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RIO Country Report 2017

The R&I Observatory country report 2017 provides a brief analysis of the R&I system covering the economic context, main actors, funding trends & human resources, policies to address R&I challenges, and R&I in national and regional smart specialisation strategies. Data are from Eurostat, unless otherwise referenced and is correct as at January 2018. Data used from other international sources is also correct to that date. The report provides a state-of-play and analysis of the national level R&I system and its challenges, to support the European Semester.

Summary

Key findings

Economic trends are broadly positive, but the risks persist; gross domestic product (GDP) is expected to grow by 3.2% in 2017 and slightly decelerate afterwards (EC, 2017c). According to Eurostat's latest data (January 2018), total gross domestic expenditure on research and development (R&D) (GERD) amounted to €387.7 million (0.84% of GDP) in 2016, which represented an absolute annual increase on €374.8 million in 2015 (0.84% of GDP). Public expenditure on research and innovation (R&I) amounted to 55.2% of GERD while business expenditure on R&D amounted to 44.8% of GERD. Investments in R&I in Croatia have experienced a downward trend for more than a decade (in 2004, GERD amounted to 1.3% of GDP); in recent years, the trend has been stagnant, which is insufficient to enable Croatia to catch up with more advanced economies. In 2016, budget deficit was reduced to 0.8% of GDP and government debt decreased for the first time in the last decade (from 86.7% to 84.2%), although it is still high. The unemployment rate decreased from 16.6% in 2015 to 13.3% in 2016, but employment rates remain among the lowest in the EU. Moreover, the opening up of the labour market in most EU countries to Croatian citizens has increased incentives for young unemployed people to seek jobs abroad, which could have negative effects on the labour force and GDP growth in the medium term. The opportunities for R&I system reforms provided by the Smart Specialisation Strategy (S3) are often underexploited. However, gradual improvements are being made, which are linked with investments in infrastructure and R&I projects in both public and private sectors. Although economic recovery after the long recession (2008-2014) is in progress, the structure of the economy and the policy environment are still insufficiently conducive to innovation-led growth.

Challenges for R&I policy-making in Croatia

1. **Increasing R&I funding and improving the absorption of European Structural and Investment Funds (ESIF):** Despite the efforts undertaken, Croatia is struggling to increase R&I investment, which is stagnant (0.84% of GDP in 2016) and far below the 2020 target of 1.4% of GDP. R&I investments from ESIF will lead to improvements, but they have often been delayed.
2. **Building a coherent and integrated R&I policy framework:** Additional efforts (the merger of two ministries) were made to integrate the government approach towards R&I into the private sector. The implementation of the adopted strategic documents has been fragmented and slow. The opportunities provided by S3 are underexploited.
3. **Strengthening the private sector's R&I capability and improving the business innovation environment:** ESIF programmes that facilitate investment in R&I (e.g. R&I projects and centres of competence) are particularly important for business and technological development. There is still a need to improve the business climate, as well as to strengthen the links between science and business and develop the 'smart' skills required to meet business needs.
4. **Strengthening public sector R&I capacity:** Reforms to the public sector R&I system (e.g. reorganization of public research institutes, evaluation of research work), coupled with investments in infrastructure and R&I projects, are expected to bring about results in the medium term. The creation of European Regional Development Fund (ERDF)-funded centres of research excellence (CoREs) provides an opportunity to improve R&I performance in priority research areas.

Main R&I developments in 2017

- New Regulations on the conditions for promotion into higher scientific grades were adopted in May 2017 (OG 28/2017), which stipulated more rigorous minimum criteria for the promotion of scientists into higher scientific/teaching grades.
- The Ordinance on the organisation and operation of the scientific area councils and scientific field committees of the National Council for Science, Higher Education and Technological

Development (NCSHETD) (OG 47/2017) has been adopted; it regulates the working and organisational procedures of the NCSHETD's councils and committees.

- The draft law on amendments to the law on scientific and higher education is in public consultation; it is intended to determine the rules relating to the promotion and working rights of scientific researchers in a more precise way. The draft has been subjected to much criticism.
- The Croatian Science Foundation launched two calls for proposals in April 2017 – for installation research grants, aimed at supporting the independent research careers of young scientists, and for support to researchers for applications to European Research Council programmes.
- A major programme funded by the ERDF – Investment in organizational reform and infrastructure in the research, development and innovation sector – was launched in May 2017 to support organisational reform and infrastructure for research institutions; evaluation has been completed, but the results are still not publicly available.
- In June, another programme targeting research institutions was launched (Investments in Science and innovation – First call), with a focus on applied research projects.
- Four new support programmes, funded by the ERDF for small and medium-sized enterprises (SMEs), were launched in 2017 (Internationalisation of business in the MSE sector; From product certification to the market, Development of entrepreneurial zones and Promotion of entrepreneurship 2017-2019). In addition, Commercialization of innovation in entrepreneurship was launched in December 2016.
- Grant contracts with 10 CoREs with a total value of €50 million, funded by ERDF, were signed in October.
- The multi-annual institutional funding based on performance indicators introduced in 2013 as a financial reform measure has been criticised as inefficient, since it has not contributed to quality in research institutions, which is attributed mainly to low levels of funding.
- The draft law on state aid for research and development projects was subject to public consultation in November.

Smart specialisation Strategies

S3 was introduced at national level by the indicative annual plan for calls for proposals, co-financed by ESIF through Operational Programme Competitiveness and Cohesion 2014-2020. It started in 2016 with public calls for proposals aimed at innovative companies (Competency and development of SMEs, Innovations in newly established SMEs) and for cooperative projects for industrial research (Increasing the development of new products and services resulting from R&D activities, Strengthening capacities for research, development and innovation). Several important R&I infrastructures envisaged in the S3 action plan have been established. They include CoREs, competitiveness clusters and centres of competence (evaluation of which is still in progress).

Foreword

This R&I Observatory country report provides a brief analysis of the R&I system in Croatia in 2017, covering the economic context, main actors, funding trends, human resources, policies to address R&I challenges, and R&I in national and regional smart specialisation strategies. Data are from Eurostat, unless otherwise referenced, and are correct as at January 2018. Data from other international sources are also correct to that date. The report provides a state-of-play analysis of the national-level R&I system and its challenges, to support the European Semester.

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1 Economic context for research and innovation (R&I)

In 2016, gross domestic product (GDP) per capita grew by 3%, mainly due to domestic demand and exports, and reached €11,100. This occurred despite political instability and parliamentary elections in September 2016, which negatively affected the policy environment. According to the latest European Commission assessment of the overall economic situation (Autumn Forecast), economic trends are broadly positive, but the risks persist (EC, 2017c). GDP has been growing at an accelerating rate from 2015. Real GDP is projected to expand by 3.2% in 2017 and slightly decelerate in the following period due to structural constraints and other issues (e.g. the effects of restructuring the country's largest private company Agrokor, a major food and retail conglomerate[1]). On the other hand, in April the government adopted the draft Convergence Programme 2017-2020, which forecasts GDP growth of 3.2% in 2017 and a gradual slowing down towards 2.5% in 2020 (GoC, 2017a). In 2016, the budget deficit was reduced to 0.8% of GDP and government debt decreased for the first time in the last decade (from 86.7% to 84.2%); however, it is still high. In June 2017, the Council closed an excessive deficit procedure for Croatia. The unemployment rate decreased from 16.6% in 2015 to 13.4% in 2016, but employment rates remain among the lowest in the EU. Moreover, the opening up of the labour markets in most EU countries to Croatian citizens has increased incentives for young unemployed people to seek jobs abroad, which could have negative effects on the labour force and GDP growth in the medium term. Although economic recovery after the long recession (2008-2014) is in progress, the structure of the economy and the policy environment are still insufficiently conducive to innovation-led growth.

1.1 Structure of the economy

In 2015, the share of gross value added (GVA) contributed by services remained stable and accounted for 69.4% (EU-28 (2014), 73.9%) of total GVA. The share contributed by knowledge-intensive services slightly declined and corresponded to 34.2% of total GVA (EU-28, 18.1%). Manufacturing grew to contribute 15.0% of GVA (EU-28 (2014), 15.5%), while the share contributed by high- and medium high-tech manufacturing rose again to 4.0% in 2015 (EU-28 (2014), 7.3%). The majority of companies are small and medium-sized enterprises (SMEs) and 91.4% of them employ up to 9 people (EU-28 (2014): 93.0%). Only 0.3% of the total firms employ more than 250 people (EU-28 (2014), 0.2%). The proportion of workers employed in high- and medium high-tech manufacturing has reversed a negative trend and increased from 3.2% in 2015 to 3.4% in 2016, whereas employment in knowledge-intensive sectors has continued a positive trend, and it reached 33.0% of total employment in 2016.

1.2 Business environment

Croatia was ranked 51st for 2017 on the Ease of Doing Business indicator in the World Bank's *Doing Business* report (World Bank, 2016). Despite the fact that in the past few years Croatia has invested significant efforts in creating an environment favourable for conducting business, such as reducing notary fees, introducing a new form of limited liability company with a lower minimum capital requirement and simplifying incorporation procedures, its position fell (in 2015, the country was 40th position and in 2016 it was 43rd).

