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Abstract

The 2015 series of RIO Country Reports analyse and assess the policy and the national research and innovation system developments in relation to national policy priorities and the EU policy agenda with special focus on ERA and Innovation Union. The executive summaries of these reports put forward the main challenges of the research and innovation systems.

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Foreword

The report offers an analysis of the R&I system in Croatia for 2015, including relevant policies and funding, with particular focus on topics critical for EU policies. The report identifies the main challenges of the Croatian research and innovation system and assesses the policy response. It was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites etc. The quantitative data is, whenever possible, comparable across all EU Member State reports. Unless specifically referenced all data used in this report are based on Eurostat statistics available in February 2016. The report contents are partly based on the RIO country report, 2014 (Račić and Švarc, 2015).

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Executive summary

The report offers an analysis of the R&I system in Croatia for 2015, including relevant policies and funding, taking into account the priorities of the European Research Area and the Innovation Union. The report was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites, etc. The quantitative and qualitative data is, whenever possible, comparable across all EU Member State reports. The report contents are partly based on the RIO Country Report Croatia 2014 (Račić, Domagoj and Švarc, Jadranka, 2015).

Context

GDP per capita amounted to €10,200 (16 100 in PPS and 59 PPS where EU28=100) in 2014 (Eurostat) and it is significantly below EU-28 level (€27,400, 27 400 PPS). GDP has continuously declined over the last several years. In 2012, GDP growth rate amounted to -2.2%, followed by decrease in 2013 by -0.9%, and continuation of the trend in 2014 (-0.4%). Positive indications, considering GDP growth rate, have been registered in the 4th quarter of 2014. The forecast for 2015-2017 is positive as well: 1.8-2.1% growth¹.

In line with the EU Council recommendations from January 2014, Croatia needs to address the issue of excessive budget deficit by 2016 – by 4.6% in 2014; 3.5% in 2015 and 2.7% in 2016. The Croatian post-crisis fiscal adjustment has not started up until 2011 and it is not accomplished yet, with 2011 being the year with the strongest fiscal adjustment. During 2011-14 GBAORD and GERD funded domestically by the government decreased steadily, both nominally and as a share of the GDP by 0.15% of GDP – GBAORD, and 0.04% – government financed GERD. Therefore we can conclude that the Croatian post-crisis fiscal adjustment has come at an expense of direct public support to R&D expenditures through significant cuts in R&D budgets. Croatia is still experiencing excessive macroeconomic imbalances which require decisive policy action and specific monitoring. In addition, already scarce state budget resources have been announced to further decrease in 2016 and 2017. GBAORD decreased from 1.54% of government expenditures in 2011 to 1.3% in 2014 (Eurostat).

The total gross domestic expenditure on R&D (GERD) amounted to €340m in 2014, which is a decrease compared to €354 in 2013. In the past years GERD was characterized by fluctuation; in 2012 it has decreased to €330m from €336m in 2011. The R&D intensity amounted to 0.81% in 2013, which was 0.06 percentage points higher in comparison to 2012 and 2011 when it was at the same level (0.75%) (Eurostat). However, GERD decreased again in 2014, amounting to 0.79% of GDP. This is significantly below the latest R&D investment target, which has been set to 1.4% of GDP by 2020.

The R&I system has gone through significant changes since mid-2013 due reduced budget resources for R&I and to the significant reforms in both research and innovation system in pursuit of scientific excellence and innovation efficiency. The austerity policy, caused by the sixth consecutive year of economic contraction and excessive public deficits, resulted in significant changes not only in funding but also in the organisation, governance, performing and evaluation of R&I activities.

Key developments in the R&I system in 2015 included:

- Two programmes of CSF (the Partnership in research and the Unity through Knowledge Fund) and three innovation programmes run by the HAMAG-BICRO (PoC, RAZUM, IRCRO) for allocation of R&I grants were re-launched in 2015, given the STP II funds availability;

¹ EC Winter 2016 Economic Forecast : http://ec.europa.eu/economy_finance/publications/eeip/pdf/ip020_en.pdf

- A new programme for technology transfer at universities (TTU) has been launched in February 2015 and co-funded by STP II resources;
- In April 2015, a new call for Centres of research excellence has been launched; in November 2015 six new Centres of research excellence have been established;
- Croatia begun its participation in the Regional innovation fund of the Western Balkan countries (ENIF) with a total national contribution of around €0.5m per year;
- Establishment of the first venture capital fund for innovation and entrepreneurship;
- A new programme announced for funding young researchers/teachers;
- S3 has been drafted and several drafts have been sent to EC for adoption (it was adopted in 2016);
- The Ministry of Science, Education and Sports (MSES) has announced a third call for research infrastructures which will be funded by European Structural and Investment Funds (ESIF) 2014-2020 for restricted applicants.

Croatia is a new member of the EU, but is making efforts to align with ERA priorities and participates actively in several international initiatives. Research e-Infrastructures are rather well developed in Croatia and in the area of open, transparent and merit based recruitment Croatia has made a big progress since 2012. On the other side, as a general rule, national research grants are not portable and the country has a weak share of publications in the top 10% most cited publications worldwide.

Croatian R&I policy is relatively young. Demand-side instruments are not developed which significantly influences innovation performance of both public and private sectors. The main supporting measures providing incentives for businesses to invest in R&D are tax incentives and direct support schemes. The country scores poorly in IUS rankings, but is on the path of important reforms which are expected to bring more efficiency in the system.

The identified challenges for Croatia's R&I system are:

1. Lack of coherent and integrated R&I policy framework
2. Strengthening private sector's R&I capability and improving the business innovation environment
3. Strengthening public R&I capacity

R&I challenges

Challenge 1: Lack of coherent and integrated R&I policy framework

Description

Croatia is the youngest member of the European Union and has a relatively young R&I system. The country has been for long characterised by a lack of sustained political commitment to innovation (OECD, 2014). One reflection of this situation could be found in the low levels of R&D intensity (as % of GDP) in the last years albeit GDP was declining. In addition, further decrease of budget resources for R&I funding has been announced for 2015 and 2016. The present science policy suffers also from the lack of coordination between government bodies responsible for research and innovation policy (Ministry for Science, Education and Sport, Ministry of Economy, Ministry of Entrepreneurship and Crafts and Ministry of Regional Development and European Funds). Their policies and supporting measures are not harmonised nor related in a way to produce a synergy in innovation and technological development. This is further reflected in the weak performance (efficiency) of Croatia, which is ranked 23rd according to the SII 2015 and 27th when calculating the ratio between innovation output and input (Edquist and Zabala-Iturriagoitia, 2015).

There is a risk that the low level of coordination and division of responsibilities between relevant public bodies could lead to an ineffective management of available ESI funding. The system already experiences significant delays in implementation of grant schemes for R&I activities. The lack of coherence and coordination in the R&I system resulted also in delays in the drafting and implementation of several important strategic documents, such as the Strategy for Fostering Innovation of the Republic of Croatia 2014-2020, Strategy for Education, Science and Technology 2014-2020 (SEST) and Smart Specialisation Strategy. Croatia needs to absorb the SF allocation 2007-2013 by the end of 2016 and at the same time to launch the new 2014-20 calls which will challenge the management capacities of administration. Besides, the programmes under ESIF include a number of new sectors (ICT, energy, climate change, health and social inclusion, education) which will require specific technical capacities in the management bodies and support for project beneficiaries.

Policy response

In the area of R&I policy, significant developments have occurred during the period 2013-2014. The National Science Council (NSC) and the National Council for Higher Education (NCHE) were merged into the single body - National Council for Science, Higher Education and Technological Development, which became the highest advisory body in the system. To better link interventions and consolidate support measures to the private sector, the government decided to merge the Business and innovation agency of Croatia (BICRO), the previous pillar institution of the Croatian innovation system with the Croatian Agency for Small Businesses and Investments (HAMAG) into a single agency called the Croatian Agency for Small Business, Innovation and Investment - HAMAG-BICRO.

Several important documents were adopted: these primarily include the Strategy for Education, Science and Technology and Strategy for Fostering Innovation of the Republic of Croatia 2014-2020. The Strategy for Education, Science and Technology offers, among other things, recommendations for the establishment of a comprehensive R&I environment. The Strategy for Fostering Innovation is one of the most important cross-sectorial strategies. It aims to strengthen the Croatian national innovation system (NIS) and provide an efficient framework to foster the competitiveness of Croatian R&D and economy in general, through innovation and technological development.

During 2015 the Smart Specialisation Strategy (S3) was still in draft but at an advanced stage, and was adopted in March 2016. The S3 is seeking to unify all the relevant aspects from the various national strategies in a strategic framework. It acknowledges that implementing such policy is very complex and requires commitment of relevant institutions and strong policy capabilities at national and regional level. The strengthening of the national innovation system is set as a priority in the Croatian National Reform Programme 2015 and the Partnership Agreement with the EU.

The development of the Croatian Research Information System (CroRIS) has been initiated in 2014, with the drafting of project documentation for the national Science and Technology Foresight Project (STF). STF involves systemic analysis of the long-term trends in science and technology in order to create and implement tools and methods for development and sustainable execution of evidence based policy in the area of RDI, specifically for development and monitoring of S3 and other strategic documents, as well as to competitiveness, economic development and society.

Assessment

The R&I framework has undergone significant reforms since 2013. Although seen as not advancing at sufficiently fast pace, they led to certain improvement and advancement in the R&I governance, such as the introduction of performance-based institutional funding. With the accession to the EU, Croatia got access to ESIF and these funds could play a very positive role in the development of the NIS, should favourable R&I policy framework be put in place. It could be expected that the merger of some key intermediary institutions (i.e., HAMAG-BICRO) and the rationalisation and connecting of the offices for EU projects in various ministries (S2E Report) would bring about better synergy between institutions. Croatia will need to make major efforts to ensure adequate capacities for absorption of ESIF for the benefits of national development (EC, 2015b).

The recently adopted (2014) strategic documents (Innovation Strategy and SEST) present a significant breakthrough in reforming the national education, research and innovation systems. However, while the implementation of SEST has been initiated immediately after its adoption, implementation of Innovation Strategy is quite slow, which raises the question will the relatively ambitious development goals be achieved by 2020. Interim and ex-post evaluation are envisaged, but in general the Croatian evaluation system seems rather weak in this aspect. A positive development in the area of evaluation is the S3 where a number of analytical documents with impact assessment were drafted during the preparation phase.

Development of the CroRIS should significantly contribute to future monitoring and development of R&I policies, as well as general evaluation on the efficiency of the overall R&I system, which currently lacks on efficient monitoring and evaluation mechanisms and policy planning tools.

Challenge 2: Strengthening private sector's R&I capability and improving the business innovation environment

Description

Analytical reports (OECD, 2014; CEU, 2015; EC, 2015b; WEF, 2014) mention several factors playing a restrictive role towards the business innovation and research activities. Overall business environment in Croatia creates disincentives to innovation due to the lack of coordination in the design of support instruments for innovation (see Challenge 1), access to finance and the inadequate framework conditions. There is still room for improvement in the regulation of product markets, facilitation of firm entry and exit and there are some delays and difficulties in obtaining licences and in contracting utilities. *"[L]ow transparency and predictability in the working of administrative bodies, unevenly developed electronic communication channels, and lengthy judicial proceedings, in particular in commercial courts"* (CEU, 2015), are among the disincentives to business innovation.

Despite the fact that the share of GERD funded by business enterprise sector increased in 2013 compared to the years before, volume and investment of private businesses R&D remains at low levels, with low interest in cooperation with the public R&D sector. In addition, R&I activities are hindered by low capacities, unfavourable structure of available incentives and limited internationalisation (EC, 2015b). Economy is dominated by the large and un-reformed public companies that are not exposed to market competition which would urge them to innovate. A new layer of SMEs is composed of sectors which are not R&I intensive and consists largely of micro companies with less than 10 employees, having modest capacities to perform or absorb research. The wholesale and retail trade sector, construction and hospitality industry make nearly 50% of all SMEs (MEC, 2012). Low and decreasing public expenditures on R&D, as well as public policies in support of innovation which are *"characterised by weak commitment, slow reform pace and inefficient governance structures"*, as reported by the European Commission (EC, 2015b) also hinder innovation capacities.

