguration (including the establishment of new intermediary organisations and transfers of authority) has been appropriate but has stopped short of substantial reforms of the governance of HEIs and PRIs, including the mechanisms of their steering and funding and incentives and career paths for researchers. As a consequence, much of the activity of institutions such as CSF constitutes temporary responses rather than efforts to address long-term challenges, in large part because of fragmentation in the older universities and between PRIs.

These imbalances will have to be addressed. The emphasis in funding should shift from the periphery of organisations (bridging and similar instruments) to capacity building within their core (HEIs, PRIs and the business sector), from a narrow concept of innovation to a broader one that emphasises ancillary capabilities, especially within firms, and finally from piecemeal solutions (e.g. for the training of researchers) to the dependable delivery of previously missing system functions.

Governance of universities and PRIs

Governance and funding arrangements for HEIs and PRIs are complex and inefficient. The management of the largest, oldest and most significant universities is fragmented, with control in the hands of the legally independent faculties. There is considerable overlap in PRIs' missions, target groups and disciplinary focus, which

persists despite recent attempts at consolidation. Moreover, in both HEIs and PRIs, funding arrangements are inflexible and disconnected from any notion of performance, and there are few incentives to plan strategically and develop individual organisational profiles. Attempts to reform the sector were met with strong resistance from academics and were abandoned.

The fragmentation in the universities hinders the development of the inter-disciplinarity that is often necessary to respond effectively to economic and social concerns. It makes it difficult to derive benefits from the lateral transfer of ideas in scientific research. Co-ordination bottlenecks due to fragmentation may lead to the duplication of support functions or uneven coverage. They discourage the pooling of resources and the drafting of university-wide plans for investment, participation in major research initiatives, and the development of a common identity and mission. Fragmentation also hinders the needed linking of institutional funding with performance via negotiated performance-based and future-oriented contracts.

Principal among the responses to the challenges facing universities would be increased autonomy and accountability for the accomplishment of public purposes. This presupposes that the larger and older universities will become governable as single entities and that their incentives to perform, plan ahead and differentiate would be strengthened. Appropriate instruments include monitoring of performance or outputs and the establishment of performance reporting and periodically negotiated performance-based contracts for both universities and PRIs.

The process of reform can be facilitated by a shared understanding of the opportunities for a significant increase in resources through the co-ordinated mobilisation of the SF. The SF provides an important opportunity to establish new research infrastructures with a well-defined research agenda, mission, target groups, and governance, ideally within HEIs and PRIs, thereby boosting their capabilities.

Evaluation

Although Croatian scientists are more "productive" than their peers in comparable countries, there are indications that research in the country suffers from a quality deficit. For instance, Croatian scientific publications and patents receive fewer citations on average than those of comparable countries. It is likely that this partly reflects resource constraints and the inefficient governance arrangements of HEIs/PRIs. Strengthening evaluation and making performance as a determinant of funding would provide the right incentives, legitimise increased funding and may uncover institutional bottlenecks to the improvement of quality and performance.

There has been progress in the establishment of formal evaluation mechanisms, e.g. ASHE's remit to evaluate HEIs and PRIs. However, for the evaluation of research and innovation programmes and support measures, external evaluation mechanisms are not systematic, not always made public, and there is no evidence that they are an input to policy learning. Efforts should focus on systematising policy evaluation and adequately using the findings, on the pooling of evaluation capabilities and the installation of system-wide norms, the accumulation of experience by a domestic community, and on linkages with international communities of professional evaluators.

Fostering innovation in the business sector

Croatian businesses innovate less frequently and commit fewer resources to innovation than their EU27 counterparts. It is fair to say that their propensity to innovate is weak. Part of the reason is Croatia's industrial structure, with a preponderance of small firms that tend to be in sectors that are known for lower rates of innovation. At the same time, business R&D expenditure is lower even than in countries with similar industrial structures and has declined in real terms and, especially, as a share of GDP. The modest resources Croatian businesses devote to R&D translate into fewer patents than in countries with comparable resource commitments. This is likely due to structural and institutional factors such as the lack of MNE headquarters, the dominance of a rather disconnected public research sector and the lack of appeal of IPR. This may have much to do with the kinds of R&D performed in Croatia, which is often linked to the activities of MNEs that ultimately choose to patent elsewhere. Features of the current tax credit scheme may also favour patenting outside Croatia.