Overall performance and ranking in the Global Innovation Index has somewhat improved (from 47th in 2016 to 41st in 2017). However, the Market Sophistication and Business Sophistication indicators are still relatively weak (Croatia was in 88th and 53rd positions respectively). Ease of Starting a Business significantly declined (from 64th in 2016 to 76th in 2017) after an improvement recorded in 2016, and Ease of Getting Credit also

[1] The bankruptcy of Agrokor was avoided by the enactment of a specific law through which a government-appointed interim CEO took over management of the company.

showed a negative trend, as Croatia took 67th position in 2017, having fallen from 63rd position in 2016 (GII, 2017).

The *Global Competitiveness Report 2016-17* (GCR, 2016) indicated a similar performance: Croatia's overall ranking was 74th (out of 138 countries), with the lowest ranking being for the Innovation and Business Sophistication subindex (92nd), much lower than the rankings for Basic Requirements and Efficiency Enhancers (both 68th).

2 Main R&I actors

The structure of the research and innovation (R&I) system has been fairly stable in recent years, with few changes in government institutions and somewhat more dynamism shown by R&I performers. However, it is often considered that the national R&I system is fragmented and that this negatively affects its performance (EC, 2015). In addition to new projects by existing R&I actors, European Structural and Investment Funds (ESIF) provide an impetus and funding for setting up new types of actors (e.g. centres of research excellence (CoREs) and centres of competence) the prominence of which is expected to increase in the future. More effective functioning of the national system of innovation thus becomes even more important.

The governance of the R&I system in Croatia (Figure 1) is centralised at the national level and lies with the **Parliament** and **Croatian Government**, which take key decisions regarding legislation and changes in research organisation and institutions. The Croatian parliament established the **Committee for Education, Science and Culture**[2] which monitors the implementation of policies, procedures and legislation in science and technology.

Within the government, the **Ministry of Science and Education (MSE)** is responsible for effective science policy and the functioning of the entire research system, while regional policies are weak due to the poor regional financial base for R&I. The MSE is supported by the **National Council for Science, Higher Education and Technological Development (NCSHETD)**,[3] as an independent advisory body in the domain of scientific research, and by the **National Council on the Development of Human Potential (NCDHP)**[4] in the domain of education for the development of the Croatian Qualifications Framework.

Innovation policy and related policy on entrepreneurship is the responsibility of the **Ministry of Economy, Entrepreneurship and Crafts (MEEC)**, which took over the activities of the Ministry of Entrepreneurship and Crafts (MEC) after snap elections in 2016. The ministry, together with the **Ministry of Regional Development and European Funds (MRDEUF)** (the managing authority for ESIF), has acquired an increasingly important role because of the growing role of ESIF in financing R&I activities.

In 2013, after reforms to the R&I system, the main funding body for competitive research projects became the **Croatian Science Foundation (CSF)**, fostering research excellence, competitiveness and the integration of the Croatian research area into the European Research Area (ERA). The **Agency for Science and Higher Education** is responsible for setting up a national network for quality assurance and evaluation of scientific research and higher education. The **Croatian Agency for Small Business, Innovation and Investment (HAMAG-BICRO)** is responsible for the implementation of all business R&I-related ESIF measures, as well as for providing support in the implementation of the Smart Specialisation Strategy (S3) and the Innovation Strategy through its Technical Secretariat. In addition, HAMAG-BICRO implements EUREKA/Eurostars programmes and participates in the Enterprise Europe Network's

[2] http://www.sabor.hr/odbor-za-obrazovanje-znanost-i-kulturu-9
[3] http://www.nvzvotr.hr/hr/aktivnosti
[4] http://www.kvalifikacije.hr/hr/nacionalno-vijece

coordination of innovation-related activities in Croatia. The **Central State Office for Digital Development**[5] monitors and develops Croatia as a digital society.

The Agency for Mobility and EU Programmes[6] was established with the task of promoting and implementing lifelong learning and EU mobility programmes. Intellectual property protection is the responsibility of the **State Intellectual Property Office**.[7] The **National Competiveness Council**[8] is an independent advisory body with the goal of creating dialogue and partnership on programmes and policies that are critical to the sustainable growth and development of the country.

A range of other national councils and agencies have an indirect influence on science and innovation, such as **the National Council for Education and Training (NCET)**,[9] which monitors the quality of pre-school, elementary and secondary education, **the Education and Teacher Training Agency**,[10] which is responsible for the provision of professional and advisory support in the area of general education, including the Croatian National Educational Standard as a part of the national curriculum, and **the Agency for Vocational Education and Training and Adult Education**.[11]

There are 182 scientific organisations registered in Croatia for scientific activity and recorded in the Register of Scientific Organisations.[12] These include 25 public research institutes and 87 higher education institutions (HEIs). There are 70 research organisations other than public institutes and HEIs, for example research units in hospitals and institutions of national importance, such as the Croatian Academy of Sciences and Arts. Several state-owned research institutes focus on applied research and services offered on the market (e.g. Energy Institute Hrvoje Požar); 25 private research organisations, which are either independent institutes (e.g. the Mediterranean Institute for Life Sciences) or belong to corporations, for example Ericsson Nikola Tesla (ICT), PLIVA (pharmaceuticals), Podravka (the food industry) and Končar Electrical Engineering Institute (electrical engineering).

Following a proposal by the NCSHETD, the MSE established 13 CoREs in 2014 and 2015. These gather and link the best scientists in a particular field and are focused on contemporary research topics. The role of the centres is to be internationally competitive and a recognisable group in terms of the quality and scope of scientific production, capable of effective international cooperation.

Several small research-based companies have been founded in recent years – Novamina (process technologies), Genos (biomedicine), Pet minuta (ICT) – some operating in regional markets – for example Genera (biotechnology) – and some in international markets – for example Bellabeat (ICT).

There are several research and technology institutions with the main mission of fostering science and industry cooperation and the commercialisation of research results. These include the Science and Technology Park of the University of Rijeka, the Technology and Development Centre of the University Osijek, the Centre for Research, Development and Technology Transfer of the University of Zagreb and the Centre for Science and Technology Development of the University of Split. Innovation Centre Nikola Tesla at the Faculty of Electrical Engineering and Computing in Zagreb is the newest centre, established in 2015. Further strengthening of technology transfer offices at universities is envisaged through financial support from ESIF.

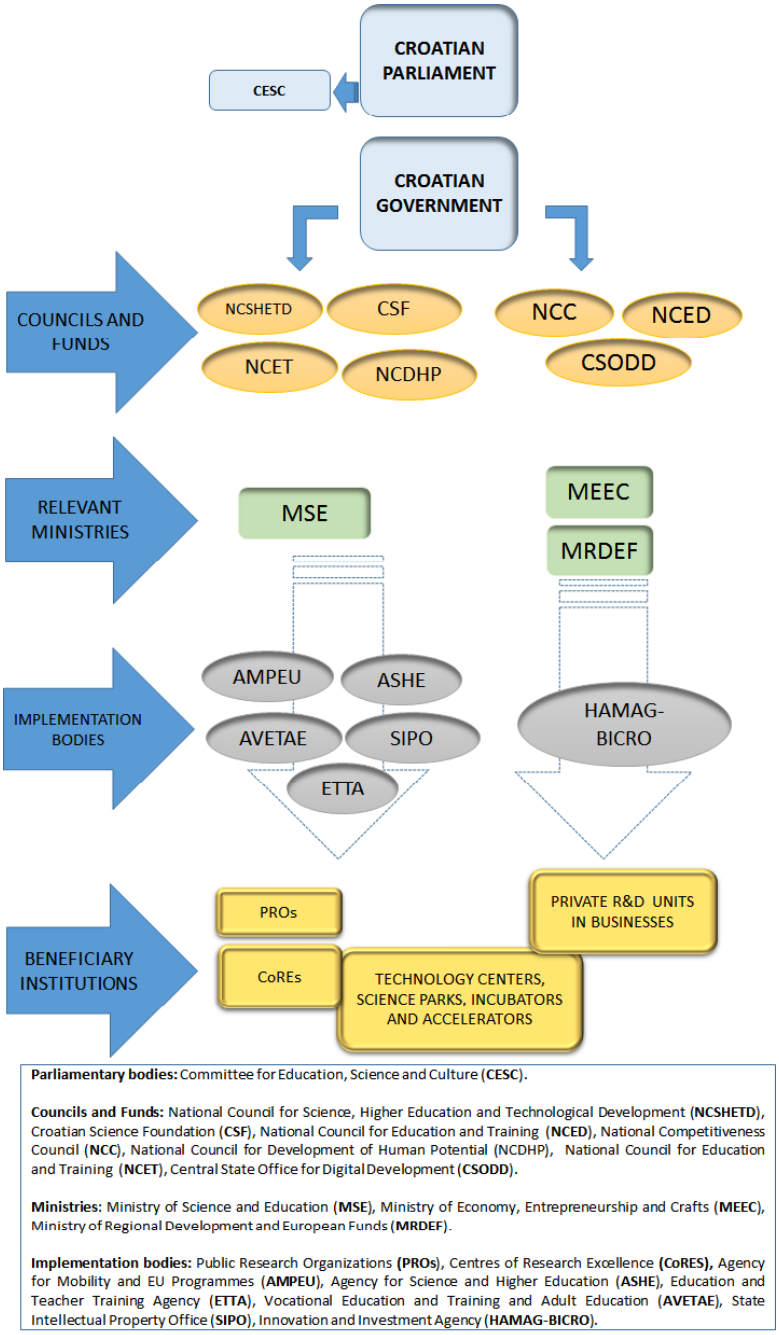
[5] https://rdd.gov.hr/o-sredisnjem-drzavnom-uredu/9
[6] http://www.mobilnost.hr/
[7] http://www.dziv.hr/en/
[8] http://konkurentnost.hr/
[9] http://nvoo.hr/
[10] http://www.azoo.hr/index.php?option=com_content&view=article&id=1999&Itemid=343
[11] http://www.asoo.hr/
[12] All legal persons performing scientific activity pursuant to the Scientific Research and Higher Education Act are entered in the Registerhttp://pregledi.mzos.hr/Ustanove_Z.aspx