Many documents report on mismatches between labour demand and supply and skills profile that is unfavourable to innovation, since *"[b]usiness 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"* (OECD, 2014). Private investment on R&I remained low, compared to other EU Member States with similar profiles, and access to finance is a major bottleneck. Croatia is lagging behind in several output indicators i.e., designs and trademarks, SMEs innovating in-house, SMEs introducing any type of innovation etc. (see Table 1). Innovation capacity is also negatively affected by insufficient public R&D investments, which contributes to the current situation of "low-level equilibrium" innovation system. As stated in the SWD 2015 *"[i]n a low-level equilibrium, business sector's weak innovation capabilities and low investment in R&D&I leads to little effective demand for and supply of innovation-related services and research"*. This represents also an important obstacle to public-private collaboration.

Policy response

Creating innovation friendly business environment for SMEs, strengthening the links between science and business and developing the necessary "smart" skills to meet the business need are among the key targets of the S3 and the National Innovation Strategy and the other R&I related strategic documents (see Challenge 1). Human resources issues are also addressed in the Strategy for Education, Science and Technology (see challenge 3). Several R&I support "infrastructures" are envisaged in the S3 Action Plan: Centres of Competence, Centres of Excellence, Competitiveness Clusters.

In the light of the reduced R&D funding, the Croatian government has reviewed and revised the grant schemes and renewed a number of instruments to support business investment in R&I. Several funding programmes were integrated in the Business Impulse Programme 2015 (IRCRO, RAZUM and Proof of Concept), funded by the joint project of the World Bank and MSES funded by IBRD loan – Second Science and Technology Project and managed by HAMAG-BICRO). Business Impulse Programme 2015 also envisages several measures aiming towards facilitating access to capital, including seed and early stage capital schemes. Publication of several grant schemes for R&I activities, funded through the ESIF, is also expected. These schemes will be implemented by the Ministry of Economy and Ministry of Entrepreneurship and Crafts.

In addition of direct funding programmes Croatia offers to the business sector the possibility to use R&D tax incentives. In 2011, an analysis of R&D tax incentives (Aralica et al., 2011) resulted in a conclusion that tax incentives in Croatia are more generous form of state aid for R&D than subsidies. In 2015 the income tax incentives have been discontinued because of the discrepancies of the Croatian legal framework and EU Commission Regulation No 651/2014 declaring certain categories of aid compatible with the internal market (GBER).

State aid for research and development projects has been granted since 2007, pursuant to Articles 111 a-f of the Act on Science and Higher Education (Official Gazette No. 123/03, 198/03, 105/24, 174/04, 02/07, 46/07) and the Rules on State Aid for Research and Development Projects (Official Gazette No. 116/07). Given that this is an "older" state aid measure, it is not in line with the regulations of the European Commission on state aid. Namely, this measure is listed on the list of aid schemes and individual aid which were put into effect in Croatia before the date of accession and apply after that date as well, in accordance with the provisions of Section 2 ("Competition policy") of Annex IV of the Treaty of Accession of the Republic of Croatia (hereinafter: the Treaty, Official Gazette, International Treaties No. 2/2012, 28 March 2012). In accordance with Annex IV of the Treaty, the duration of the measure is limited to 31 December 2014 and no requests for state aid for research and development projects have been granted from that date on.

Assessment

The overall funding provided to the business sector is insufficient and additional sources should be made available. In order to facilitate greater participation of the private sector in ESIF, a comprehensive evaluation of previous public calls should be conducted in order to eliminate unnecessary administrative burden which hinders or slows down project application. This implies building competence and maintaining organisational stability in the agencies, dealing with R&I related ESIF.

Renewal of some of the direct grant schemes which proved successful seems a suitable way forward. Over the last few years, the private sector gained more prominent place in the R&I system (compared to the traditional model where the public sector accounted for the bigger part of GERD). Evaluating the needs of the business and putting in place new instruments using ESIF and in the light of the S3 have the potential to further nurture R&I private activities and to help Croatia exit the trap of "low-level equilibrium" (WB Report 2015 on Smart Specialisation in Croatia). As for the indirect measures, according to the evaluation of the R&D tax incentives, they *"have increased the number of firms having R&D expenditures, although not necessary the value of expenditures itself"* (Aralica et al., 2011). However, 90% of the total tax incentives have been used by a small number of large companies. There are estimations that the tax breaks tend to be of little relevance to SMEs and to favour incumbent firms to the detriment of entrants (Arahamian and Correa, 2015). This indicates that further evaluation of this instrument is needed. When it comes to newly planned grant schemes for fostering R&I activities in the business sector, significant efforts of relevant public bodies should be invested in the design of these measures in a way to correspond to actual needs of potential applicants and enable implementation of clear and transparent evaluation procedures.

Challenge 3: Strengthening public R&I capacity

Description

In Croatia there are 25 public research institutes in five main fields of science. Most of them are in Social sciences and Humanities. Also, tertiary educational attainment and matching between academic curricula and labour market (e.g., increasing the number of graduates in STEM) need further improvement. Croatian universities are mostly fragmented and faculties are usually organised as individual legal entities, rather than departments of one single legal person, i.e. university. This leaves individual faculties with significant autonomy which may be an obstacle for implementing coherent strategies and long-term planning. At the same time, public research is largely underfunded and funding arrangements are rather fragmented. Public research funding was insufficiently linked to performance and evaluation of HEIs/PROs was largely underused until 2013.

Project funding was primarily based on allocation of a large number of competition-based project grants (around 2,500) from the State budget through the Z-project programme², administered by the MSES. This negatively affects the level of integration of Croatian HEIs and PROs, especially when it comes to possibility of fast adaptation to international competition and achieving excellence – Research excellence composite indicator score is still very low with only 2 EU Member States performing worse than Croatia (18.89 compared to EU28 47.8 in 2012). There are also significant obstacles when it comes to commercialisation of research results and development of science-industry linkages.

Policy response

Reforms of the science and higher education system have been initiated by the adoption of the Act on Science and Higher Education in July 2013. A new model for public R&D funding has been developed, focused on awarding multi-annual (three-year basis) block grants for HEIs and PROs from the State budget by MSES, using performance-based indicators. The process of awarding project-based R&D grants has also experienced significant changes. Since 2013, responsibility for R&D grants allocation has been transferred from MSES to the Croatian Science Foundation. New procedures include more rigorous project evaluation process aimed at selection of fewer high quality research projects (around 20%). Through these institutional changes, Croatian Science Foundation became a principal agency for allocation of project-based public funding of R&D activities in Croatia.

Another new form of institutional funding has also been introduced in 2014. This refers to the Centres of Research Excellence, whose establishment has been funded by MSES from the State Budget for the initial phase of establishing 7 Centres. In November 2015 six new Centres of research excellence have been established. Additional resources for the Centres are planned through ESI Funds, in line with S3 (see S3 Implementation Plan).

Unity through Knowledge Fund (UKF) was merged with the Croatian Science Foundation (CSF). It supports collaborative research with Croatian scientists living in Croatia and abroad and leading international scientific institutions to raise absorption capacity for EU funds, especially ESIF and Horizon 2020.

The Strategy for Education, Science and Technology was adopted in October 2014. This is a comprehensive document with a numerous measures to improve the R&D&I ranging from changing the HEIs and PROs management and *funding*, developing science-business collaborations including to measures for sufficient supply of (post)graduates in science, technology, engineering and mathematics.

By the end of 2014, the Government initiated the process of restructuring of the public research institutes in order to rationalize resources and raising the quality of research as well as accountability of public research institutions. By now, the Government has adopted the Decision on establishing the Committee for drafting the model of restructuring of public research institutes in Croatia in December 2014 which should be applied in a near future.

Assessment

Proposed reforms can seem somewhat radical and their actual implementation remains to be seen in the future, but the initial results of these reforms are rather promising. Although this is only the beginning, there are positive signs. The institutional funding in combination with the process of re-accreditation of the PROs and HEIs contributed significantly to strengthening the financial accountability and responsibility of the public research organisations.

² This programme was considered not creating sufficient level of competition and was ended, while funding was transferred to CSF

The awarding of project research grants assumes a rigorous evaluation process that should end up with a smaller number of high quality research projects, up to 250 per call per year. However, this can put at risk significant segments of the national scientific base since Croatia has insufficient public research funding and there is a lack of diversified resources for competitive research funding. For example, research funds have proved to be insufficient³ to cover all needs of researchers especially in natural, medical and technical sciences (S2E Report, JRC-IPTS, 2015). Already as a full member of the EU, Croatia should target efforts towards a better use of ESIF and H2020 projects, which is highly dependent on governance capacities.

The science and higher education policy should be devised more coherently and carefully to prevent the devastation of research potentials due to the budget restraints. For example, a large cohort of young scientist at universities in the status of post-doctoral degree, teaching assistant or assistant professor were expected to terminate their job contracts with universities in 2015 and succeeding year, primarily due to the changes introduced by the new Act on Science and Higher Education. This was prevented by a special decision of the government to continue to fund these young scientists. This will surely contribute to strengthening the scientific base and prevent the loss of financial resources invested in their education.

³ Some PROs decided to cover, for example, only a part of costs for scientific conferences in order to allow mobility for as many researchers as possible

1. Overview of the R&I system

1.1 Introduction

Croatia is a small country with a surface area of 88,073 km², out of which 56,594km² is land area and 31,479km² are territorial waters (CBS, 2015). According to the latest Eurostat data, Croatia had 4.23 million inhabitants in 2015, which is 0.5% less than in 2014. Downward trend in the number of Croatian population currently lasts for 10 consecutive years. Croatian population has a share of 0.83% of total EU population.

According to the Eurostat data, GDP per capita amounted to €10,200 (16 100 in PPS and 59 PPS where EU28=100) in 2014, which is significantly below EU-28 level (€27,400). GDP has continuously declined over the last several years. In 2012, GDP growth rate amounted to -2.2%, followed by decrease in 2013 by -0.9%, and continuation of the trend in 2014 (-0.4%). Positive indications, considering GDP growth rate, have been registered in the 4th quarter of 2014. The forecasts for the coming years are also positive (1.8-2.1%).

General government debt has been increasing constantly since 2008, reaching 85.1% of GDP in 2014. Debt increase has been mainly caused by the accumulation of budget deficit, reduction in nominal growth and stock-flow adjustments, as reported by the European Commission (EC, 2015b). Budget deficit has reached 5.3% of GDP in 2012, and further increased to 5.6% of GDP in 2014 (Eurostat). Within the Country report for Croatia, the European Commission (EC, 2015b) reported that, in the absence of further measures, the budget deficit could further deteriorate in 2015 and 2016. In Croatian Convergence Programme for the period 2015-2018, there are plans to correct the excessive deficit by 2017, which is not in line with the 2016 deadline recommended by the Council, as reported within the 2015 Country Specific Recommendations (CEU, 2015).

Croatian economy is characterised with significant prevalence of service sectors, which account for about two thirds of the GDP. According to the Croatian Bureau for Statistics (CBS) data, manufacturing comprised around 12% of GDP in 2013, while the share of trade in GDP amounted to 9.6% in the same year. Real estate activities contributed to 8.7% of GDP in 2013, followed by financial and insurance activities whose share amounted to 5.6% of the GDP structure. When it comes to gross value added, Eurostat data indicates that value added of manufacturing decreased from 23.4% in 2011 to 22.8% or total value added in 2013, while value added of high-technology manufacturing increased from 1.7% to 2.2% in the same period. Employment in high and medium-high technology manufacturing has decreased from 3.8% of total employment in 2011 to only 3.3% in 2014, while the employment in knowledge-intensive sectors has been gradually increasing from 29.5% of total employment in 2011 to 33.5% in 2014. (Eurostat)

Unemployment has remained as one of the largest structural problems of the Croatian economy. Unemployment rate amounted to 16% of labour force in 2012, increased to 17.3% in 2013, remained at the same level in 2014 and decreased to 16.3% in 2015.

The total gross domestic expenditure on R&D (GERD) amounted increased in 2013 to €354.6m, compared to €330m in 2012, but decreased again in 2014 to €340m.. As a percentage of GDP, gross domestic expenditure on R&D amounted to 0.81% in 2013, which indicated a slight increase compared to 0.75% in 2012 and 2011. In 2014, GERD decreased again to 0.79% of GDP (Eurostat). This is significantly below the national target of 1.4% of GDP by 2020, within the Economic Programme of Croatia from April 2013. According to the Eurostat data, turnover from innovation decreased from 14.4% of overall turnover in 2010 to only 10% in 2012. Significant expectations have been put to absorption of available EU funding for R&D activities and infrastructure as a mean to support and increase R&D funding in Croatia.

However, limited capacities of relevant public authorities for design and implementation of new programmes funded by ESIF, combined with structural challenges of the Croatian economy and limited absorption capacities of SMEs, do not present the quality base necessary for increasing the R&D expenditures to 1.4% of GDP by 2020.