Public support for business-sector innovation has mostly focused on the interface between public research and businesses, mostly favouring a one-way transfer of ideas from public research to the market. The rationale for this approach may be traced back to a widely held view that the country has a strong but underused science base. The contrast between this view and the weak economic outcomes of public R&D motivated efforts to strengthen linkages and transfer mechanisms. However, when compared to other countries, Croatian science lags behind. Moreover, the business sector has little capacity to absorb the kinds of knowledge produced in university and PRI research settings. Evidence from a variety of sources supports the view that the binding constraint is not at the interface but at the core of public sector and, especially, business-sector innovation capacities.

Support in terms of public-private R&D interface measures has been helpful to a small number of firms and has led to a few success stories in terms of spin-offs and commercialisation. It has however meant that policy support has left aside the majority of Croatian firms which are still taking their first steps in innovation. For these firms innovation activity largely consists of new-to-the-firm innovation in the form of adoption of processes, physical investments in equipment and machinery, and associated adaptations. Among the minority of firms that innovate, the challenge is to progress to the next steps, which include new-to-the-market, new-to-the-industry and new-to-the-world innovation. Even in these cases, there is a poor fit between the needs of firms and the type of policy support provided.

The most pressing limitation is the small amount of resources devoted to direct (via grants) and indirect (via tax credits) support for business R&D and innovation. To give an idea of the magnitude of the shortfall, resources will have to increase several times just to match the commitments of other new EU member states. Success in raising the innovation potential of the business sector will hinge on the adoption of a wider concept of innovation and the deployment of a wider range of support measures (covering education, training, firm-to-firm networks, etc.), in order to appeal to a greater variety of companies and to have the potential to have a lasting impact on firm innovation behaviour.

Strengthening the links in the innovation system

There are few links between the business sector, the universities and PRIs and they have not had a substantial impact. Croatia trails internationally in terms of co-operation on innovation among firms and between firms and other institutional actors. Co-publication data suggest that university-industry collaboration is about half as frequent in Croatia as it is on average among EU countries. The weak links with industry are also apparent in the structure of the income of HEIs and PRIs.

In part this reflects the limits imposed by a system that devotes few resources to R&D and innovation and in which business innovation capacities are weak. Such limits can be understood in terms of the infrequent, small-scale innovation activity and highly concentrated R&D activity in relatively few business firms. In this context there are few potential partners for collaboration and few opportunities for identifying projects of common interest. Lack of links with industry also reflects public research actors' inability to respond to the needs of industry and society, owing to insufficient incentives for individual researchers and to organisations' lack of flexibility to mobilise and combine resources.

Such a situation is common in many developing innovation systems and can be described as a "low-level equilibrium", with little effective demand for and supply of innovation-related services. In the business sector, this is due to a lack both of interest and of ability. In Croatia, many firms derive profits in markets that are not very competitive, which effectively dampens the attractiveness of innovation. Strengthening competitive pressures and promoting an export orientation would do much to increase the attractiveness of innovation. In addition, the ability of firms to make use of innovation is constrained by a lack of in-house capabilities and associated activities in design, engineering, marketing, IT and other knowledge-intensive activities. Overcoming this situation will require changes in the incentives, organisation and governance of HEIs/PRIs, such as interventions to strengthen competition and to facilitate the accumulation of in-house capabilities in business firms. More extensive spillovers from the activities of strong R&D and innovation performers, such as multinational subsidiaries, would also help.

The adoption of a definition of university-industry linkages that goes beyond science-push R&D activities would be a necessary first step in achieving a stronger impact on the behaviour and capabilities of participants and on the economy more generally. In addition to R&D collaboration, linkages worthy of promotion would include regular consultation on the content of skills, the introduction of sandwich courses with longer (up to one year) work placements, joint workshops, industry involvement in doctoral schools, development of professional doctorates with distinct criteria for advancement and tailored HEI study programmes for those already in employment (part-time/summer courses) including in entrepreneurship. Government co-funded and HEI-led on-the-job-training schemes at the premises of multinational subsidiaries may help increase the incidence and impact of knowledge spillovers and may be worth attempting.