The formation of the centres of competence is under way, with ESIF of €105 million earmarked for their operation. They are important new infrastructures that will foster public-private partnerships to create innovations and new technologies. Together with the National Innovation Council, the Innovation Network for Industry and the innovation thematic platforms set out by the National Strategy for Fostering Innovation[13] and S3[14] will improve the efficiency of the recently stagnant national innovation system.

On the initiative of the government, 13 competitiveness clusters[15] have been established to provide sector-specific synergies to increase national competitiveness. Although their role is still rather limited, they are expected to be integrated into the Innovation Network for Industry and to have an active role in the overall national innovation system.

[13] http://www.mingo.hr/public/documents/Strategija_poticanja_inovacija_18_12_14.pdf
[14] http://s3platform.jrc.ec.europa.eu/regions/HR/tags/HR
[15] http://www.aik-invest.hr/en/competitiveness/competitiveness-clusters/

Figure 1. Organogram of the R&I system



Source: authors' analysis.

3 R&I policies, funding trends and human resources

Main R&I policy developments in 2017

Document title, hyperlink and date of publication/announcement	*Short description*
Draft law on amendments to the law on scientific and higher education 29/05/2017	New regulations on the organisation of R&I activities with an emphasis on promotion and working rights of scientific researchers. The draft is in public consultation.
Regulations on the conditions for promotion into higher scientific grades (OG 28/2017) 29/03/2017	Adoption of the new, more rigorous minimum criteria for promotion into higher scientific/teaching grades
Ordinance on the organisation and operation of the scientific area councils and scientific field committees the NCSHETD (OG 47/2007) 17/05/2017	Adoption of the new rules and procedures of work of NCSHETD, including on promotion of researchers into higher scientific/teaching grades
Installation research grants 04/04/2017	Programme of the CSF for supporting independent research careers for young scientists
Support to researchers for applications to ERC programmes 29/04/2017	Programme for developing cooperation between Croatian researchers (visiting researchers) and one of the current European Research Council (ERC) projects
Increasing the development of new products and services resulting from research and development activities 04/05/2016-31/12/2019	Programme for support for business R&I and for cooperation with the public sector R&I, funded by the European Regional Development Fund (ERDF)
Support for the development of the centres of competence 19/08/2016-31/12/2017	Programme for the development of the centres of competence (ERDF)
Investment in organisational reform and infrastructure in the research, development and innovation sector 08/05/2017-21/06/2017	Programme to support organisational reform and infrastructural renewal for R&I institutions (ERDF)
Investments in Science and Innovation – First Call 13/06/2017	Programme targeting research institutions, with a focus on applied research projects (ERDF)
Frontier research of the Centres of Excellence (CoREs) Closed 05/04/2017, contracts signed 05/10/2017	Development of cutting-edge research by selected CoREs (ERDF)
Internationalisation of business in the SME sector 29/03/2017-31/12/2017	Increased participation of the Croatian economy in global markets (ERDF)

Commercialisation of innovation in entrepreneurship 09/12/2016-31/12/2017	Support projects aimed at higher-value-added products and services (ERDF)
From product certification to the market 03/05/2017-29/12/2017.	Ensuring the quality, safety and reliability of products to increase exports (ERDF)
Development of entrepreneurship zones 21/04/2017-22/09/2017	Development of the quality and availability of infrastructure in existing business zones
Promotion of entrepreneurship 2017 – 2019 08/05/2017-28/07/2017	Promotion of entrepreneurship in society
Draft law on state aid for research and development projects 03/11/2017	Regulation of state aid for research and development (R&D)

R&I funding trends

According to Eurostat's latest data (January 2018), total gross domestic expenditure on R&D (GERD) amounted to €387.7 million (0.84% of GDP) in 2016, which represented an absolute increase on €374.8 million in 2015 (0.84% of GDP). Public expenditure on R&I amounted to 55.2% of GERD, while business expenditure on R&D (BERD) amounted to 44.8% of GERD. Investments in R&I in Croatia have experienced a downward trend for more than a decade (in 2004, GERD amounted to 1.3% of GDP); in recent years, the trend has been stagnant. This makes Croatia the country with the eighth lowest R&I investments in the EU and the country with the fourth lowest investment in R&I in euros per inhabitant (€88.7). The latter figure represents only 15.6% of the EU average (€592.9).

3.1 Public allocation of R&D and R&D expenditure

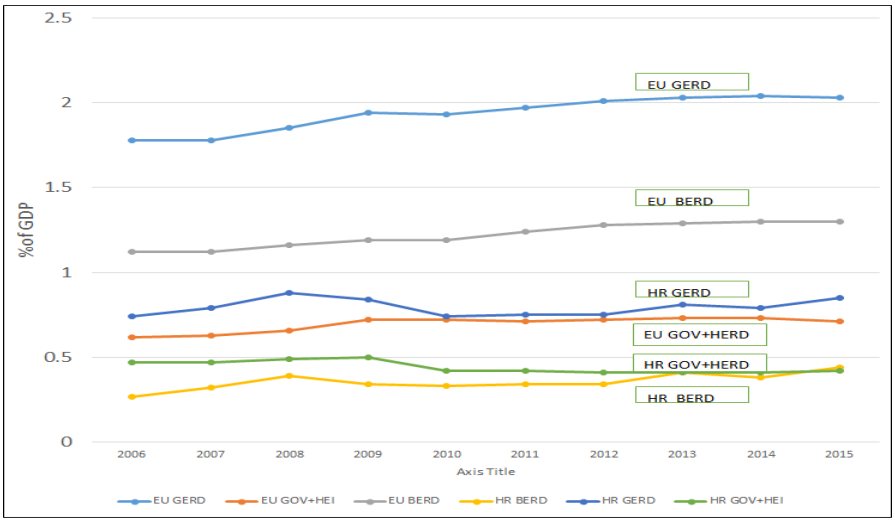
Overall R&I intensity in Croatia is significantly below both the 2.03% EU average and the national target of 1.4% set by the 2013 Economic Programme of Croatia. The low investment in R&I is caused by an overall slowdown of the national economy, started by the global financial crisis in 2008. However, the long-term structural deficiencies of the Croatian economy, such as strong service orientation (tourism), budget restrictions, and low entrepreneurship and innovation capital, also hinder both public and private interest in R&I. The low level of investment in R&I is recognised as one of the reasons for the lack of efficiency of the R&I system, in terms of low numbers of publications, especially in frequently cited journals, and the Croatian research community's lack of international integration (EC, 2017a).

Public funds for research projects were almost halved by the research funding reform in 2013. The reform was intended to strengthen research excellence, competitiveness and performance-based institutional funding, but its impact remains limited. There are weaknesses in the monitoring and evaluation of institutional research performance, related to institutional funding. On the other hand, it is questionable whether it is possible to have a fact-based evaluation when the funds for research grants in 2017 amount to around €12 million for the entire research community, making many research activities unfeasible. Overall public spending on R&I as a proportion of GDP in 2015 reached only 59% of the EU average (Figure 2). Limited public resources resulted in a

sharp decline in public sector R&D intensity, from 0.5% in 2009 to 0.42% in 2015. State budget resources for R&D (government budget appropriations or outlays on R&D – GBAORD) oscillate around 1.5% of the total government expenditures. Exceptions to this include a lower budget of 1.29% in 2013 and a higher budget of 1.68% in 2015. The latter figure should be taken with caution as, in January 2015, the significant resources for Croatian Health Insurance were separated from the State treasury system, which could have artificially enlarged the percentage of GBAORD for that year. Eurostat's provisional data indicate a decline in the value of GBOARD to 1.52% in 2016.