Overall, last several years have been characterised with the introduction of structural reforms in R&I and other national systems stemming towards improvement of resources' allocation efficiency and business climate. Main reforms in the area include changes in the allocation of research grants, development of new strategic development documents, re-organisation of both instruments and institutions for allocation of R&I grants, etc. These reforms can be evaluated as substantial and comprehensive, but the actual results of the implemented measures remain to be seen in the future.

Table 1 Main R&I indicators 2012-2014

Indicator	2012	2013	2014	EU average 2014
GDP per capita in €	10,300	10,200	10,200	27,300
GDP growth rate	-2.2	-0.9	-0.4	1.3
Budget deficit as % of public budget	-5.3	-5.4	-5.7	-2.9
Government debt as % of GDP	69.2	80.6	85.0	86.8
Unemployment rate as percentage of the labour force	16.0	17.3	17.3	10.2
GERD in €m	330.0	354.684	339.857	283.887.569
GERD as % of the GDP	0.75	0.81	0.79	2.03
GERD (EUR per capita)	77.2	83.2	80	558.4
Employment in high- and medium-high-technology manufacturing sectors as share of total employment	3.8	3.6	3.3	5.7
Employment in knowledge-intensive service sectors as share of total employment	30.8	32.8	33.5	39.8
Turnover from innovation as % of total turnover	10.0	N/A	N/A	N/A
Value added of manufacturing as share of total value added	24.0	22.8	N/A	26.2 (2012)
Value added of high tech manufacturing as share of total value added	1.7	2.2	N/A	2.5 (2012)

Data source: Eurostat

1.2 Structure of the national research and innovation system and its governance

1.2.1 Main features of the R&I system

The governance of R&D system in Croatia is centralised at the state level under the authority of the Ministry of Science, Education and Sports (MSES)⁴. Research and innovation activities are mostly funded by the public resources from the central state budget.

⁴ <http://public.mzos.hr/Default.aspx?sec=2127>

Public R&D funding is based on annual budget cycles proposed by the National Council for Science, Higher Education and Technological Development (NCSHETD)⁵, the highest advisory body in respective domains, and agreed with the MSES and the Ministry of Finance.

The investments in R&D have been rather low and stagnant in both public and private sector over the past last decade, since 2004. With the total investments in science and research (GERD) of around 0.8% of the GDP (0.79% in 2014), compared with investments of above 2% of the GDP in the EU-28, Croatia is considerably lagging behind the EU Member States.

The low investments of business sector in R&D (around 0.34% of GDP) are of particular concern since it indicates that Croatia is missing the research base in the business sector which hinders development of complex innovation needed for international competitiveness and economic recovery. About 90% of all investment in R&D in the business sector is concentrated in medium and large companies, dominated by a several multinational companies, such as PLIVA or Ericsson Nikola Tesla. SMEs have limited technological capabilities and absorption capacities, generating only limited interest for R&D. A little below 8% of private investments in R&D come from micro and small enterprises (e.g. Genos⁶), thus showing their weak engagement in R&D activities (OPCC, 2014).

Since the European Structural and Investment (ESI) Funds acquire increasing importance in R&I funding the budget cycles are supplemented with the dynamics of ESI funds.

The regional research policy does not exist in Croatia, mainly due to the insufficient resources (small tax base) for R&I activities. The regional development policy exists mainly at the county level (NUTS 3) and is related to affairs of local significance such as local economic development, primary education, traffic infrastructure, health services and other social and cultural institutions. Croatia suffers from considerable and long term regional disparities. In the last ten years the average income is three times higher in the richest regions than in the poorest one (RCIC, 2013).

According to the Regional Innovation Scoreboard 2014 (EC, 2014 – most data refer to 2010), the whole Croatia as well as the North-West Croatia which is the most developed region (due to the capital city Zagreb) are classified as a moderate innovators. The remaining two regions (old nomenclature, nowadays there are only 2 NUTS2 regions) are modest innovators. The role of science and research as vehicles of regional development has not been so far adequately articulated. The main legal acts - the Act on Regional Development (Official Gazette 147/2014), the Strategy of Regional Development 2011 – 2013 (adopted in June 2010), and the Strategy of Cluster Development in Croatia 2011 – 2020 (carried out in 2011) do not deal specifically with regional research capacities. The regional policy is likely to change with the implementation of the Operational Programme "Competitiveness and Cohesion" 2014-2020 (OPCC, 2014) co-financed by ESI funds. Although the OPCC is not organised by specific regions but by the nine thematic objectives the success of the Priority axes 1 of the OPCC which aims to strengthen the research and innovation will depend on regional involvement and commitment of entrepreneurs who are supposed to play a critical role the R&I regional development.

⁵ <http://www.nvzvotr.hr/hr/>

⁶ <http://genos.hr/hr/o-nama/tvrtka-genos/>

1.2.2 Governance

The R&D sector has been subjected since the mid 2013 to substantial reforms aiming for scientific excellence and due to budget restrictions and austerity policy. The reforms and budget cuts resulted mainly in shrinking the science base and the new funding system affected researchers' operational resources for regular research activities while the funds for young researchers have been reduced. According to Eurostat the number of researchers (FTE) has decreased since 2010 in the government sector for 11% (from 2,097 to 1,857) and in the higher education sector for 10% (from 3,716 to 3,337). The Partnership Agreement (PA, 2014) states that the main structural deficiency in the R&I area is related to weak governance of the national innovation system and lack of an integrated policy framework for R&I embedded in Croatia's mainstream development strategies. The governance of public research and higher education remains a challenge to ensure higher efficiency and effectiveness of investments (EC, 2015b).

Despite some new measures were well tuned (e.g. performance based institutional funding to strengthen social accountability and responsibility of the public institutes) there is perception that an opaque governance structure spawns a policy-making and implementation system that lacks cohesion (World Bank, 2015, p. 2). On the other hand, there are opinions that researchers perform quite well under the present circumstances of financial restrictions and weak R&I governance (Casa, 2015; Herak 2012).

Within the restricted budget resources and limited fiscal space the ESIF occurs as a crucial investments resources for structural reforms including strengthening of R&I (it will allocate € 10.68b in the period 2014-2020 or over 3% of GDP on annual basis or about ten times as much as that for 2007-13 (EC, 2015). Limited administrative and technical capacities of management bodies, at local and beneficiary level, are combined with difficulties linked to the switchover from the IPA to the ESIF (EC, 2015, p. 87; Račić and Švarc, 2015). This has contributed to delays in the absorption of the 2007-2013 allocation. Croatia needs to absorb the SF allocation 2007-2013 by the end of 2016 and, at the same time, launch the new 2014-2020 programmes which will challenge the management capacities of administration. The programmes under ESIF include a number of new sectors (ICT, energy, climate change, health and social inclusion, education) which will require specific technical capacities in the management bodies and support for project beneficiaries. Croatia will need to make major efforts to ensure adequate capacities for absorption of ESIF for the benefits of national development.

The Smart Specialisation Strategy still needs to be adopted, while the Strategy for Fostering Innovation of the Republic of Croatia 2014-2020 is being implemented very slowly. Besides a lack of broad policy orientations and well-coordinated implementation, the governance of the R&I system suffers from the lack of effective communication with the research community. Some recent reforms and measure did not get the full buy-in from the research community (e.g. the initiative for restructuring of public institutes⁷).

The involvement of different stakeholders (industry, NGO, local/regional authorities) regarding organisation and funding of research activities is rather weak due to the traditional closeness of research community and centralised governance at the state level. However, a wider range of stakeholders is usually involved in the preparation of documents of a broader national significance such as the various strategies, action plans, etc. Relevant stakeholders are also included in preparation of tender documents for Calls for proposals when Calls are open for public consultations (in case of open calls). They usually participate through consultations, public hearings or direct involvement in documents' preparation. Many research institutions plan to intensify cooperation with business, public, civil sector and society at large, in order to promote and encourage science and knowledge society culture, networking, cooperation and science promotion.

⁷ <http://public.mzos.hr/Default.aspx?art=13622>

The State budget for 2015, 2016 and 2017 foresees reduction instead of an increase in public resources for R&I, which diminishes the financial sustainability of R&I systems and policy. On the other hand, despite budget resources are small and insufficient they are allocated regularly.

However, the CSF warns (CSF, 2015) that the payment of funds for research projects in 2015 could be compromised since the overall financial obligations contracted for about 500 projects during 2013 and 2014 amounts to around €13.3m while the envisaged funds in the State budget are remarkable less.

The main policy making institution in the Croatian science and innovation system is the Ministry of Science, Education and Sports⁸ (MSES) which is responsible for the entire research and higher education system, and innovation policy related to commercial exploitation of research results. The Ministry of Economy⁹, the Ministry of Entrepreneurship and Crafts¹⁰ and the Ministry of Regional Development and European Funds¹¹ acquire increasingly important role in R&I system because of the growing role of entrepreneurship and business ventures in innovation system and access to the European Structural and Investment Funds (ESIF) for financing R&I activities. MSES is responsible for institutional funding organised around the Multi-annual Institutional Financing of Research Activities in the PROs and HEIs based on performance indicators. It is also the principal administrative body for carrying out programmes in research, higher education and innovation funded by the Structural funds 2007-2013 and ESIF 2014-2020 (Specific objectives of the Priority Axes 1) which are expected to become the most significant funding resource since Croatia received access in July 2013. The MoE is responsible for remaining specific objectives of the Priority Axes 1 related to creating of favourable innovation environment by promoting business investment in R&I, developing links and synergies between enterprises, research and development centres and among other promoting investment in product and service development, technology transfer, demand stimulation, networking, clusters and open innovation through smart specialisation, and supporting technological and applied research.

The Croatian Science Foundation¹² (CSF) became the main funding body for competition-based fundamental scientific research since 1 July 2013 when the allocation of competitive research grants was transferred from MSES to the Foundation. It administrates also the programmes Partnership in research and the Young Researchers' Career Development Project. Furthermore, the Unity through Knowledge Fund (UKF) was affiliated with CSF in February 2014 in order to maximise its efficiency. The Fund performed a call for the programme Crossing Border Grants funded by the Loan Agreement for the Second Science and Technology Project (STP II).

The highest advisory body for the scientific research, higher education and technology is the National Council for Science, Higher Education and Technological Development¹³. The Croatian Academy of Sciences and Arts¹⁴ (CASA) occasionally provides relevant opinions about the science policy and development. The Agency for Science and Higher Education¹⁵ (ASHE) is responsible for setting up a national network for quality assurance and evaluation of scientific research and higher education. The Agency receives growing importance in monitoring and reforming of the science and higher education systems owing to the evaluations which serve as a ground for reorganisation of the system.

⁸ <http://public.mzos.hr/Default.aspx?sec=2428>

⁹ <http://www.mingo.hr/>

¹⁰ <http://www.minpo.hr/default.aspx?id=68>

¹¹ <https://razvoj.gov.hr/>

¹² <http://www.hrzz.hr/default.aspx?id=47>

¹³ <http://www.nvzvotr.hr/hr/>

¹⁴ <http://info.hazu.hr/>

¹⁵ <https://www.azvo.hr/en/>

The Business and innovation agency of Croatia (BICRO), the previous pillar institution of the Croatian innovation system has been merged with the Croatian Agency for Small Businesses and Investments (HAMAG) into a single agency called the Croatian Agency for Small Business, Innovation and Investment – HAMAG-BICRO¹⁶ in May 2014 (OG 56/2013). The merger was a local move to better link up-stream and down-stream interventions. The HAMAG-BICRO is now a large agency with little over a hundred employees. It has been assigned with a special role in the implementation of the Europe Strategy 2020 and absorption of the ESIF. The Agency is a pillar implementing institution for the programme “Business impulse”¹⁷ - the underlying government programme to encourage small businesses and crafts, which includes support for innovative entrepreneurship. The programme is funded from the EU Structural funds 2007-2013 (88.7%) and national resources (11.3%) with a total budget of €586m in 2015 that presents the vast amount of funding for entrepreneurs. It implements a range of innovation programmes for commercialisation of research results: the Proof-of-concept Grant Fund (PoC), the Development of Knowledge-based Companies Programme (RAZUM), the Research and Development Programme (IRCRO) and support for the University offices for technology transfer (UTT), as well as the EUREKA programme.

By contrast to fairly good system of evaluation of research organisations related to quality assurance of scientific research, the evaluation of the public policy measures, in particular at the research programme level, is relatively scarce and weak in Croatia. Ex-post evaluations of research programmes funded by the national resources, e.g. by the CSF or MSES have been carried out mostly for administrative purposes of funding institutions and focused on project activities rather than on the fulfilment of the specific goals of science policy designed by a programme. Therefore, they are usually not publicly available and are not used either for international benchmarking, policy learning or improvements of the programmes.