Fostering critical mass, excellence and relevance in public research

The new universities founded over the last decade have facilitated the expansion of higher education and resulted in a more geographically balanced distribution of tertiary education and research capacities. Many PRIs also cater to a wide range of missions and disciplines. However, universities and PRIs still suffer from resource constraints, especially for research. Judging by the number of scientific publications, universities and

PRIs have improved their performance over the past decade, although their publications have a lower impact than in comparable countries. In terms of disciplines, engineering and some other technical disciplines have experienced a relative decline.

The ability to steer the system towards more large-scale and long-term research is hampered by a lack of resources, volatility in funding, and sub-optimal institutional and governance structures. Moreover, public organisations have few incentives to perform and to plan strategically. The highly fragmented management of the older universities, the fragmentation of PRIs, and inflexibility in the use of various funding streams compound the problem.

Policy has paid much attention to commercialisation of public research (such as incubators, spin-offs, technology parks) at the expense of systematic capacity building at the core of public research organisations. As a result, Croatia has little experience in handling large, long-term research investments, unlike other countries with developing innovation systems that have experimented with and acquired experience in large-scale research programmes linked to economic (often sectoral), social or systemic challenges, such as competence centres and doctoral schools (typically with 50-150 researchers over a period of 7 to 12 years).

A rise in R&D intensity and more broadly in the incidence of economically useful innovation requires strategic planning and can only happen once a backbone of specialised human resources, coherent research programmes with a long-term orientation, and associated investments in infrastructure are in place – all of which take time. Competence centres and doctoral schools can play a role, provided they are anchored to meaningful long-term research programmes. The introduction of performance-based budgeting and greater autonomy in HEIs and PRIs are important pre-conditions for taking a more focused, long-term outlook.

While important steps have been taken to improve the quality of research, with the founding of ASHE and various systematic evaluation exercises, there is much room for improvement. Competitive funding accounts for a small share of total funding. CSF should have significantly more funds for its competitive funding programmes and its mission should be focused on the promotion of scientific excellence by fostering within-country competition and increased international collaboration.

Care will need to be exercised in the geographic distribution of capacities for R&D and innovation. One the one hand, dedicated development agencies or equivalent functions provided by incubators, business centres, technology transfer offices and chambers of commerce can help businesses develop their innovation capacities irrespective of their location. On the other hand, proximity to industrial centres, usually close to large cities, is important for economically useful innovation; typically these are the places where suppliers, clients and a host of service providers (including HEIs and PRIs) provide the stimuli and support for innovation. In light of the limited resources available, it may be preferable to favour a clustering of investments on technological capacities near industrial centres, ideally on locations with good international links. Nevertheless, regionally targeted measures and associated agencies and organisations will be needed to integrate innovation actors from all regions in the national and European institutional framework and help them access markets, playing the role of "first-stop shop" rather than "one-stop shop".

The Structural Funds provide a unique opportunity to bring about lasting change in all of these dimensions. They can be used to support the emergence of large-scale activities, provide stability and continuity, and establish mechanisms (for competitive funding and evaluation) to promote scientific excellence. It will be important to ensure that the planning and monitoring capacities at MRDEUF are sufficient to cope effectively with the unprecedented demands imposed by the SF. Coordination between MRDEUF and the innovation policy stakeholders (especially the implementation agencies) is necessary and should be strengthened.

Maximising the benefits from the internationalisation of R&D and innovation

Cross-country studies suggest that integration in international scientific and innovation networks is associated with high R&D productivity (Varga et al., 2012). The Croatian innovation system has become more internationalised over the last decade, but there is significant scope for further internationalisation. Indicators on international mobility and scientific co-publications indicate that Croatia is not as internationalised as one would expect given its size, geographic location and links to the EU.

Internationalisation has not been very visible on the national STI policy agenda. With the exception of a few *ad hoc* initiatives such as those for personnel mobility, the Unity through Knowledge fund and support for EUREKA participation, few policy interventions address this issue. It may be worth developing an internationalisation strategy for R&D and innovation to which specific initiatives can be attached in terms of funding (FP, European Research Council), mobility, participation in international infrastructures and provision of sufficient support for an export-oriented business sector.