Sustainability of R&I funding is expected to come from ESIF for 2014-2020; funds include €646.79 million intended to strengthen the economy by applying R&I.[16] The total allocation of €10.68 billion should contribute 3% of GDP on an annual basis (EC, 2015, p. 87). However, most ESIF for R&I are intended for specific projects engaged in industrial applications and the commercial exploitation of research resulting from cooperation with companies. Significant resources will be invested in new research infrastructure, whereas a smaller amount was dedicated to frontier research of CoREs (€50 million).

Figure 2. Comparison of investments in R&I, EU-28 and Croatia (2006-2015)



Source: Eurostat

There is a common perception that the Croatian innovation system is largely inefficient and characterised by fragmentation, subscale investments and poorly defined policies (EC, 2015). This is reflected in the weak innovation performance of Croatia, which ranks 26th out of 28 EU Member States according to the European Innovation Scoreboard (EIS, 2016).

Inefficiencies in the national innovation system and underinvestment in R&I lock the Croatian economy into its current low-innovation growth model. Croatia is a moderate innovator among the EU Member States and performs below the EU average in all innovation dimensions except two (EIS, 2016). They are human resources – Croatia is a leading country among the Member States by percentage of young people with upper secondary education – and non-R&D innovation expenditure as a percentage of total turnover of companies. However, in tertiary education attainment (see section 3.3) and business R&I expenditure Croatia lags behind the EU average.

The weakest dimensions of the R&I system in Croatia include, first, open, excellent and attractive research systems (especially with regard to the number of scientific publications among the top 10% of most-cited publications); second, innovators

[16]https://strukturnifondovi.hr/eu-fondovi/esi-fondovi-2014-2020/op-konkurentnost-i-kohezija/

(especially fast-growing firms); and, third, intellectual assets (especially in terms of Patent Cooperation Treaty (PCT) patent applications).

As far as tax incentives for R&I are concerned, Croatian companies have been unable to use tax relief for R&I for the last two years, as the relevant law and regulations expired at the end of 2015 and a new one has not yet been adopted.[17] However, the National Reform Programme for 2017 (GoC, 2017) foresees the adoption of the new regulations in the near future. State aid recipients received over €16 million in tax relief for R&D projects in 2014 (GoC, 2017, p. 72).

3.2 Private R&D expenditure

Investments by Croatian companies in R&I remain rather low and reached only 0.43% of GDP in 2015, while provisional Eurostat data suggest a further decline in 2016 (0.37%). Yet this is the highest level of business investment since 2003, when the private sector invested 0.43% of GDP. There is also a promising trend, with 0.7% of GDP projected for 2020 (MoE, 2014). As Croatian companies become more interested in R&I, in 2015, private R&I investments slightly exceeded, for the first time, the public sector's investments in research activities (51.2% of GERD from the private sector versus 48.8% from the public sector). Private companies also contribute 8.4% of total funds for R&I activities in universities and 8% of funds for the government R&I sector. The contribution of private companies to public sector R&I activities is greater than that in many EU and Organisation for Economic Co-operation and Development (OECD) countries (OECD, 2015, p. 99) and speaks in favour of relatively good public-private cooperation. However, provisional Eurostat data suggest a decline in the share of BERD within GERD, which in 2016 amounted to 44.8%. Furthermore, the influence of such cooperation on technological and economic change is rather modest, being characterised by a 'downwards path' limited to standardised services, measurement and quality control, instead of an 'upwards path' focused on development of new high-tech products and processes. The lack of scientific cooperation is illustrated by the low level of public-private co-publications, which has been in decline since 2008 and reached only 5.7 co-publications per million population in 2015, while the EU average is 28.7 such co-publications per million population.

The downward path is a result of the structural orientation of the economy towards low- and medium-tech sectors, especially in services such as trade and tourism. Tourism accounts for almost one-fifth of GDP and has a very low research intensity. Other factors, such as the limited integration of Croatian firms into global value chains and lack of internationalisation (EC, 2016a), hold back research capacities in the private sector and orient companies towards non-R&I innovation expenditures (often in service sectors), which are above the EU average (EIS, 2016).

Nevertheless, rapid global technological development should prompt Croatian companies to invest more in R&I if they are to remain competitive. Today, they invest only €45.4 per inhabitant, which is eight times less than the EU average. Business investment in R&I is concentrated in a small number of sectors, including – in addition to scientific research (19%) – pharmacy (34%), communications equipment (13%) and motor vehicles (10%). Computer programming accounts for 3% and finance activities account for 2.1% of business investment.

A few large companies – PLIVA (pharmaceuticals), Ericsson Nikola Tesla (ICT), Podravka (the food industry), Končar Institute (electrical engineering) – invest the most in R&I. However, none are among the EU 1,000 European leaders in R&I intensity (EC, 2016c). The technological capabilities of SMEs are weak; over 70% of companies have products

[17] http://www.total-croatia-news.com/business/14919-no-r-d-incentives-for-entrepreneurs-in-croatia

that are not innovative at all (GEM, 2016). Most entrepreneurs in the SME sector are in the 'red ocean', markets, where they compete with a large number of firms with similar products.

One interesting estimate suggests that the proportion contributed by medium-sized enterprises to total R&D investment in Croatia is higher than in most other European countries (MEC, 2013). According to that analysis, almost one-third (29.4%) of all employees in the SME sector were employed in the high-tech manufacturing industry or in knowledge-intensive activities. The need to strengthen private sector R&I capability is addressed by S3 (April 2016) and by the national Innovation Strategy (December 2014).

3.3 Supply of R&I human resources

The Croatian scientific community is rather small and in 2015 it consisted of 11,089 researchers (headcount) or 6,367 (full-time equivalent (FTE)). The proportion of female researchers is around 50%, which speaks in favour of gender equality among research personnel in Croatia; in the EU on average around 30% of researchers are female. More than 70% of researchers hold doctorates and around 30% hold masters degrees. The majority of researchers (83% in 2015) are employed in the public sector, while the private sector traditionally employs a small proportion of researchers (around 15%-17%) (data from the Croatian Bureau of Statistics, 2016) due to the structure of the economy and technological lagging. These are the reasons for the low degree of public-private intersectoral mobility of researchers. In addition, there are no special programmes to encourage intersectoral mobility and current regulations make it difficult to enter the scientific system.

Croatia is at the bottom of the list of European countries by the share of the total number of researchers in the working-age population (aged 25-64). The scientific community has been steadily getting smaller since 2010, and being reduced by 11.5% in 2015, while the number of researchers in the EU, according to Eurostat's estimations, increased by around 17.4% in the same period. The share of researchers in active population decreased from 0.38% in 2010 to 0.34% in 2015 (in EU-28 it stood at 0.76 in 2015). The number of researchers per thousand population is half that of the EU-28 (Croatia, 2.62; EU-28, 5.61). The steady downward trend is very worrying, since it threatens the national intellectual and technical base. The slowest-growing indicator of human resources is the proportion of scientists and engineers in the working-age population, which amounted to 4.9% in 2016 (2010: 3.7%). The EU average is 7.4% (2010, 5.3%). New graduates in science and engineering per thousand population (aged 25-34) in Croatia represent 14.4% (EU average, 17.6%) (EC, 2017a).

One of the strengths of the Croatian education system is a high proportion of young people with secondary education, which makes Croatia the leading EU country in this respect (EIS, 2016). Unfortunately, the proportion of 30-34-year-olds in Croatia with tertiary education fell from 32.1% in 2014 to 30.8% in 2015 and to 29.3% in 2016, despite the continuous rise in the number of tertiary education students. Compared with the EU average of 39.1%, this is a relatively low percentage and the downward trend is worrisome, as it moves Croatia away from its Europe 2020 target of 35%.

The education and labour market systems suffer from structural weaknesses and incompatibilities. After the global economic crisis (2008-2014) the labour market started to recover in 2015, showing some new trends of polarisation in both demand for occupation and level of education. The demand for both low-skilled and high-skilled professions is growing while the demand for professions requiring secondary education, which best responded to pre-crisis demand in 2008, is currently declining. In 2015, over 80% of highly educated people were employed, compared with only 63.8% of people with at most secondary education. However, only 76.2% of tertiary education graduates found employment within one to three years of graduation in 2015, while this proportion in 2008 was 86.3%. This figure puts Croatia among the six worst performers in the EU,

after Greece, Italy, Spain, Cyprus and Portugal (EC, 2016b). Although this is often attributed to an inefficient education system (e.g. lack of practical learning during studies), it is realistic to suppose that lack of jobs is as or more important.

Analysis of the 'My job' portal (Tkalec, 2017) reveals that private sector employers mostly seek low-skilled service workers (retail staff, chefs and waiting staff) to fill seasonal jobs in tourism, which account for 18% of GDP. However, other seasonal sectors, such as transportation, construction and shipbuilding, continue to report shortages of low- and medium-skilled workers (despite high unemployment and inactivity rates), and call for increased import quotas for foreign workers (EC, 2017a). Most of these jobs are often precarious, poorly paid and offer poor job quality, living standards and social inclusion; changes in wages and working conditions are needed. Yet the employment rate of the low-skilled workforce is one of the lowest in Europe (40.2% versus 53.2% in Europe as a whole) (EC, 2016b), which demonstrates a need for lifelong learning. Unfortunately, the participation rate of adults in education and training is also among the lowest in the EU, at 3% while the EU average is 10%.