The innovation programmes co-funded by the Loan Agreement for Second Science and Technology Project (STP) such as RAZUM, IRCRO or PoC have been subject to ex-post evaluation and results were usually available to interested public. The results are often interpreted in the way that they provide the accurate and comparable information about the quality and efficiency of funding through R&I programmes and to estimate their success in meeting the programmes’ overall goals. However, the role of this evaluation in science policy development can be estimated as largely very modest.

The macroeconomic models which will assess the impact of R&I on economic growth and support the budgetary policies are not developed.

1.2.3 Research performers

There are 184 scientific organisations¹⁸ registered in Croatia for scientific activity and recorded in the Register of scientific organisations¹⁹ which make them eligible for public funding. They include 25 public research institutes, 92 higher education institutions of which 10 universities (8 public and 2 private universities), 74 faculties, art academies and departments, 4 schools of professionally oriented higher education (two public and two private) and 4 public polytechnics and 67 other legal entities outside the system of higher education and public research institutes which include 3 institutions and 1 company of special importance (National University Library, Croatian Academy of Sciences and Arts, The Miroslav Krleža Institute of Lexicography, Institute for Immunology), and other institutions like hospitals and medical research units, archives, museums and others.

¹⁶ <http://www.hamagbicro.hr/>

¹⁷ <http://www.minpo.hr/default.aspx?id=544>

¹⁸ <https://www.azvo.hr/en/science/scientific-organisations>

¹⁹ <http://public.mzos.hr/Default.aspx?art=5489&sec=2167>

Besides the 25 public institutes there are several research institutes in state ownership oriented to market research (e.g. Energy Institute Hrvoje Požar, Institute of Civil Engineering). All institutes are mission oriented towards developing a certain area of science.

There are several research and technology institutions with the main mission of fostering science – industry cooperation and commercialisation of research results, such as the Science and technology Park of the University of Rijeka²⁰, the Technology and Development Centre of the University Osijek²¹, the Centre for Research, Development and Technology Transfer of the University of Zagreb²² and the Centre for science and technology development of the University of Split.²³

The higher education sector dominates in R&I system since it makes up around 44 % of all R&D institutions, employs between 50% - 60% of all researchers and perform majority of research projects (ASHE, 2010). Together with the 25 public institutes, in 2013 they performed around 50.2% of research activities which is slightly more than performing of private sector (50.1% of GERD). Universities are mostly teaching-oriented universities while the "third mission" or cooperation with industry is modestly developed mainly due to the weak interest of the business sector for research activities. Nevertheless, around 10% of total revenues (7.9% in 2014) (CBS, 2016) of universities are coming from the business sector mainly for various scientific services and cooperative research projects.

The private sector is technologically weak and underinvested in the domain of research (0.34% of GDP in 2014). However, in 2013 it showed a trend of growth and exceeded slightly the public sector in funding of research activities (42% of GERD vs. 41% of the public sectors) which reverses the role of public and private sector in funding science that has long been dominated by the public sector. However, it was a short-term recovery since the business sector declined again in 2014. The majority of GERD in 2014 was financed (52%) and performed (0.41% of GERD as % of GDP) by the government while business sector contributed to financing of GERD with 48% and to performing with 0.38%.

There are around 25 private research organisations which are either independent institutes (e.g. the Mediterranean Institute for Life Sciences) or belong to corporations (e.g. Ericsson Nikola Tesla). Several small research-based companies occurred in the last years like Genos and Genera in biomedicine or Pet minuta (Five minutes) in e-business. The last one is not registered as research company in the Register of research organisations managed by Ministry of science, education and sports, which only means that there is more research-based companies which are not formally registered as such.

In the private business sector R&D is concentrated in a few large multinational companies: PLIVA (pharmaceuticals), Ericsson Nikola Tesla (telecommunication), Podravka (food industry) and Končar – Electrical Engineering Institute (electrical engineering). Medium and large enterprises fund more than 90% of the private investments in R&D, while large enterprises invest highest portion, more than 60% of R&D investments. Little less than 8% of private investments in R&D come from micro and small enterprises²⁴, thus showing their weak engagement in R&D activities (OPCC, 2014).

The innovation potentials in production sectors are coming mostly from technological mastering and business sophistication in SMEs in medium-low and medium-high tech sectors which made around 48% of a total of 11,560 SMEs in the manufacturing sector. Another 4.6% or more than 500 firms are classified as high-tech (MEC, 2013).

²⁰ <http://www.step.uniri.hr/en/>

²¹ <http://www.tera.unios.hr/>

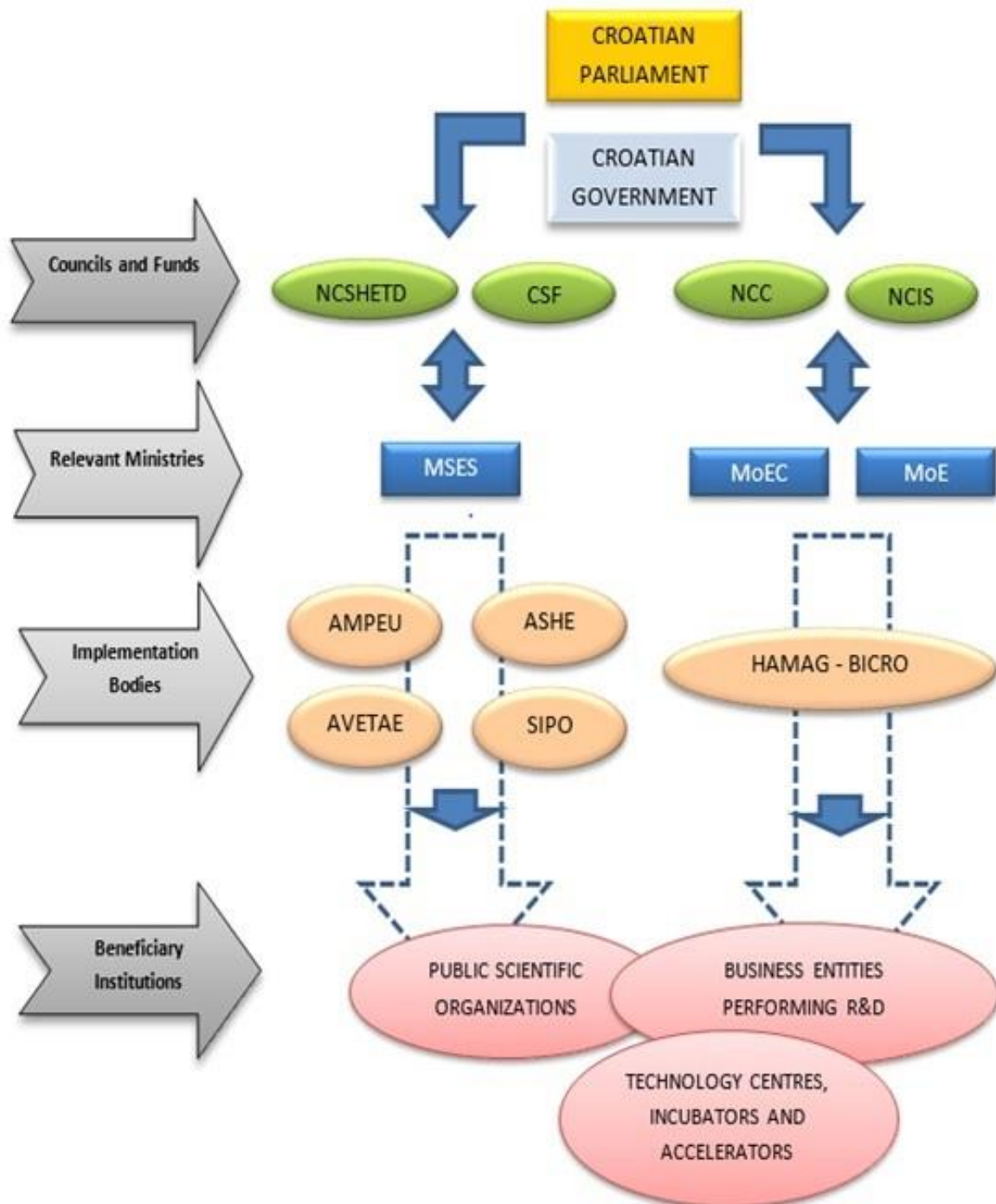
²² <http://cirtt.unizg.hr/en/about-us/>

²³ <http://www.unist.hr/znanost-i-tehnologija/centar-za-znanstveno-tehnologijski-razvitak/eu-programi-fondovi-projekti>

²⁴ Less than 10: micro, 10-49, small, 50-249 medium-sized, 250+ large enterprise

FDI have not brought new technologies since the majority of FDI is realised in wholesale trade and commission trade followed by financial intermediation trade. The Croatian economy is a service-oriented economy, i.e., services account for 68.1% of GVA which are concentrated (with the exception of financial intermediation), in low-tech services like wholesale and retail trade, transport, storage and communications which do not require R&I (Bečić and Švarc, 2010).

Figure 1 A schematic diagram (organogram) for the research and innovation system



- **Ministries:** Ministry of Science, Education and Sports (MSES), Ministry of Economy (MoE), Ministry of Entrepreneurship and Crafts (MoEC)
- **Councils and Funds:** National Council for Information Society (NCIS), National Competitiveness Council (NCC), Croatian Science Foundation (CSF), National Council for Science, Higher Education and Technological Development (NCSHETD)
- **Implementation Bodies:** Agency for Mobility and EU Programmes (AMPEU), Agency for Science and Higher Education (ASHE), State Intellectual Property Office (SIPO), Croatian Agency for SMEs, Innovations and Investments (HAMAG - BICRO), Agency for Vocational Education and Training and Adult Education (AVETAE)

2. Recent Developments in Research and Innovation Policy and systems

2.1 National R&I strategy

Goals and measures for development of the national innovation system are proscribed by several national strategies, most notably by Strategy for Education, Science and Technology and Strategy for Fostering Innovation in the Republic of Croatia 2014-2020. Strategy for Education, Science and Technology²⁵ was adopted by the Government of Croatia in October 2014 (OG 124/2014). The Strategy includes a large number of goals, sub-goals and measures which are mainly focused on all levels of educational system from primary to higher education, and adult education, as well. It envisages a wide spectrum of reforms in the education system such as enhanced system of quality assurance, development of national competence standards for teachers and introduction of new national framework curriculum. In higher education, the Strategy announces a revision of study programmes, differentiation of learning outcomes between professionally-oriented and academic university courses, harmonisation of study programmes in line with labour market needs, etc.

The Strategy consists of five main sections of which four are related to education (primary, secondary, higher education and adult education) while the fifth part is related to science and technology. Strategy emphasise six complex objectives: /1/ changes in the higher education and science strategic management; /2/ creation of the internationally competitive HEIs and PROs that create new scientific, social, cultural and economic value; /3/ creation of an environment that encourages interaction, cooperation and transfer mechanisms between the research community with innovative economy and social activities; /4/ involvement of HEIs and PROs in the process of smart specialisation and associated technological development; /5/ development of the national research and innovation infrastructure with public access, with the inclusion of the European infrastructure and connections; and /6/ improving the system of public funding and encouraging investments of business and social sectors in research and development.

Each of the goals is preceded by a short explanation of situation and main reason for its inclusion. However, analyses of strengths and weaknesses, emerging opportunities and market developments are either quite general or insufficient. Croatian Government adopted Action plan for the implementation of the Strategy in September 2015 even though this plan lacks the information on financial means required for the implementation.

The reforms of the R&I system which were recently implemented were not therefore directly related to the concrete measures of the Strategy but they more reflect its tendencies toward more efficient science and innovation system. The Strategy has not taken into account the possibilities for joint programming and cross-border co-operation with the EU. The leverage effects of national and EU instruments are also not taken into account since Croatia has not used up till now the ESIF for funding research and innovation activities.