Notes

1. This section draws extensively on Švarc (2006).
2. See art. 17 of the modified Law on incentives for the development of small business, voted in May 2013: http://www.zakon.hr/cms.htm?id=385 (in Croatian).
3. MoEC is active in so-called business clusters which are organised bottom-up, while MoE is implementing so-called competitiveness clusters, which are set up in a top-down fashion, linking to the industrial policy and sectoral policies (12 priority sectors are determined by the industrial strategy, and a nation-wide competitiveness cluster is then set up in each of these priority sectors).
4. BICRO has s made notable efforts to strengthen awareness among companies on IPR matters. In cooperation with SIPO, BICRO has realised several workshops and produced guidance publications covering various aspects of IP (introduction to IP, searching through free patent databases, trademark and industrial design protection, copyright in ICT etc.). BICRO also participates to the EU IPR Helpdesk Ambassadorship program.
5. The synthesis of these empirical observations is due to Prof. Martin Bell, SPRU, University of Sussex.
6. Examples include the Swiss National Science Foundation (SNF), the Austrian Science Fund (FWF), the Dutch Organisation for Scientific Research (NOW) and the Academy of Finland.
7. A minor share of the total budget of PRIs and HEIs is derived from contract research and grants from funding agencies (15.8%, PRIs and 19.9%, HEIs, 2010), including 4.9% (PRIs) and 2.8% (HEIs) from abroad.
8. The Herfindahl index (HFI) is a measure of concentration of a quantity (in this case R&D funding) across sectors, calculated as the sum of the squares of the shares p of each NACE sector i out of the national total (HFI=$\Sigma pi2$). Here is reported the equivalent number of equally sized sectors that would give rise to the calculated index value (=1/HFI) which, unlike the unitless index, has a more intuitive interpretation. HFI was calculated on the basis of 52 discrete sectors that were either 3-digit NACE or the nearest higher level aggregation available. The Slovak Republic is excluded as more than 10% of government funded BERD was not apportioned to specific sectors.
9. Although over 270 companies used tax incentives, 90% of the total tax incentives concerned 9 companies in 2008 and 27 in 2009.
10. The changes in legislation and regulation discussed in this section are distinguished in terms of their pervasive impact on the rules of the game affecting the behaviour of actors in the innovation system.
11. This is a project funded by the Twinning Financing Programme to develop flood hazard maps and flood risk maps for Croatia. The Croatian partners are the Ministry of Regional Development, Forestry and Water Management, Croatian Waters; the EU partners are the Netherlands (Ministry of Economic Affairs, Agriculture and

Innovation, Dutch Government Service for Land and Water Management, Regional Water Authority Brabantse Delta and the DLO Agricultural Research Service), France (Ministry of Ecology, Sustainable Development, Transport and Housing (MEDDTL), International Office for Water) and Austria (Austrian Environment Agency, Federal Ministry for Agriculture, Forestry, Environment and Water Management, Via Donau).

12. A notable Croatian example is Dok-Ing, an innovative manufacturer of robots which started with a public procurement contract which arose from the need for demining robots after the war in Croatia.

13. Literature on the systemic nature of innovation emphasises the crucial importance of the configuration of actors in the system and the synergies, interactions, flows and linkages between them. In contrast to the market failure rationale for government intervention, such an approach highlights the importance of systemic problems that go beyond the scope of markets, and can be linked to co-ordination failures between and within decision makers in governments, the business sector and the public research sector (OECD, 1997; Woolthuis et al., 2005; Kubeczko and Weber, 2007). The idea of co-ordination failures is broad and may include instances of "too little" co-ordination, co-ordination of the wrong kind, or even "too much" co-ordination. Indeed, co-ordination has costs – in terms of time and effort to open communication channels, build and maintain working relationships etc. – that have to be balanced against its potential benefits. In some cases the costs of continuous co-ordination are high enough to justify setting up organisational boundaries, which, in addition to saving on continuous co-ordination costs, have the added advantage of efficiency improvements due to the division of labour.

14. A process driven by the increasing complexity and sophistication of science, the co-ordination costs implied by specialisation and more extensive divisions of labour, and a move towards interdisciplinarity, the combined effect of which is reflected in, for example, the increase over time in the incidence of co-authorship.

15. The importance of capability accumulation in design has been recognised in various EU policy documents (including the Innovation Union 2020 report). Actions taken at the European level include the launch of the *European Design Innovation Initiative,* which has a list of recommendations for raising the profile of design (http://ec.europa.eu/enterprise/policies/innovation/policy/design-creativity/edii_en.htm).

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