There is also a shortage of highly skilled professionals in non-market services (medical doctors, nurses, mathematics teachers) and market services (ICT professionals, mechanical engineers) (CEDEFOP, 2016). Economic emigration of professionals with lucrative and highly skilled knowledge, many of whom currently face low wages and precarious types of work, is an important cause of the shortage of skilled professionals. However, a number of shortcomings of the education system play a prominent role in this, such as limited enrolment and high dropout rates (especially in science, technology, engineering and mathematics (STEM) subjects) and insufficient numbers of STEM students. Although there is a variety of reasons for these shortcomings (e.g. lack of motivation, insufficient resources to study) the low quality of primary and secondary education contributes to a great extent. It produces insufficient knowledge of mathematics and other basic skills such as literacy and reading ability (EC, 2016b). Low competences in mathematics and science may result in a lack interest in STEM subjects. Most students in Croatia graduate in social sciences and the humanities (around 55%), while the proportion of graduates who studied STEM subjects is around 30%. The rest are graduates are in services (9%) and agriculture and veterinary studies (4%).

Croatia recorded one of the worst results in the EU in applied science and mathematics according to the Programme for International Student Assessment in 2015 (EC, 2017a). The modernisation of schools through a comprehensive curricula reform drafted in 2016 as a part of the 2014 Strategy for Education, Science and Technology (SEST) is on hold for more than a year because of major ideological and political disputes (EC, 2016b). Educational reform is a critical factor for social and economic progress and has been hindered by political disputes.

4 Policies to address innovation challenges[18]

4.1 Challenge 1: Increasing R&I funding and improving the absorption of ESIF

Description

Overall R&I intensity in Croatia is significantly below both the 2.03% EU average and the national target of 1.4% set by the 2013 Economic Programme of Croatia. Investments in R&I in Croatia have shown a downward trend for more than a decade and decreased from 1.3% of GDP in 2004 to only 0.85% in 2015 (€374.808 million) and 2016 (€387.7 million[19]). Croatia has the eighth lowest R&I investments in the EU by proportion of GDP and the fourth lowest allocation for R&I expressed in euros per inhabitant (€88.7). The latter reached only 15.6% of the EU average (€592.2). Budgetary constraints on government spending resulted in a decline in public sector R&D intensity, from 0.5% in 2009 to 0.42% in 2015. Public funds for research grants have been reduced by funding reform in 2013 (almost halved compared with the years before); this reform was aimed at strengthening research competition and funding only excellent, highly evaluated research projects.

Policy response

Political commitment to creating the conditions for increasing R&I investment has increased, but it is still insufficient. Significant increases in the state budget for R&I are not anticipated in the coming years, and reliance on ESIF will intensify. However, new regulations on the R&D tax credit are expected to be implemented soon. Although larger companies with in-house R&D capacities benefited most from the R&D tax credit, it is an important incentive for the entire private sector looking to invest in R&D.

New programmes launched by the CSF in 2017 (Installation Research Grants;[20] Support to Researchers for Applications to ERC programmes[21]) exist in the context of a relatively low national budget. The government will builds on the additional funds from ESIF 2014-2020 through the implementation of S3, adopted in 2016. The MSE launched one programme for R&I activities funded through ESIF in 2016 (Support to CoREs[22]) and created additional ones in 2017 (Investment in Organisational Reform and Infrastructure in the Research, Development and Innovation Sector, the Science and Innovation Investment Fund). Specific grant schemes for R&I have been launched by the MEEC and will be implemented in cooperation with the MSE, with the aims, for example, of increasing the development of new products and services resulting from R&D activities[23] and developing centres of competence.[24] Other programmes aimed at increasing innovation activities mainly target companies and are managed by the MEEC. Two programmes of this kind were launched in 2016 (Competency and Development of SMEs;[25] and Innovations in Newly Established SMEs[26]), while a range of programmes for SMEs were launched in 2017 (Internationalisation of Business in the MSP Sector,[27] Commercialisation of Innovation in Entrepreneurship,[28] From Product Certification to the

[18] Besides innovation challenges, for the preparation of the next Semester Country Reports, examples of successful practices in Member States in 2017 are also of interest; examples may be offered in relevant sections of the report and/or discussed during the Brussels visit.
[19] Provisional data.
[20] http://www.hrzz.hr/default.aspx?id=134
[21] http://www.hrzz.hr/default.aspx?id=2313
[22] http://www.strukturnifondovi.hr/natjecaji/1315
[23] http://www.strukturnifondovi.hr/natjecaji/1158
[24] http://www.strukturnifondovi.hr/natjecaji/1194
[25] http://www.strukturnifondovi.hr/natjecaji/1248
[26] http://www.strukturnifondovi.hr/natjecaji/1193
[27] http://www.strukturnifondovi.hr/natjecaji/1386
[28] http://www.strukturnifondovi.hr/natjecaji/1318

Market,[29] Development of Entrepreneurial Zones,[30] Promotion of Entrepreneurship 2017-2019[31]).

Assessment

Public spending on R&I in Croatia remains insufficient and is identified as one of the main causes of weak scientific production and lack of international recognition (EC, 2017a). The overall public spending on R&I as a proportion of GDP in 2015 reached only 59% of the EU average, while overall R&I intensity still lags considerably behind the national target of 1.4% of GDP. Following the reform of the research funding system in 2013, the resources for competitive research projects were considerably reduced compared with the pre-reform period, from €16 million to €6.7 million in the period 2013-2015. The resources were increased in 2016 to €11.5 million, but funding issues still made many research activities unfeasible. The impact of funding reform intended to encourage socially responsible research and scientific merit remains limited, since increased competition and performance-based funding have been coupled with budgetary constraints. The government expects additional funds, mainly from ESIF, which will target large research institutions capable of carrying out industrial research and cooperative projects with companies. Many researchers have remained outside of these financial flows, with insufficient resources for research. This could threaten the national science base and contribute to the erosion of knowledge, including the knowledge needed for future industrial and technological research.

The new calls for ESIF were prepared and launched in 2017, including the national project on science and technology foresight, project pipeline preparation and several grant schemes for investment in collaborative science and industry projects.

ESIF provide significant financial resources to eligible institutions, which will be used to renew the research infrastructures of many institutions and make them more internationally competitive. The implementation of the ESIF programmes in 2016 and 2017 may be considered satisfactory, since publication of public calls took place in accordance with the schedule in the indicative plan for the implementation of S3. However, taking maximum advantage of ESIF to leverage R&I investment demands proper administrative capacity (see challenge 2) and absorptive capabilities in business (see challenge 3), which are both considered areas of weakness (EC, 2015). Croatia will need to invest more effort to ensure adequate capacities for absorption of ESIF for national development (EC, 2015).

4.2 Challenge 2: Building a coherent and integrated R&I policy framework

Description

Many analyses state that R&I policies in Croatia are characterised by the lack of a coherent and integrated R&I policy framework and insufficient levels of coordination and synergy between the government bodies responsible for R&I policy, the MSE and the MEEC (OECD, 2014; EC, 2016a; Račić and Švarc, 2015). This reflects low R&D capacities and poor innovation performance (see challenge 1) as well as a low rate of absorption of ESIF during the programming period 2007-2013. OECD experts concluded, for example, that low commitment on the part of the government has contributed to low levels of and high volatility in R&D funding and has hampered long-term planning as regards human resources and investment in innovation (OECD, 2014, p. 16). Public policies in support of innovation are perceived as lacking commitment, slow to reform, inefficient in

[29] http://www.strukturnifondovi.hr/natjecaji/1406
[30] http://www.strukturnifondovi.hr/natjecaji/1393
[31] http://www.strukturnifondovi.hr/natjecaji/1407

governance structures and incapable of mobilising public resources for the R&D needed for an innovation-driven economy (EC, 2015).

Policy response

As described in the previous year's report (Račić et al., 2017) the R&I institutional landscape has been reshuffled in the search for better integration and coordination of the system. A range of governance institutions were rationalised, resulting in new institutions such as the MEEC (formerly the MEC), the NCSHETD and HAMAG-BICRO. In addition, the former Ministry of Science, Education and Sports became the MSE.

Several important documents were adopted (the SEST,[32] the Strategy for Fostering Innovation of the Republic of Croatia 2014-2020,[33] and the Croatian Research and Innovation Infrastructures Roadmap 2014-2020[34]). In April 2016, S3 was adopted. S3 seeks to unify all the relevant aspects of the various national strategies in one strategic framework. The strengthening of the national innovation system is set as a priority in the Croatian National Reform Programme 2016.

Croatia drafted, for the first time, a national ERA roadmap, *ERA Roadmap: Implementation Plan of the Republic of Croatia 2016-2020*[35] (October 2016). The plan gives an overview of the national strategic framework and provides guidelines for further development of science and technology, as well as a brief overview of the current situation in Croatia within each of the ERA priorities.