The Strategy is complemented by the other strategic documents and Operational Programme Efficient Human Resources 2014-2020 (OPEHR, 2014) which emphasises the need of better connection of education and research system with the labour market as well as Operational Programme Competitiveness and Cohesion 2014-2020 (OPCC, 2014) which emphasises the need for strengthening the economy through research and innovation. Within this framework the OPCC envisages the following funding priorities under the public policy measures by 2020:

²⁵ <http://www.novebojeznanja.hr/> (last access: 17 March, 2016)

- organisational reform of scientific organisations and modernisation of the R&D infrastructure;
- strengthening scientific excellence and efficiency;
- creating conditions for business sector investments in research, development and innovation;
- directing the focus of public research organisations to applied research activities suiting the needs of industry and economy;
- supporting innovation and transfer of knowledge;
- support spending on research, development and innovation in companies in order to increase the overall level of spending on research and development;
- spurring common interest in the implementation of R&I projects among research institutions, including the academic sector, public authorities and companies;
- creating a favourable environment for companies in areas of development, research and innovation;
- supporting the implementation of socially-useful innovation.
- Listed goals envisage changes in the entire R&I system from academia to private research sectors and cover research and innovation in an integrated manner. The changes aim to improve research efficiency and connect private and public research sector resulting in the economic growth. The important changes in the last three years included a range of significant reforms in funding, organisation and coordination of R&I system (see chapter 2.2) which are now making a ground for further actions foreseen in the OPCC. Since OPCC is a background document for using ESIF there are expectations that it will actually shape the R&I policy initiatives through funding opportunities and directions and will take into account the needs for exploiting opportunities for joint programming with the EU, cross-border co-operation and the leverage effects of EU instruments.

Another important strategy is the Strategy for fostering innovation 2014-2020²⁶ which was adopted in December 2014 (OG 153/2014). It is focused on development of long-term and systematic promotion of innovation as a fundamental value of the performance of the economy and society as a whole. It consists of four strategic goals:

1. improving the efficiency of the national innovation system;
2. increasing the share of the business sector research investments in total R&D investments;
3. increasing the number of basic and applied research to strengthen the competitiveness of the economy;
4. increasing the human capacity for research, technological development and innovation.
5. The strategic goals will be accomplished through the implementation of the measures structured into four thematic pillars:
6. development of the innovation system of the Republic of Croatia and improving the legislation and fiscal framework for fostering innovation;
7. strengthening innovation potential economy;
8. Encouraging cooperation and flow of knowledge between business, the public and the scientific research sectors;
9. strengthening of human resources for innovation and creation of an encouraging environment for making "world class" and internationally competitive researchers.

Each thematic pillar consists of a number of priorities and measures. The realization of the Strategy will be monitored through the Action plan which is also an integral part of the Strategy as well as other strategies this one also lacks information on time frame and financial means required for the implementation.

²⁶ [Strategy for fostering innovation in the Republic of Croatia 2014-2020 \(last access: 6.1.2016\)](#)

The main indicators of success include the following data: the position of Croatia at the Innovation index, increased spending on R&D as a share of GDP, increased business investments in R&D (50% of GERD), increased number of research projects for the need of economy, increased number of patent application per inhabitant, increased number of researchers and increased foreign investments in R&D. Important measures for improvement of the national innovation system include, among others, establishment of the Innovation Network for Industry (INI), creation of Thematic Innovation Platforms (TIPs) and the Centres of Competences (CEKOMs).

These new structures are also emphasised by the Draft of the Smart Specialisation Strategy as the important mechanism of science-industry cooperation to upgrade the research base of industry and intensify commercialisation of research results through business ventures. The specialisation areas chosen by the Croatian Smart Specialisation Strategy (JRC-ITPS, 2015) include 5 areas: Health and quality of life; Energy and sustainable environment; Transport and mobility; Security; Food and bio-economy

The Industrial Strategy adopted in October 2014 (OG 126/2014) identifies the key industrial activities that will have the greatest growth capacity, development and employment. According to the analysis, those include: production of basic pharmaceutical products; manufacturing of computer, electronic and optical products; manufacturing of fabricated metal products; Computer programming, consultancy and related activities (ICT); production of electrical equipment and production of machinery and equipment. Following these key industrial activities, the Strategy aims to create 85,619 new jobs by the end of 2020, with 30% of those highly skilled jobs.

2.2 R&I policy initiatives

The R&I systems has gone through turbulent times since mid-2013 due to the significant reforms in both research and innovation system in pursuit of scientific excellence, innovation efficiency and reducing budget resources for R&I. The austerity policy caused by the sixth consecutive years of economic contraction and excessive public deficits resulted in significant changes not only in funding but also in the organisation, governance, performing and evaluation of R&I activities. Many institutions and programmes for supporting research based innovation which were developed for over a decade were transformed or revised (e.g. BICRO, UKF, CSF and HIT). However, some programmes like the UKF and innovation programmes (RAZUM, PoC, IRCRO) have been re-launched in 2014 due to the activation of the STP II resources.

The legislative framework that marked the beginning of the systemic changes in R&I and higher education systems consists basically of the three acts: the Act on Amendments to the Act on Science and Higher Education (OG, 94/2013 and OG 139/2013), Act on Amendments and Supplements to the Croatian Science Foundation (OG 78/2012), and Act on Quality Assurance in Science and Higher Education (OG 45/2009). The reforms have received, despite certain improvements and advancements in the governance of the research and higher education systems, many critics by scientific community (e.g., the budget cut-offs for scientific research and reduction by 3% in wages in 2013 produced uncertainties and dissatisfactions in the scientific community).

The State budget for 2015 and projections for 2016 and 2017 envisage reduction instead of an increase in public resources for R&I, which diminishes the financial sustainability of R&I systems and policy. The foreseen decrease in the budget for regular activities of public institutes, mostly salaries, is around 36% in 2017 compared to 2015. The decline of budget for research activities based on the performance based intuitional funding is estimated to 7%.

However, Croatia received a remarkable opportunity to address the needs in research, innovation and skills by the EU membership which gives Croatia access to the EU Structural and Investment Funds (ESIF) with a fund of €10.68b for the period 2014-2020 (TO1 €664m EU share).

It makes €1.5b a year (World Bank, 2014) or over 3% of GDP on annual basis or about ten times as much as that for 2007-2013 (EC, 2015). However, Croatia has not activated these funds for research or innovation activities and the damage caused to scientific system by under-investments has not been compensated so far, as expected, by EU funds.

The main reasons stem from the limited administrative and technical capacities in management bodies, at local and beneficiary level. In combination with the difficulties linked to the switchover from the IPA to the ESIF (EC, 2015b) it has contributed to delays in the absorption of the 2007-2013 allocation. A tender for submission of projects proposals for research and development grant schemes within the Operational Programme Competitiveness and Cohesion 2014-2020 is planned for 2015.

There is a general trend of replacing national resources with the European Structural Funds and directing the research policy initiatives towards programmes tailored by the future requirements of the ESIF 2014-2020. The latter include research oriented toward industrial applications while fundamental research remained underinvested under the responsibility of the State.

The most substantial change in science policy relates to the new model of financing scientific activities from the State budget that includes two main components: allocation of the competition-based research grants and introduction of the new model of performance-based institutional funding.

The allocation of the competition based research grants was transferred in the second half of 2013 from the MSES (the practice being in force since 1991) to the Croatian Science Foundation (CSF) and assumes a strict evaluation process that should result in a small number of high quality research projects (around 20% of proposals). The CSF has become a principal and, in the absence of other sources, the only public funding agency dealing with fundamental research. The main intention of this reform was to terminate the current practice of financing a large number of low-competitive scientific projects and high acceptance rate (more than 80% of proposed projects) in order to reach a critical mass of researchers and resources that could yield significant scientific results recognised at the international level.

According to the Annual report of the CSF (CSF, 2015) the Foundation has conducted so far two public calls for two programmes which replaced the previous MSES' programme for allocation of the projects grants: /1/ Installation research projects²⁷ for early career researchers and Research projects²⁸ for senior scientists to enhance their international competitiveness and mentoring competences.

Within the first tender the CFS has provided 238 project grants (36% of 665 submitted projects). The second tender was closed in September 2014 and from a total of 412 submitted projects 199 were financed. The total budget for the first public call was €6.6.m and for the second call €6m of which €1.3 for the Installation research projects and remaining €4.6m for the Research projects.

The main improvement was carried out in the area of institutional funding where new model of institutional funding was established and it depends on the institutional performance indicators that are evaluated during the first six months of 2013 and agreed between the MSES and PRO/HEI on a three years basis. This reform of research funding was launched by the new Act on Science and Higher Education and the Decision on the Multi-annual institutional funding for research programme in public research institutes and universities 2013-2015, which was adopted on 6 June 2013 (Official Gazette 69/2013).

²⁷ <http://www.hrzz.hr/default.aspx?id=1166>

²⁸ <http://www.hrzz.hr/default.aspx?id=139>

The Multi-annual institutional funding²⁹ has contributed to the autonomy and responsibility of universities and research institutes. Institutes decide autonomously about the internal distribution of allocated financial means for improving research activities with the final aim to meet evaluation criteria which include international competitiveness, scientific recognition, high-quality publishing, research results and outcomes with the impact on socio-economic potentials. The total funds allocated by the State budget amounted to around €6.6m in 2014

Majority of these resources (85%) were allocated to the seven Croatian universities while 25 public institutes received only 15%³⁰. The University of Zagreb has established the Fund for the development of the University and carried out a public call at the university' level for research projects to allocate the given resources. The systemic and integrated data on granted funds are presently missing. National Fund which would include all universities has not been established.

The total funds allocated to CSF in 2014 amounted to around €13m, €10,26m in 2015 and the projection is 10,39m for 2016. The low level of envisaged resources left some of the excellent and perspective research groups without funds. This could threaten and reverse the initial goals of the programme focused on strengthening of research excellence. It is often forgotten that Croatia has a relatively narrow financial base for scientific research due to the technologically weak private sector and a lack of diversified resources for competitive research funding.

The lack of investments in R&I, followed by slow implementation of planned reforms, already affected the relatively small science base in Croatia (about 6,529 researchers in FTE or 45% of average in the EU-28 (Eurostat). The approved system for recruitment of young researchers which was managed by the MSES for the last two decades was replaced in 2013 by the new programme managed by CSF.

Young Researchers' Career Development Project – Training of Doctoral Students³¹ the main goal is to enable scientifically active mentors to create a new cohort of researchers and university teachers through their involvement in the mentors' research projects. The total funds of €3.5m in 2015 were allocated to CSF mostly for gross salaries of PhD students and their doctoral studies. The CFS is funding so far 179 young researchers of 192 applications.

The government announced on 31 July 2015 a new programme³², which will finance around 1200 young researchers on postdoctoral level as well as assistant professor and provide the opportunity for young post-doctoral researchers to compete for these job positions. Positions are also open to foreign young researchers and teachers. A total value of the programme is €266m that presents a vast amount of capital under the current circumstance invested in the knowledge that Croatia needs. It is expected that research community in Croatia will be enlarged for around 15%.

The Second Science and Technology Project³³ (STP II), whose objective is to modernise the Croatian research system was launched in April 2013, after successfully completing STP I³⁴ in May 2011. With a loan of €20m from the International Bank for Reconstruction and Development (IBRD), the project will bridge the existing gap in financing of research and development to full availability of EU Structural Fund. The main aim of the project is to improve the capacity of Croatia's R&D and innovation institutions for absorption of the EU Structural and Cohesion funds. The STP began on July 31, 2013 and will last until July 30, 2017.

²⁹ <http://public.mzos.hr/Default.aspx?sec=3521>

³⁰ According to the MSES announcement, available at: <http://public.mzos.hr/Default.aspx?art=12597&sec=1933>.
<http://www.hrzz.hr/default.aspx?id=1171>

³¹ <http://drum.hr/vlada-ce-zadrzati-mlade-znanstvenike-u-hrvatskoj-i-omoguciti-povratak-onima-koji-su-otisli/>

³² <http://www.worldbank.org/projects/P127308/second-science-technology-project?lang=en> (last access: 15 February, 2015)

³⁴ <http://www.worldbank.org/projects/P080258/science-technology-project?lang=en>

Due to these funds, several programmes which were terminated in 2013 have been re-launched in 2014 and 2015. They include two programmes of UKF (now at CSF), three innovation programmes run by the HAMAG-BICRO (PoC, RAZUM, IRCRO). A new programme for technology transfer at universities (TTU) has been launched and co-funded by the STPII resources.

The UKF/CSF' programmes include the Partnership in research³⁵ programme which has been re-launched in December 2014. The aim of the programme is to establish research cooperation between PROs/HEIs and business partners to attract research funds outside the State budget; the total State budget amounts to €2m for 2-3 year projects.

Another important instrument was re-launched – the Unity through Knowledge' fund (UKF), a programme which has been running since 2007 as an independent fund and was considered as a very successful programme with internationally recognised research results. The CFS took the responsibility of the UKF in February 2014 to maximise its efficiency. New calls for project proposals under the UKF for the programme Crossing Border Grants have been announced in early March 2015. The total value of the programme under STP II is EUR 1.4 million.