During 2016, the MSE drafted a strategic project proposal, Science and Technology Foresight (implementation is planned for the period 2017-2021). One of the main project outcomes is the establishment of a comprehensive and coherent overview of the Croatian R&I system.

Assessment

The reconstruction of the institutional set-up for governance of R&I undertaken in 2014-2016 has led to certain improvements and advances in R&I governance. The recent merger of the Ministry of Economy and the Ministry of Entrepreneurship and Crafts should integrate the government approach towards the private sector. Similarly, it could be expected that the merger of some key intermediary institutions (i.e. HAMAG-BICRO) and the rationalisation and connection of the offices for EU projects in various ministries (Račić and Švarc, 2015) will bring about better synergies between institutions and programmes, as envisaged in the Operational Programme Competitiveness and Cohesion (OPCC) 2014-2020.

The adopted strategic documents (the Innovation Strategy and the SEST) present a significant breakthrough in reforming the national education and R&I systems. However, most measures boil down to administrative measures, administrative reshuffling, drafting and enacting of new documents, strategies, etc. This raises the question of their actual implementation. The innovation and research aspects seem scattered and the development goals, set to be achieved by 2020, might appear overly ambitious. Interim and ex-post evaluations are envisaged, but in general the Croatian evaluation system seems rather weak in this aspect. A positive development in the area of evaluation was the preparation of S3, in relation to which several analytical documents with impact

[32] http://www.novebojeznanja.hr/

[33] http://www.mingo.hr/page/donesena-strategija-poticanja-inovacija-republike-hrvatske-2014-2020

[34] https://mzo.hr/sites/default/files/migrated/croatian_research_and_innovation_infrastructures_roadmap.pdf

[35] https://ec.europa.eu/research/era/pdf/era_progress_report2016/nationalroadmaps/era_national-roadmap-2016_hr.pdf

assessments were drafted. However, further monitoring and evaluation of S3 implementation remains an issue.

4.3 Challenge 3: Strengthening the private sector's R&I capability and improving the business innovation environment

Description

Investment by Croatian companies in R&I remains rather low and reached only 0.37% of GDP in 2016. There was a constant upward trend in the period 2006-2015 (0.26% and 0.43% respectively) towards Croatia's Europe 2020 target of 0.7% of GDP; however, Eurostat's provisional data suggest a significant decline in 2016. The contribution of private companies to public sector R&I activities is greater than that in many EU and OECD countries (OECD, 2015, p. 99) and speaks in favour of relatively good public-private cooperation. However, this cooperation is manly limited to standardised services instead of research cooperation, which is illustrated by the low level of public-private co-publications, which has been declining since 2008 (10.6 co-publications per million population versus the EU average of 33.9). Croatian companies invest mainly in non-R&D innovation such as equipment and machinery, and the acquisition of patents and licences. Investment in non-R&D innovation is Croatia's best-performing indicator measured by the EIS. Low investment in R&I is a result of the structural orientation of the economy towards low- and medium-tech sectors, especially in services (e.g. trade and tourism) and limited integration of Croatian firms in global value chains.

The overall business environment in Croatia creates disincentives for innovation due to the lack of coordination in the design of support instruments for innovation, lack of access to finance and inadequate framework conditions (OECD, 2014; CEU, 2015; EC, 2015). According to the World Bank's 2017 *Doing Business* report (World Bank, 2016), Croatia's overall ranking for ease of doing business is 51st (43rd in 2016). Out of ten indicators rated to determine a country's ranking, Croatia recorded progress in six and a deterioration in one. The largest fall in the rankings (26 places) was in the area of access to credit. According to the *Global Competitiveness Report* 2016-2017 (GCR, 2016), Croatia's overall ranking in 2015 was 74th (out of 138 countries), and it was ranked 92nd for Innovation and Business Sophistication. The worst pillars were Labour Market Efficiency (100th) and Innovation (103rd). The most problematic factors for doing business were identified as Inefficient Government and Bureaucracy, Tax Rates, Policy Instability, Tax Regulations and Corruption (GCR, 2016).

Policy response

The Croatian government is trying, through various channels, to intensify business activities and to encourage investment in R&I (see challenge 1). However, the policy measures to improve competiveness and the business climate in general are still very modest. Various direct funding schemes had been put in place in the past through the nationwide Impulse programme and various instruments of HAMAG-BICRO to improve innovation and access to finance. In addition, indirect support was provided through R&D tax incentives. but the relevant instrument is being revised and the new version has not yet been established.

The new support schemes funded by ESIF include actions targeting the development of new products and services resulting from R&D activities. These programmes mainly involve larger companies interested in cooperation with the public research sector and in networking through centres of competence.

However, there is a range of programmes for non-R&D innovation and increasing the technological and entrepreneurial capabilities of SMEs. Two programmes of this kind were launched in 2016 and another four in the first six months of 2017. They aim to increase internationalisation of businesses and certification of products, develop entrepreneurial zones and promote entrepreneurship (see challenge 1).

Creating innovation-friendly business environments for SMEs, strengthening the links between science and business, and developing the necessary 'smart' skills to meet business needs are among the key targets of S3, the Innovation Strategy and the other R&I-related strategic documents.

The draft law on state aid for R&D projects was subject to public consultation in November 2017.

Assessment

The intensity of R&I activities in the business sector is low and more incentives are needed. The efforts of the Croatian government to intensify business activities and to encourage business investment in R&I have relied largely (since 2016) on ESIF, which has replaced the previous national programmes (e.g. the Impulse programme and the HAMAG-BICRO instruments). The implementation of S3 and enacting new instruments using ESIF may increase opportunities to expand R&I in the business sector and to help Croatia exit the trap of 'low-level equilibrium' (World Bank, 2015). Taking into account the unwillingness of companies to invest in R&I, ESIF programmes (e.g. research, development and innovation projects and centres of competence) appear to be of particular importance for business and technological development.

Many programmes funded by ESIF have been launched to develop new products and services resulting from research activities and to improve innovation in SMEs. However, some crucial institutions envisaged by S3 are still on hold, hindering R&I activities in the business sector. They include, for example, the Technology Network for Industry (TNI), intended to act as an umbrella network for many other supporting institutions (thematic innovation councils, innovation platforms and action working groups), which in turn are intended to help industry and companies to develop R&I capabilities. The absence of these institutions has probably contributed to the slow uptake of the entrepreneurial discovery process and the lack of networking activities between the Croatian industry and research sectors, which are important for business R&I activities.

The expected adoption of the law on state aid for research and development projects will also increase incentives for business investment in R&I.

The reform measures designed to improve overall competiveness and the business climate have remained very modest despite structural reforms, and have been on the policy agenda for more than a decade. Complex reforms are rarely undertaken; they usually suffer from inadequate planning, insufficient political will and a lack of resource commitments. They often encounter strong resistance from various interest groups that are or may be affected by their implementation.

4.4 Challenge 4: Strengthening public sector R&I capacity

Description

R&I systems in Croatia are generally perceived as weak and uncompetitive at the international level. The country's research excellence composite indicator score is still very low compared with the EU-28 (47.8 in 2012), with only Romania (13.2) and Lithuania (14.1) performing worse than Croatia (18.89) (Račić, et al., 2017). Scientific production in prestigious journals is among the lowest in the EU (4.5 in Croatia versus 10.5 in the EU among the top 10% of most-cited publications). Public-private cooperation remains at a relatively low level, as shown by the number of public-private co-publications, which decreased by 9.37% in 2016 (EIS, 2016). Performance has also worsened in relation to PCT patent applications (EIS, 2016).

The large universities retain archaic structures and organisations, resistant to change and competition. The organisation of faculties as individual legal entities makes universities fragmented and incapable of creating coherent and long-term strategies for development

and modernisation. Increasing the number of graduates in STEM subjects is perceived as a national educational priority, but little has been done in this respect.

There are weaknesses in the evaluation of institutional research performance and in links between performance and funding. The criteria for the promotion of researchers into higher scientific grades are loose and cause unnecessary tensions among researchers who compete for the same posts. As pointed out in *Country Report Croatia 2016* (EC, 2016a), 'Subcritical scale, fragmentation, relative isolation and a mismatch between academic curricula and labour market needs continue to affect public research'.

On the other hand, there are some informal analyses (Herak, 2012) that suggest that Croatian science is more efficient than in many other Member States, if scientific production is related to factors such as research funds, GDP or number of researchers. This reasoning is supported by the last Horizon 2020 evaluation report (EC, 2017b), according to which Croatia receives €85,644 per million of national investments and outperforms 15 European countries (6 EU-13 and 9 EU-15). Croatia receives €5,042 per researcher and is higher ranked than several EU-13 countries that invest more in R&I, such as Poland, the Czech Republic and Hungary.

Policy response

The overall system of public funding for R&D has been rationalised since 2013. The rationalisation involved changes in both the funding of competition-based projects and institutional funding. The changes include two measures adopted in 2013: multi-annual institutional block funding based on performance indicators (OG 69/2013); and a rigorous evaluation process for awarding project grants that is intended to result in the selection of a smaller number of high-quality research projects (up to 250 per year).

The issues of competition among researchers and increasing their productivity have partly been addressed with the adoption of the 2013 Act on Science and Higher Education, which put limits on the promotion of researchers into higher scientific grades. Unfortunately, the limits were based on administrative criteria – the available coefficients for working posts within institutions – instead of scientific merit. Scientific merit and productivity were taken into account by the new Regulations on the conditions for promotion into higher scientific grades, adopted in May 2017 (OG 28/2017), which stipulated more rigorous minimum criteria for promotion into higher scientific/teaching grades. In parallel, the Ordinance on the organisation and operation of the scientific area councils and scientific filed committees of the NCSHETD (OG 47/2007) has been adopted; it regulates the working and organisational procedures of the NCSHETD's councils and committees. Finally, the draft law on amendments to the law on scientific and higher education is in the final phase of public consultation;[36] it is intended to determine the rules relating to the promotion and working rights of scientific researchers in a more precise way.

The SEST (2014) includes numerous measures to improve the research, development and innovation, ranging from changing the management and funding of HEIs and public research organisations to developing science and industry collaborations and bringing in measures to ensure a sufficient supply of (post)graduates in science, technology, engineering and mathematics.

Several programmes for strengthening public sector R&I funded by ERDF have been launched. They include 13 CoREs, which were established in 2014 and 2015. A public call for frontier research was published in November 2016, with a total value of €50 million. Another programme addresses the process of restructuring public research institutions in the research, development and innovation sector. A public call for investment in the organisational reform and infrastructure of these institutions was published in May 2017. The total value of the programme amounts to €41 million.

[36] https://esavjetovanja.gov.hr/ECon/MainScreen?entityId=5433

The programme for support to researchers for applications to ERC programmes was published in April 2017 by CFS.

In the domain of science and industry cooperation, two programmes important for public research institutions were launched in 2016. The first relates to increasing the development of new products and services resulting from R&D activities. The second relates to the pre-selection of 34 centres of competence, the best of which will be selected to perform collaborative research projects supported by €105 million from ERDF.

Assessment

Although the reforms to the research funding system from 2013 (multi-annual institutional funding based on performance indicators and rigorous evaluation processes for awarding project grants) are aimed at strengthening research quality, the subcritical level of public research funding (public spending on R&D as a proportion of GDP in 2015 reached only 59% of the EU average) reduced the impact of the reform measures. Almost four years after the introduction of the measures, there have been no evaluation studies of their impact on research activities. According to informal analyses, performance-based institutional funding has not contributed to the quality of institutions because the link between performance and funding has not been established in practice. Performance-based institutional funding relies mainly on 'per head' numbers, rather than on the scientific merit of the institutions. This has prompted the idea of replacing performance-based funding with more structured programme-based funding that would define goals and resources for research programmes. Croatia's austerity policy has been blamed for the failure of science policy in this respect.

There are also no studies that assess the quality of the projects funded under the new regime for awarding research grants, which began in 2013 and aimed to encourage high-quality research. Again, an informal estimation suggests that the policy of funding a reduced number of projects challenges the sustainability of the research system due to limited resources for research and their concentration on a smaller number of projects engaging a smaller number of researchers.

The new policy on promotion into higher scientific grades (introduced by the 2013 Law on science and higher education) was based on administrative barriers – the available coefficients for working posts within institutions – rather than more rigorous scientific merit. This undermined those carrying out high-quality research and discouraged scientific production, giving rise to clientelism and corruption. This policy failure has been partly corrected by the new Regulations on the conditions for promotion into higher scientific grades (OG 28/2017), which stipulate new, more rigorous minimum criteria for promotion into higher scientific/teaching grades. Since this regulation was adopted very recently, in May 2017, how it will be implemented in practice remains to be seen. The Law on amendments to the 2013 Law on science and higher education, which is currently in draft form, addresses this topic and will therefore have an important role. The public consultation has indicated that the draft law has many shortcomings. For example, it does not address essential issues for the R&I system such as funding of PhD students and graduates, the inappropriate 'autonomy' of universities and inefficient institutional funding.

A report on the state of play of the implementation of the SEST (for the period 24 October 2014 to 31 March 2016) was published in May 2016.[37] It found that the realisation of all six strategic goals in science and technology had begun or been partially accomplished. The aforementioned regulations on promotions in science are part of the achievement of these goals.

[37] http://novebojeznanja.hr/UserDocsImages/Dokumenti%20za%20web/Izvje%C5%A1%C4%87e%20o%20provedbi%20SOZT_do%2031.3.2016..pdf

Public calls for strengthening public sector R&I, funded by ERDF, were implemented according to the indicative plan for the OPCC 2014-2020. They included the establishment of up to 13 CoREs and improving the infrastructures of public research institutions in the research, development and innovation sector. Two programmes (centres of competence and research-based products/services) that follow the triple helix model of science and industry cooperation were launched in 2016. These programmes renew and significantly improve the science and technology structures and activities in the research, development and innovation sector and will hopefully result in some technological leapfrogging. However, many institutions and researchers do not have the opportunity to benefit from these programmes because their research activities do not relate to science and industry cooperation or the commercialisation of research.

5 Focus on R&I in National and Regional Smart Specialisation strategies

Croatia's Smart Specialisation Strategy (S3) was adopted in March 2016 (Official Gazette 32/2016) and there have been no new major policy developments since then. This short period limits the analysis of the content and status of the strategy's implementation. To date, S3 implementation has been focused on the implementation of the programmes funded by ESIF and envisaged by the indicative plan for calls for proposals for the years 2016 and 2017. A range of public calls was published, aimed at the development of the research sector, SMEs and innovation.

Since Croatia is a small country whose size corresponds to some regions in large Member States, the concept of smart specialisation has been applied only at the national level. The implementation of S3 in the past year focused on the execution of programmes envisaged by the indicative annual plan for calls for proposals, co-financed by ESIF through the OPCC 2014-2020.[38] The implementation of the programmes may be considered satisfactory, since the publication of public calls took place in accordance with the schedule in the indicative plan.

The realisation of the action plan for the implementation of S3 started in 2016 with public calls for proposals aimed at innovative companies (Competency and Development of SMEs, Innovations in Newly Established SMEs), and cooperative projects for industrial research (Increasing the Development of New Products and Services Resulting from R&D Activities, Strengthening Capacities for Research, Development and Innovation). Several important R&I infrastructures envisaged in the S3 action plan have been also established. They include centres of competence, CoREs and competitiveness clusters. On the initiative of the government, 13 competitiveness clusters have been established (as non-profit organisations) prior to the implementation of S3. Although their role is still rather limited, they are expected to be integrated in the Innovation Network for Industry and to have an active role in the overall national innovation system.

The public call for CoREs was launched in 2013 and resulted in the establishment of 13 CoREs in 2014 and 2015 (they have been approved by the European Commission). However, the call for the programme aimed at funding CoREs' frontier research was not launched until November 2016. The call was closed in April and grant contracts related to 10 CoREs were signed in early October.

A public call relating to centres of competence was launched in August 2016 and resulted in February 2017 in the selection of 34 registered applicants who have the right to apply for grants until the end of 2017, subject to availability of funding.

The MSE continued financing project pipeline documentation for research infrastructure projects from ESIF (e.g. Operational Programme Regional Competitiveness 2007-2013)

[38] Operational Programme Competitiveness and Cohesion 2014-2020

in 2016 and 2017. In May 2017, the MSE published a call for proposals for organisational reform and infrastructural renewal for research institutions engaged in research, development and innovation projects, as well as a call related to the strategic project Science and Technology Foresight. However, the majority of programmes and public calls published in the first part of 2017 were aimed at the development of SMEs and included Internationalisation of Business in the MSP Sector (March 2017), From Product Certification to the Market (May 2017), Development of Entrepreneurial Zones (April 2017) and Promotion of Entrepreneurship 2017-2019 (May 2017).

However, many of the activities envisaged in the action plan have been delayed due to various factors. These primarily relate to delays in the creation of an institutional framework for governance and monitoring of S3 (section 7.2. of the strategy). The National Innovation Council, which was envisaged as the umbrella institution for the coordination of S3 implementation, has not yet been established, nor has the Intergovernmental Working Group for the operational management of S3, whose main aim is to monitor the execution of the S3 action plan.

The Innovation Industry Council, as one of the three S3 consultancy bodies, has also not been established. The remaining two councils were established in 2014 and are the NCSHETD in the domain of scientific research, and the NCDHP as the central strategic body for the Development of the Croatian Qualifications Framework.

The TNI, intended to act as an umbrella network for thematic innovation councils, innovation platforms and action working groups for each of the thematic priority fields, has not been established. The network of these institutions is supposed to support the Croatian industry by the 'triple helix model' (each thematic innovation council should consist of about 30 representatives of stakeholders from different sectors). The idea is to speed up the entrepreneurial discovery process and encourage networking activities between Croatian industry and scientific and research institutions in order to identify mutual needs and synergies.