The use of the European Structural funds 2007-2013 remained lower than expected despite the fact that national resources are limited and insufficient. Croatia used the IPA funds for grant scheme Science and Innovation Investment Fund (SIIF), targeted at capacity-building for technology transfer and commercialisation of research. Altogether 24 projects were funded with a total value of €11.4m in the period 2007-2015. Several infrastructure projects were also funded within the programming period 2007-2013, including the Biosciences Technology Commercialisation and Incubation Centre – BIO Centre and Research Infrastructure for Campus-based Laboratories at the University of Rijeka.

A grant scheme funded by the SF 2007-2013 called Strengthening capacities for research, development and innovation³⁶, was launched in January 2014 with a focus on applied and industrial research. The projects should be realised in cooperation between research institutions (applicant) and industrial/business partners in order to achieve results with potential commercial applications or the creation of new relevant knowledge. The grant scheme is administered by the MSES. The selection and contracting of projects has been completed by the end of 2014 followed by the initial implementation of 19 projects. The total indicative budget of the call was €9.3m out of which the contribution of the ERDF amounted to €7.9m and national contribution – to €1.4m. In this call the maximum grant amounted to around €1m and the minimum grant amounts €0,2m. Percentage of project financing was up to 100% of the total costs of the applicants and up to 80% of the total cost of the partner.

Owing to the activation of the STP II, several innovation programmes coordinated by the HAMAG-BICRO have been relaunched in February 2015 as follows:

- The RAZUM programme³⁷ (Development of knowledge-based companies) with the aim to fund R&D activities in SMEs that will result in innovative product or service ready for market. A total fund of €2.9m has been provided by the STP II. Financial aid is granted in the form of a conditional loan for a maximum of 70% of the costs, while the remaining 30% is financed from own resources. The largest amount of an individual project is €1.2m while the project duration is limited to a maximum of 24 months.

³⁵ <http://www.hrzz.hr/default.aspx?id=2209>

³⁶ <http://public.mzos.hr/Default.aspx?art=12962>

³⁷ <http://www.hamagbicro.hr/inovacije/privatni-sektor/razum/>

- The IRCRO programme³⁸ (Collaborative research development Programme) with the aim to fund the development of new products, services or processes undertaken by individual entrepreneurs or SMEs and involve cooperation between research institutions and private sector. A total fund for the programme of €1.8m has been provided by the STP II. Projects grants are aimed to co-finance 50% of eligible project costs. The maximum amount for co-financing of the project is €0.2m. Project duration is limited to a maximum of 24 months.
- The PoC programme³⁹ (Proof of Concept) is the newest policy measure introduced in 2010 with the aim to ensure pre-commercial capital for technical and commercial testing of innovation concepts. The PoC consist of two components: the PoC for entrepreneurs with a total funds of €1.9m and PoC for researchers with a total funds of €1.1m. So far, PoC has achieved significant results in terms of the number of applications and the quality of applied projects. Its evaluation procedures are transparent and effective, which is one of the reasons for the continuous increase in the number of applications.

The programme for support of the Technology transfer at universities (TTU)⁴⁰ is a new programme launched in February 2015 which is also funded by the STPII and coordinated by HAMAG-BICRO. The main goal of the programme is to strengthen the role of technology transfer offices at PROs and HEIs for fostering and implementing technology transfer. The overall indicative amount available under TTO Program is €1.5m. The programme funds 100% of the total eligible costs. The funding grants range between €10,000 and €75,000 per project. Project duration is 18 months.

The establishment of high-tech industrial network through the creation of the sectorial technology platforms and networking of centres of excellence and centres of competence envisaged by the Innovation strategy 2014-2020 has not yet begun. This sluggish realisation of innovative strategies and mechanisms for cooperation of scientific research and the business sector greatly slows down the overall technological development and innovation.

The **programme for establishing the centres of research excellence**⁴¹ (CoREs) was launched in June 2013 with the aim to identify research groups of international relevance with the potential in developing the frontier research and cutting-edge science. An amount of €0.26m per year was earmarked in the State budget for 2016, 2017 and 2018 while the additional funds will be provided by the EU Structural funds 2014-2020 (primarily, ERDF). The National Council for Science, Higher Education and Technological Development (NCSHETD) proposed, and the minister of science, education and sports approved seven CoRE in November 2014.

However, the NCSHETD concluded that the first call failed to reach a satisfactory proposal of CoREs for some of the priority areas of the current and future development of Croatia and announced in April 2015 a new call for CoREs⁴². Based on the proposal of the NCSHETD from 6 November 2015, the minister of science, education and sports approved six new CoREs. The activities of the approved CoREs seem rather stagnant which may be the result of the weak preparation of the centres' activities or lack of financial resource since the SF 2014-2020 is not used up to now for research activities.

³⁸ <http://www.hamagbicro.hr/inovacije/privatni-sektor/ircro/javni-poziv/>

³⁹ <http://www.hamagbicro.hr/inovacije/privatni-sektor/poc-za-poduzetnike/>

⁴⁰ <http://www.hamagbicro.hr/inovacije/javni-sektor/utt-program/o-programu/>

⁴¹ <http://www.zci.hr/>

⁴² <https://www.zci.hr/hr/novosti/20-novosti/416-javni-poziv-za-dostavu-projektnih-prijedloga-za-osnivanje-znanstvenih-centara-izvrsnosti-u-republici-hrvatskoj-2015>

The New International Fellowship Mobility Programme for Experienced Researchers in Croatia – NEWFELPRO⁴³ was launched in Croatia in June 2013. The project is co-financed through the Marie Curie FP7-PEOPLE-2011-COFUND program. Its total value is around EUR 7 million, of which 60% is financed from national sources. Out of total 79 scholarships, 23 were approved in 2015 (7 in outgoing fellowship scheme; 14 in incoming fellowship scheme; 2 in reintegration fellowship scheme). Project duration is from 2013 until 2017.

The investments in the large research infrastructures are usually not an integral part of the above policy instruments and programmes. Instead, they mostly include the procurement of research equipment needed for the realization of the specific project/programme.

Several research infrastructures have been funded from the Structural funds 2007-2013. They include the construction and equipping of the new incubation centre for research and companies in the field of bioscience and biotechnology (BIOCentre) which expands over 4,500 square meters within the Borongaj campus of the University of Zagreb, as well as development of research infrastructure for Campus-based laboratories of the University of Rijeka. The latter includes equipping of the Centre for Highpass Biomedicine Technology; Centre for Micro and Nano Science and Technology; Centre for Advanced Computing and Modelling and the laboratory of the Faculty of Civil Engineering. Owing to these funds the University of Rijeka is one of the best equipped research centres in the region that is able to conduct advanced research in medicine.

The new large research infrastructures and upgrading of the existing is planned to be funded by the ESIF 2014-2020 in the framework of the Operational Programme for Competitiveness and Cohesion 2014-2020. The MSES has initiated in 2011 the programme "Preparation of the research infrastructure projects pipeline"⁴⁴ aimed at supporting the preparation of technical documentation for research infrastructure which is funded from Structural funds 2007-2013; the current Indicative list of projects consists of 33 project proposals.

The MSES announced the third call for the large research infrastructures in November 2015⁴⁵. The third call is restricted for applications which were already selected by the MSES during the first two calls in the period 2011-2015. The main objective of the call is to build administrative capacity and readiness to use EU funds and other instruments for research, development and innovation which will be funded by the SF 2010-2013.

The large research infrastructures are planned within the Research and Innovation Infrastructure Roadmap in Croatia 2014-2020⁴⁶. The Roadmap also takes into account the ESI 2014-2020 funds, as well as developments of the developments of the pan-European scientific research infrastructures and plans for participation in the EU initiatives like GEANT, MERIL, ERIC, etc. as well as the national research potentials.. This document was adopted by the MSES in April 2014 and the revision in line with the Smart Specialisation Strategy (S3) priorities is expected to be launched in April 2016. This version will include S3 priorities and sub-priorities and some other prerequisites for strengthening science and technology system e.g. guidelines for participation in international research and technology bodies and networks. Draft of the revised document also includes a list of instruments to be financed from ESI funds e.g. through OPCC 2014-2020 (table 8) but other sources as well e.g. through Second Science and Technology project, Croatian Science Foundation etc. The content of the Roadmap is further discussed in paragraph 4.2.2 RI roadmaps and ESFRI.

⁴³ <http://www.newfelpro.hr/default.aspx?id=66>

⁴⁴ <http://public.mzos.hr/Default.aspx?art=12983&sec=3423>

⁴⁵ <http://public.mzos.hr/Default.aspx?art=13925&sec=1933>

⁴⁶ [file:///C:/Users/%C5%A0varc/Downloads/Croatian_Research_and_Innovation_Infrastructures_Roadmap%20\(4\).pdf](file:///C:/Users/%C5%A0varc/Downloads/Croatian_Research_and_Innovation_Infrastructures_Roadmap%20(4).pdf)

2.2.1 Evaluations, consultations, foresight exercises

Evaluations of research and innovation policies or programmes are rather weak. The results of the previous evaluation studies are used for the improvements of the future programmes also sporadically. Periodic or interim evaluations of research projects and programmes have been carried out mostly for administrative purposes of funding institutions. Three ex-post evaluation studies of innovation programmes have been carried out up to now during 2011 and 2012 focused on the Science and Technology Project⁴⁷ (World Bank, 2012a) and the programmes co-funded by the STP I – RAZUM, IRCRO, UKF, TECHRO, TEST (Radas et al, 2011; Ohler, 2014).

The international benchmarking analyses and related set of indicators are mainly carried out in order to participate in international or European databases (e.g. Eurostat, CIS, US, etc.) or for drafting strategic documents. The most recent such strategic documents are: the Strategy for Fostering Innovation of the Republic of Croatia 2014-2020, the Draft of the Smart Specialisation Strategy (S3), the Strategy for Education, Science and Technology, the Industrial Strategy 2014-2020 and the Partnership Agreement for the European Structural and Investment Funds (PA, 2014).

The Industrial Strategy adopted in October 2014 (OG 126/2014) identifies the key industrial activities that will have the greatest growth capacity, development and employment. According to the analysis, those include: production of basic pharmaceutical products; manufacturing of computer, electronic and optical products; manufacturing of fabricated metal products; Computer programming, consultancy and related activities (ICT); production of electrical equipment and production of machinery and equipment. Following these key industrial activities, the Strategy aims to create 85,619 new jobs by the end of 2020, with 30% of those highly skilled jobs.

The Strategy of Smart Specialisation was adopted in 2016 and includes 5 specialisation areas: (1) Health and quality of life; (2) Energy and sustainable environment; (3) Transport and mobility; (4) Security; (5) Food and bio-economy. Apart from the Smart Specialisation Strategy and the Industrial strategy 2014-2020, which both identified future areas of development in their respective domains, other foresight exercises or strategic intelligence studies focused on emerging strengths have not been carried out.

A macroeconomic model to assess R&I impact on economic growth is also not in place. However, the World Bank study (2012b) tried to estimate the rate of return on R&D compared with possible public investments in education and infrastructure. The estimated rates of returns on R&D (73%) are at least double the value of returns on infrastructure and seven times higher than on education. Yet Croatia's aggregate R&D investments are at a relatively low level (0.9% of GDP in 2011, as compared to 3-5% in innovation-driven economies such as Finland, Sweden and Israel) (World Bank, 2012b). It is concluded that government should prioritise public expenditures in R&D at the expense of some other sectors since R&D and innovation continues to hold the key to boosting productivity and securing long term development in Croatia.

Generally speaking, an efficient monitoring and review system for strategic intelligence, technology foresight or roadmaps as well as innovation surveys, industrial research or benchmarks are not in place. Instead, substantial efforts of the Government and other stakeholders is required to analyse innovation and research capacities at national and international level and to identify emerging opportunities.

⁴⁷ <http://public.mzos.hr/fqs.axd?id=21801>

However, by the NRP 2014 and 2015 project documentation for the national Science and Technology Foresight Project (STF) was drafted during 2014. STF involves systemic analysis of the long-term trends in science and technology in order to create and implement tools and methods for development and sustainable execution of evidence based policy in the area of RDI, specifically for development and monitoring of Smart Specialisation Strategy and other strategic documents, as well as to competitiveness, economic development and society. One of the most relevant project outcomes will be an integrated data base – the Croatian Research Information System (CroRIS).

2.3 European Semester 2014 and 2015

The main objective of the National Reform Programme (NRP) 2015 in the domain of R&I is to create conditions for improving the quality of scientific work and stimulate the creation of new knowledge and innovation through better management and allocation of resources for research and development. By the end of 2015, introduction of a new system of financing in science is planned, as well as creation of a model for restructuring the network of public research institutes. The aim is to optimise the use of human and material resources, achieve better connectivity with the economy and increased international visibility, which is supposed to bring about higher productivity and competitiveness of the entire system in the medium term and in international environment.

The measures for better management and coordination of R&I system included in the NRP 2014 have been partially accomplished. The most efficient measures include /1/ funding of research activities in PROs and HEIs based on performing indicators; /2/ strengthening the role of the NCSHTD as the highest authority for R&D and /3/ initiating the process of re-accrediting public scientific institutes.

On the other hand, the establishment of the Centres of Research Excellence (CoREs) was estimated as inadequate, which resulted in a new public call for COREs in 2015⁴⁸; a comprehensive audit of the system of state incentives for research, development and innovations has not been established; the scientific excellence in the areas of smart specialisation aimed at better cooperation between academic and business sectors was also not initiated since the Smart Specialisation Strategy has not been approved by the EC during 2015.

The goals which refer to raising investment in research and development were not achieved. The main objective of measures envisaged in funding area in both the NRP 2014 and NRP 2015 is the increase in the share of total domestic expenses for research and development to 1.4% of GDP by 2020 compared to 0.75% of GDP in 2012 and 0.81% in 2013. By NRP 2014, the annual investments in R&D are expected to increase to 0.85% of GDP in 2014, based on a forecasted growth rate of investments of 8%.

Despite NRP 2014 strongly supports the idea of transforming the existing knowledge into productivity gains and innovation, the business R&D remains rather weak. The need for strengthening the economy through research and innovation is currently included in the Operational Programme Competitiveness and Cohesion 2014-2020 (OPCC, 2014) and emphasises nine funding priorities under the public policy measures by 2020 (see section 2.1 National R&I strategies).

NRP 2015 acknowledges and welcomes strategic documents adopted in 2014: the Strategy for Education, Science and Technology, the Industrial Strategy of the Republic of Croatia 2014-2020 and the Strategy for Fostering Innovation in Croatia 2014-2020.

⁴⁸ <https://www.zci.hr/hr/novosti/20-novosti/416-javni-poziv-za-dostavu-projektnih-prijedloga-za-osnivanje-znanstvenih-centara-izvrnosti-u-republici-hrvatskoj-2015>

NRP 2015 acknowledges a successful start of other initiatives in R&I system in 2014, such as /1/ the selection and contracting of initial 19 projects within the grant scheme Capacity Building for Research, Development and Innovation from the OPRC 2007-2013; /2/ the revision of rules governing the state incentives for research, development and innovation which was conducted during 2014 and included the standardization of criteria for granting incentives in accordance with EU directives (GBER); the implementation of a pilot project involving the creation of applications for online submission of projects will begin in mid-2015; /3/ an agreement on equipping centres at the University of Rijeka campus as a part of the national research infrastructure development; /4/ the construction and equipping of the new incubation centre BIOCentre within the Borongaj campus of the University of Zagreb; /5/ the public tender for re-launched programmes - Partnership in research and the Unity through Knowledge Fund.

It emphasizes the following measures which will be undertaken to support efficiency in R&I system: /1/ restructuring of public research institutes; /2/ preparation of public tenders for funding scientific research activities of scientific excellence centres within the OPCC 2014-2020 and /3/ signing the Contract on the Western Balkans R&D Centre – WISE within the Western Balkans Regional R&D Strategy.

The NRP 2015 foresees the following measures for accomplishing the national objective of the Europe 2020 Strategy in R&I:

1. Strengthening the national innovation system and innovation potential of the economy
 - Drafting a programme of state incentives for research, development and innovation for the period of 2015-2020 (in December 2015);
 - Improved model for monitoring statistical and other indicators for monitoring the research, development and innovation through the Science and Technology Foresight project within the OPCC 2014-2020 (December 2015)
2. Improving the quality, management and funding system for research organisations and encouraging scientific excellence
 - Introduction of new funding methods for scientific activities (December 2015);
 - Restructuring of the public research institutes – creating a model for restructuring the public research institutes (June 2015);
 - Strengthening the absorption potential of scientific organisations with a view to withdraw funding from EU funds and programmes;
 - Introducing a new instrument for encouraging investments in the equity of innovative small businesses in the initial and early stages of development supported by the ESI funds (second half of 2015)

These measures respond only partially to the weaknesses of R&I system identified by the EC Semester Country Report for 2015. It states that there is the sharp decrease in public R&D intensity from 0.50% of GDP in 2008 to 0.41% in 2013. However, the projections of the State budget in 2014 suggest that public funds will continue to decrease in the next period 2015-2017 (see the chapter 2.2. R&I policy initiatives) making the already difficult situation even worse. The business sector suffers from a subcritical accumulation of innovation capabilities and low aggregate business expenditure in R&D. The Croatian enterprises are faced at the same time with relatively high labour costs, lack of information on technology along with lack of qualified personnel needed for innovation. The public research sector is characterised by excessive fragmentation, relative closure and a persistent mismatch between academic curricula and labour market needs.

The Report emphasises that Croatia can base its transition to knowledge-intensive economy on the ESIF 2014-2020 which occurs as a crucial investment resources for structural reforms including strengthening of R&I. However, benefiting from the EU funds require an overhaul of the governance of public policy and publicly funded research. Public policies in support of innovation in Croatia are considered by OECD (OECD, 2014) and the European Commission (EC, 2015b) as ineffective and characterised by weak commitment, slow reform pace and inefficient governance structures.

2.4 National and Regional R&I Strategies on Smart Specialisation

The Smart Specialisation Strategy (S3)⁴⁹ was adopted by the Croatian Government in March 2016.

The preparation of the S3 is coordinated by the Ministry of economy (MoE) supported by the EU co-funded team of experts (S3-Expert team) who assisted in drafting the analytical part of the Strategy in the period September 2013-March 2014. Besides, MoE has established the Inter-ministerial Working and Steering Group which included MSES, MoEC, MRDEUF, MLPS and other relevant ministries. MoE conducted partnership consultations to provide inputs and feedback to ideas for strategic directions of S3. In the process of preparation, private and public research sectors were continuously consulted, and the four rounds of regional workshops (Partnership Consultations) were held.

A number of analytical input documents have been produced as a starting point for the S3 such as Business expenditure on R&D, Cross-Sector competitive advantage analysis, Technology usage and availability including KETs, Research and development, KET deployment in Croatia by the PRODCOM identification methodology, etc.

It turned out that identification of economic areas, industries and key enabling technologies of strong comparative advantages presented a challenging task especially in Croatia characterised by much diversified economic structure, scattered research capacities and a lack of analytical data. The specialisation areas given in the Draft of the Croatian Smart Specialisation Strategy include 5 areas:

3. Health and quality of life;
4. Energy and sustainable environment;
5. Transport and mobility;
6. Security;
7. Food and bio-economy.

Within these five priority areas, 13 thematic priority areas has been defined, as follows: (1) Pharmaceuticals, biopharmaceuticals and production of medical equipment and devices; (2) Health services and new methods of preventive medicine and diagnostics; (3) Nutrition; (4) Energy Systems, technologies and equipment; (5) Environmentally friendly technology, equipment and advanced materials; (6) Production of road and rail components and systems with high added value; (7) Environmentally friendly transport solutions; (8) Intelligent Transportation Systems and Logistics; (9) Cyber security; (10) Defence Technology and dual-use products; (11) Mine program; (12) Sustainable production and food processing and (13) Sustainable production and wood processing.

The smart specialisation areas chosen by the Croatian authorities correspond to several areas funded by the FP7. The area of Food, Agriculture and Fisheries and the area of Security which are among the leading research areas supported by the FP7 are fully integrated in to the national S3 strategy.

The Strategy also recognised two important cross cutting themes: KETs and ICT (tourism and creative and cultural industries have been excluded in the meantime).

⁴⁹ The Draft of the S3 is available at: <http://europski-fondovi.eu/sites/default/files/dokumenti/Nacrt%20Strategije%20pametne%20specijalizacije.pdf> (last access:6.1.2016)

Delivery instruments have been created in line with SWOT analysis that emphasised several key weaknesses in R&D system in Croatia e.g. declining share of students in STEM fields, mismatch between educational system and business needs, unfavourable skill profile in the business sector for RDI, low mobility of researchers and low shares of researchers in business sector, insufficient market driven research, lack of R&D collaboration between science and research institutions and business sector, scattered research resources with insufficient capacities to conduct excellent science, fragmented and inefficient national innovation system and lack of linkages in innovation value chain, insufficient commercialisation of research results and insufficient research orientation towards the needs of the economy, insufficient investment in R&D in business sector and limited patenting and commercialisation culture. In order to tackle these challenges, the Strategy will include European Structural funds allocation for delivery instruments envisaged by MSES, MoE and MoEC.

The monitoring and evaluation of the S3 has been envisaged as a complex set of elements that requires continuous and coordinated activities focused on common goals. The central role is assigned to a single body – the Inter-Ministerial Working Group for the S3 - which is planned to be established to monitor the implementation of the Action plan of the S3 based on the performance indicators. It is anticipated that the administrative and technical support in the process of monitoring and evaluation will be provided by the Technical Secretariat for S3 established within HAMAG-BICRO to use existing resources. The Secretariat will support the work of the National Innovation Council and the Inter-Ministerial Working Group for the S3. It will also collect and process the performance indicators of S3 which will be used to assess the success of implementation of the Action plan. The set of performance indicators consists of 44 specific indicators by thematic priorities which describe the improvements in both quantitative (numeric) and qualitative (socio-economic changes) way. The evaluation will be carried out on an annual basis and report will be prepared by HAMAG-BICRO.

The other sectorial strategies have been taken into account when the Smart Specialisation Strategy was drafted, primarily the Industrial strategy 2014-2020, the Strategy for Fostering Innovation 2014-2020, the Strategy for Education, Science and Technology, the Strategy for the development of tourism (OG 55/2013)⁵⁰, the Energy development strategy⁵¹, the Draft of the Strategy for fostering investments, the Entrepreneurship Development Strategy 2013-2020⁵² and Croatian Research and Innovation Infrastructures Roadmap.

The development of infrastructure for research, development and innovation include two components:

- The construction of new and improvement of existing infrastructure for research, development and innovation; envisaged funds for the period 2015-2020 amount to €242.7m;
- The centres of competence (CEKOM); envisaged funds for the period 2015-2020 amount to €150m.

Within the first component it is planned for now to finance three significant research infrastructures: the Centre of Competence for Translational Medicine at the Children's hospital "Srebrnjak", research infrastructure of the Institute Rudjer Bošković (O-ZIP IRB) and the Croatian scientific and educational cloud (HR-ZOO). The remaining infrastructure is not determined but scientific organisations from the indicative list of infrastructure projects are expected to submit their proposals which link to S3 priorities and their needs.

⁵⁰ <http://www.mint.hr/UserDocsImages/130426-Strategija-turizam-2020.pdf>

⁵¹ <http://www.europski-fondovi.eu/sites/default/files/dokumenti/Energetska%20strategija%20RH%20do%202020.pdf>

⁵² <http://www.europski-fondovi.eu/sites/default/files/dokumenti/Strategy-HR-Final.pdf>

CEKOMs have an important role for the development of research infrastructure in the business sector. Their function is to increase the capacity for innovation particularly for SMEs by providing R&D infrastructure and services for industrial research and experimental development in areas that have not adequately developed R&D infrastructure.

The total allocation of ESI funds for S3 was estimated at €1,042.4m, of which the EU participates with the amount of €704.5m, national co-financing amounts to €53.9m, and private co-financing amounts to €284m.

S3 has also foreseen the measures for more intensive participation of the private sector in performing and investments in R&D. The most fundamental measure involves the establishment of the Innovation Network for Industry (INI), and the creation of Thematic Innovation Platforms (TIPs) as an effective way for encouraging public-private partnerships. In addition, a special grant scheme for private companies to invest in R&D projects is foreseen. The total funds for the scheme amount to €341.6m of which the private funds totalled €136.6m while remaining funds will be provided by the public resources.