Although there has been no evaluation of the current S3 implementation, certain conclusions can be drawn from the review of the specific strategic goals and the implementation of instruments for their realisation (Table 6).

Table 6. Connections between specific strategic objectives and implementing instruments

Specific strategic goals	**Implementing instruments**	**State of implementation**
Increased capacity of RDI sector to perform excellent research and to serve the needs of the economy		
	Strengthening infrastructural capacities of research organisations	Call closed. The evaluation process is ongoing
	Development of R&D infrastructural project documentation 'Project pipeline preparation for ERDF 2014-2020'	Call launched
	CoREs	Call closed. Grant contracts have been signed for 10 CoREs

	Support to scientific organisations conducting R&D projects geared to the needs of the economy	Call announced
	Strategic project Scientific and Technological Foresight	Contract signed
	Centre of Competence for Translational Medicine at the Children's Hospital Srebrnjak	Call in preparation
	Strategic project Centre for Advanced Laser Techniques	Call closed. The evaluation process is ongoing
	Strategic project HR-ZOO – Croatian Scientific and Educational Cloud	Call in preparation
	Development and strengthening of synergies with Horizon 2020 horizontal activities: twinning and ERA chairs	Call closed. The evaluation process is ongoing
Overcoming the fragmentation of the innovation value chain and the gap between the scientific research and business sectors		
	Development of innovation networks for industry and creation of innovation platforms	No initiative
	Establishment and development of competence centres	Calls announced, 34 potential centres of competence selected
	Strengthening links between the scientific and business sectors through the support of the Technology Transfer Bureau and science and technology parks	To be decided
Modernisation and diversification of the Croatian economy through investing in the business sector in research, development and innovation		
	Support for business investment in research, development and innovation	Calls announced
	Support for building the capacity of SMEs for innovation.	Many calls announced
Upgrading the global value chain and fostering the internationalisation of the		

Croatian economy		
	Support for the implementation of the competitiveness clusters initiatives	Clusters have been established (no further initiatives)
	Support for building the capacity of SMEs for innovation	Calls announced
Partnership work on addressing social challenges		
	Support for social innovations	n.a.
Development of smart skills		
	Establishment of the infrastructure for smart skills policies	n.a.
	Establishment of instruments for a medium-term assessment of skills	n.a.
	Implementation of the Croatian Qualifications Framework	Partial implementation

A detailed plan for monitoring and evaluating the implementing of S3, with a set of indicators on outputs and outcomes, was envisaged (section 8.3 of the strategy). However, little of the plan has been realised.

The National Innovation Council and the Interministerial Working Group, the pillar intuitions for coordination, monitoring and evaluation of the implementation of S3 have not been established, and nor has the technical service at HAMAG-BICRO.

However, the Board for Control and Monitoring of the Management of the OPCC was established on 18 December 2014. The board consists of 71 members, of which 63 are members with voting rights. The board has so far adopted the annual report on the implementation of the OPCC for 2014 and 2015, the period before the adoption of S3 in April 2016. No reports on the implementation of S3 have been adopted and published.

According to informal information from the government on the use of ESIF, in 2017 a significant step towards more efficient use of structural funds was made.[39] At the beginning of the year, only 9% of the funds had been committed; this percentage had increased to 25% by the end of September 2017. In 2017, the Central Finance and Contracting Agency agreed, together with the MEEC and the MRDEUF, 80 contracts with a total value of €133 million. This speaks of the government's efforts to speed up the process and sign contracts as soon as possible to create growth and development in all segments.

Since S3 was launched recently, in April 2016, there have not yet been any evaluation or impact studies. There have been no special reports on the implementation of the entrepreneurial discovery process either, but it is expected that this process will be put into practice as part of the programmes for fostering innovation in SMEs and for cooperation between the research and business sectors. Until outcomes of S3 implementation are observed and measured, it is reasonable to assume that they are limited.

[39] http://www.strukturnifondovi.hr/potpisano-28-ugovora-o-dodjeli-bespovratnih-sredstava-za-projekte-vrijedne-670-milijuna-kuna

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Abbreviations

BERD	business expenditure on R&D/izdaci poslovnog sektora za istraživanje i razvoj
CoREs	Centres of research excellence
CSF	Croatian Science Foundation/Hrvatska zaklada za znanost
ERA	European Research Area/Europski istraživački prostor
ERC	European Research Council
ERDF	European Regional Development Fund/Europski fond za regionalni razvoj
ESIF	European Structural and Investment Funds/Europski strukturni i investicijski fondovi
EU	European Union/Europska unija
EU-28	28 Member States of the European Union/Europska unija uključujući 28 država članica
GBAORD	government budget appropriations or outlays on R&D/proračunska izdvajanja za istraživanje i razvoj
GDP	gross domestic product/bruto domaći proizvod
GERD	gross domestic expenditure on R&D/bruto domaći izdaci za istraživanje i razvoj
GVA	gross value added
HAMAG-BICRO	Croatian Agency for Small Business, Innovation and Investment/Hrvatska agencija za malo gospodarstvo, inovacije i investicije
HEIs	higher education institutions/institucije visokog obrazovanja
MEC	Ministry of Entrepreneurship and Crafts/Ministarstvo poduzetništva i obrta
MEEC	Ministry of Economy, Entrepreneurship and Crafts/Ministarstvo gospodarstva, poduzetništva i obrta
MSE	Ministry of Science and Education/Ministarstvo znanosti i obrazovanja
MRDEUF	Ministry of Regional Development and European Funds/Ministarstvo regionalnog razvoja i EU fondova
NCDHP	National Council on the Development of Human Potential
NCSHETD	National Council for Science, Higher Education and Technological Development/Nacionalno vijeće za znanost, visoko obrazovanje i

	tehnološki razvoj
OECD	Organisation for Economic Co-operation and Development/Organizacija za ekonomsku suradnju i razvoj
OPCC	Operational Programme Competitiveness and Cohesion
PCT	Patent Cooperation Treaty
R&I	research and innovation/istraživanje i inovacije
R&D	research and development/istraživanje i razvoj
S3	Smart Specialisation Strategy
SEST	Strategy for Education, Science and Technology/Strategija obrazovanja, znanosti i tehnologije
SMEs	small and medium-sized enterprises/mala i srednje velika poduzeća
STEM	science, technology, engineering and mathematics
TNI	Technology Network for Industry

Factsheet

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
GDP per capita (euro per capita)	10500	10500	10500	10300	10300	10200	10600	11100		
Value added of services as share of the total value added (% of total)	67.28	68.24	68.36	68.55	69.06	69.34	69.4			
Value added of manufacturing as share of the total value added (%)	14.44	14.08	14.37	14.43	14.09	14.58	14.9			
Employment in manufacturing as share of total employment (%)	17.34	16.58	17.22	17.46	17.11	17.14	16.62	17.02		
Employment in services as share of total employment (%)	57.85	58.48	57.67	60.03	61.79	63.67	64.23	65.58		
Share of Foreign controlled enterprises in the total nb of enterprises (%)		2.32	2.73	2.79	2.72	2.77	3.19			
Labour productivity (Index, 2010=100)	98.3	100	103.8	106.2	109.2	107.2	112.2	114.9		
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	0.41		0.62	0.71	0.78	0.81	0.8	0.51		
Summary Innovation Index (rank)	25	24	24	24	24	26	25	26		
Innovative enterprises as a share of total number of enterprises (CIS data) (%)				37.9		39.7				
Innovation output indicator (Rank, Intra-EU Comparison)			26	26	27	27				
Turnover from innovation as % of total turnover (Eurostat)		10.5		10						
Country position in Doing Business (Ease of doing business index WB)(1=most business-friendly regulations)						39	40	43	43	51
Ease of getting credit (WB GII) (Rank)						56	63	67		
EC Digital Economy & Society Index (DESI) (Rank)						24	24	23	24	
E-Government Development Index Rank		35		30		47		37		
Online availability of public services – Percentage of individuals having interactions with public authorities via Internet (last 12 months)	17	19	17	26	25	32	35	36	32	
GERD (as % of GDP)	0.84	0.74	0.75	0.75	0.81	0.78	0.84	0.84		
GBAORD (as % of GDP)	0.69	0.72	0.75	0.72	0.61	0.71	0.8	0.74		
R&D funded by GOV (% of GDP)	0.43	0.37	0.36	0.34	0.32	0.33	0.31			
BERD (% of GDP)	0.34	0.33	0.34	0.34	0.41	0.38	0.43	0.37		
Research excellence composite indicator (Rank)	27	26	25	28	25	24				
Percentage of scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country		3.46	4.06	3.36	4.12	4.06				
Public-private co-publications per million population	24.36	29.75	31.94	25.49	17.13	12.48	5.68			
World Share of PCT applications	0.03	0.03	0.03	0.02	0.03	0.02	0.01			
Global Innovation Index				37	42	40	47	41		

Data sources: various, including Eurostat, the European Commission and international scoreboard data.

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