2.5 Main policy changes in the last five years

Main Changes in 2011

- *There were no significant changes in R&I system, the general institutional and programme set up from the previous period was rather stable and partly expanded with the measures focused on scientific excellence and internationally competitiveness (the CSF launched two new programmes in this context, the Research projects and Collaborative research programmes);*
- *The next policy focus was on alignment with the ERA priorities especially in the area of labour market for foreign researches by removing administrative barriers, strengthening participation and knowledge circulation through ESFRI initiatives (DARIAH, CLARIN, ESS) and knowledge circulation through the EU mobility programmes such as Marie Curie-People, EURAXESS;*
- *The uncertainty of budgetary resources for programmes has increased due to the severe fiscal constraints;*
- *Preparation of the Indicative list of infrastructural projects for ESIF 2014-2020 is underway.*

Main changes in 2012

- *The new government elected in December 2011 has initiated many reforms in both R&I system and in surroundings in order to improve business climate and to eliminate the structural rigidities that hamper the country's growth potential including efficiency of the innovation and research system;*
 - *The reforms in R&I were based on the Draft of the act amending the Act on Science and Higher Education from 2003; the reforms will come into full swing during 2013 and 2014;*
 - *The allocation of research grants was transferred from the MSES to the Croatian Science Foundation stipulated by the Act on Amendments and Supplements of CSF (OG 78/2012) which will fundamentally change the system of research funding in the forthcoming period;*
 - *The new strategic documents were drafted, primarily the National Strategy for the Croatian innovation development 2013-2020, and the Guidelines for strategy of teaching, education, science and technology;*
 - *The reforms have started the process of shrinking the innovation system in both institutions and programmes; the beginning is marked by the fusion of HIT with the BICRO;*
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- *The realisation of the BICRO's programmes like RAZUM, TECHRO or IRCRO was slowed down while UKF programmes, despite international recognition, were partly terminated due to the lack of budget resources;*
- *On the eve of Croatia's EU accession an expert group for carrying out the Smart Specialisation Strategy is appointed by the Ministry of economy;*
- *The first evaluation studies of the innovation supporting programmes were carried out by the World Bank and the Institute of Economics from Zagreb;*

Main changes in 2013

- *Croatia became the 28th member of the EU on 1 July 2013 which provided Croatia with an access to the European Structural and Investment Funds(ESI);*
- *Financing of scientific activities was passed over fully to the Croatian Science Foundation (CSF) from MSES; CSF became a single funding institutions for allocation research grants for research; the number of projects were reduced by ten times in order to strengthen competitiveness;*
- *Institutional funding of research activities at PRO and HEI was transformed from the formal system based on number of researchers into the performance-based funding;*
- *Research institutions gained more autonomy and responsibility in spending allocated resources which relates to more accountable institutional research policy and management;*
- *Promotion of scientists into higher scientific grades were tightened; scientific titles are separated from the job positions;*
- *Programme for establishing of the centres of research excellence (CoRE) was launched for the first time in June 2013*
- *The Smart Specialisation Strategy was in progress with the assistance of EU co-funded team of experts;*
- *The Second Science and Technology Project (STP II), a joint project of the MSES and World Bank, was launched in April 2013.*

Main Changes in 2014

- *The landscape of R&I system was significantly changed; majority of traditional and long-lasting funding schemes, institutions, regulations and researchers' acquired rights have been significantly reduced, transformed or revised (in order to establish open, transparent and merit-based recruitment);*
 - *The majority of funding instruments and institutions for allocation grants for R&I activities were terminated (all CSF' programmes prior to 2013) or re-organised (BICRO, SIIF, UKF, MSES's project grants);*
 - *Croatian Science Foundation (CSF) remained main funding institutions for allocation research grants for fundamental research;*
 - *External evaluation of research activities at public institutes has been carried out in 2014 which faced many institutes with necessary changes in managing research activities to meet evaluation criteria in the next evaluation cycle;*
 - *The CFS's Action plan 2013-2014 and the projects of the State budget projections foresee further decrease in the State budget for R&I and 2015 and 2016*
 - *In alignment with the decreased State budget, the science policy is directed towards programmes financed by the ESI funds; the new funding programmes have been launched for doctoral students, capacity building in industrial R&D and researchers' mobility;*
 - *The first National reform programme was carried out;*
 - *The Partnership agreement for the European structural and Investment funds in the EU financial period 2014-2020 was adopted;*
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- *Strategy for Education, Science and Technology 2014-2020 was adopted;*
- *The Strategy for Fostering Innovation of the Republic of Croatia 2014-2020 was adopted;*
- *The first national Research and Innovation Infrastructures Roadmap in Croatia 2014-2020 was completed in April 2014;*
- *S3 was prepared to be sent to EC for adoption;*
- *The preparation of the Indicative list of infrastructural projects which could be financed from the ERDF is continued; in 2014 it consists of 33 project proposals for research infrastructure;*
- *The seven centres of excellence were established.*
- *The Business and innovation agency of Croatia (BICRO), has been merged with the Croatian Agency for Small Business and Investments (HAMAG) into a single agency called the Croatian Agency for Small Business, Innovation and Investment – HAMAG-BICRO in May 2014.*
- *The Government initiated the process of restructuring of the public research institutes and adopted the Decision on establishing the Committee for drafting the model of restructuring of public research institutes in Croatia in December 2014;*

Main Changes in 2015

- *The majority of funding instruments for allocation grants for R&I activities which were abolished in 2013 and 2014 were re-launched in 2015, given the STP II funds availability; They include two programmes of CFS (the Partnership in research and the Unity through Knowledge Fund) and three innovation programmes run by the HAMAG-BICRO (PoC, RAZUM, IRCRO);*
- *A new programme for technology transfer offices (TTO) has been launched in February 2015 and co-funded by STP II resources;*
- *The use of the European Structural funds 2007-2013 is below expectations;*
- *After seven initial Centres of research excellence (CoREs) have been approved by the NCSHETD in November 2014, the NCSHETD concluded that the first call failed to reach a satisfactory proposal of CoREs for some of the priority areas and announced in April 2015 a new call for CoREs; Additional six Centres of research excellence have been established in November 2015;*
- *Croatia begun its participation in the Regional innovation fund of the Western Balkan countries (ENIF) with a total national contribution of around €0.5m per year;*
- *The Croatian Government and the International Bank for Reconstruction and Development (IBRD) signed in July 2015 a loan agreement of €20m for the establishment of the first venture capital fund for innovation and entrepreneurship, a project developed jointly by the MoEC, HAMAG-BICRO and IBRD;*
- *The third call for large research infrastructures which will be financed in in the framework of the Operational Programme for Competitiveness and Cohesion in the programming period of 2014-2020 from ESIF is announced in November 2015;*
- *The Croatian Science Foundation (CSF) remained main funding institutions for allocation of research grants for fundamental research and it continues the programmes "Research projects" and "Installation research projects";*

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- *The Croatian Science Foundation (CSF) warns in its latest Annual report (CFS, 2015) that the funds for research projects in 2015 could be compromised due to the budget restrictions;*
 - *The government announced on 31 July 2015 a new programme for funding around 1200 young researchers on postdoctoral level as well as assistant professor who would otherwise become unemployed; a total of €266m has been foreseen in the State budget for the programme for the next 6 to 10 years;*
 - *The State budget for 2015 and projections for 2016 and 2017 envisage reduction instead of an increase in public resources for R&I, which diminishes the financial sustainability of R&I systems and policy;*
 - *S3 has been drafted and several drafts have been sent to EC for adoption;*
 - *Revision of the Croatian Infrastructure Roadmap in compliance with the Smart Specialisation Strategy (S3) priorities started in October 2015.*
 - *As on 1 January 2015, the measure of awarding state aid support for research and development projects in the form of tax incentives has been suspended until the new legal frame will be developed, in accordance with the GBER regulation.*

3. Public and private funding of R&I and expenditure

3.1 Introduction

In the period of strong development of Croatian economy, national development goal was to reach R&D expenditures level of 3% of GDP by 2010, with annual increase of at least 25%. GERD reached its maximum in 2004, when it amounted to 1.05% of GDP, after which it declined to 0.87% in 2005 and 0.75 in 2006. Slight increase was then recorded in 2007, when GERD reached 0.8% of GDP and in 2008 (0.9%). However, under the influence of economic downturn caused by global financial crisis, recession and structural gaps of Croatian economy, GERD declined again in 2009, reaching 0.85% of GDP, and in 2010 (0.75%), after which it reached 0.76% in 2011 and 0.75% of GDP again in 2012. With the adoption of the Economic Programme of Croatia in April 2013, new goal has been set to reaching R&D expenditures in the amount of 1.4% of GDP by 2020. Slight increase has been recorded in 2013, when GERD reached 0.81% of GDP, but followed by further decrease in 2014 to 0.79% of GDP.

From the current situation point of view, achieving of this, significantly lowered goal for R&D expenditures, still presents a challenging task. Expenditures on R&D have been constantly decreasing since GERD reached 1.05% in 2004 (with the exception of 2008 - 0.9% of GDP), revealing structural gaps of the overall R&D system, as well as of the economy in general.

Business enterprise sector has increased its share in GERD by sectors of performance, from 45.8% in 2012 to 50.1% in 2013, but decreased again to 48.23% in 2014. The slight increase of BES performance in 2013 can primarily be attributed to weaker public sector performance, caused by decrease of available funding, combined with initiated reforms of the overall system of R&I public funding in Croatia.

Share of government budget appropriations or outlays on R&D (GBAORD) in total general government expenditures in Croatia amounted to 1.54% in 2012, has decreased to 1.29% in 2013 and remained nearly at the same level in 2014 (1.3%), which was lower than in the preceding years (1.46% in 2009; 1.54 in 2011) and also lower than the EU-28 average of 1.38% in 2014. Total GBAORD amounted to €334,206 in 2011 (0.76% of GDP) and decreased to €318.465m in 2012, reaching 0.72% of GDP. Additional decrease was reported for 2013, when GBAORD reached €268.714 and in 2014 it has stagnated at €268.733, thus remaining at about 0.62% of GDP in 2013 and 2014.

Table 2 Basic indicators for R&D investments

Indicator	2011	2012	2013	2014	EU average (2014)
GERD (as % of GDP)	0.75	0.75	0.81	0.79	2.03
GERD (Euro per capita)	78.4	77.2	83.2	80	558.4
GBAORD (€m)	334.206	318.465	268.714	268.733	92,828.145
R&D funded by BES (% of GDP)	0.29	0.29	0.35	0.34	N/A
R&D funded by GOV (% of GDP)	0.36	0.34	0.32	0.33	N/A
R&D funded by HES (% of GDP)	0.01	0.01	0.01	0.02	N/A
R&D funded by PNP (% of GDP)	0	0	0	0	N/A
R&D funded from abroad	0.09	0.11	0.13	0.1	N/A
R&D performed by HES (% of GERD)	27.76	26.53	24.36	25.69	23.16
R&D performed by government sector (% of GERD)	27.38	27.62	25.53	26.06	12.15
R&D performed by business sector (% of GERD)	44.71	45.85	50.10	48.25	63.86

Data source: Eurostat

3.2 Smart fiscal consolidation

3.2.1 Economic growth, fiscal context⁵³ and public R&D

In 2014 the economy contracted for the 6th year in a row reducing real GDP by about 12.5%. Investment plummeted by 9% of GDP between 2008 (28%) and 2014 (19%) due to a steep drop in construction. Household consumption was affected by worsening consumer confidence due to deteriorating labour market conditions. Exports failed to grow due to low investment into productive domestic assets. In 2015 the country entered a recovery phase driven by private consumption. However, the absence of structural reforms may trigger a negative impact on future growth. The Commission expects a growth of 2.1% both in 2016 and 2017, *ceteris paribus*⁵⁴, which is still low for an economy with considerable room for convergence.

The general government deficit was decreasing in the pre-crisis period (2.7% of GDP in 2008). However, as a consequence of administrative fragmentation, weak public sector governance and loose fiscal policy during the crisis and decreasing GDP it reached 7.7% of GDP by 2011 and it remained above 5% until 2014. Supported by revenue windfalls due to higher-than-expected growth and some containment of expenditure growth the 2015 is expected to fall to 4.2% of GDP in 2015. Prolonged recession coupled with the inclusion in the 2008-2013 public debt calculation of major state-owned enterprises (according to the new accounting rules) increased sharply the level of public debt (Figure 2) to the 2015 level of 86%. The debt is expected to rise further moderately to reach 87.4% by the end of 2017 due to rising interest payments (Croatia's 4.2% effective interest rate is among the highest in the EU).

⁵³ Sources: DG ECFIN, National Reform Program 2015, RIO

⁵⁴ Further fiscal consolidation measures foreseen for 2016-2017 may have a negative impact on growth.

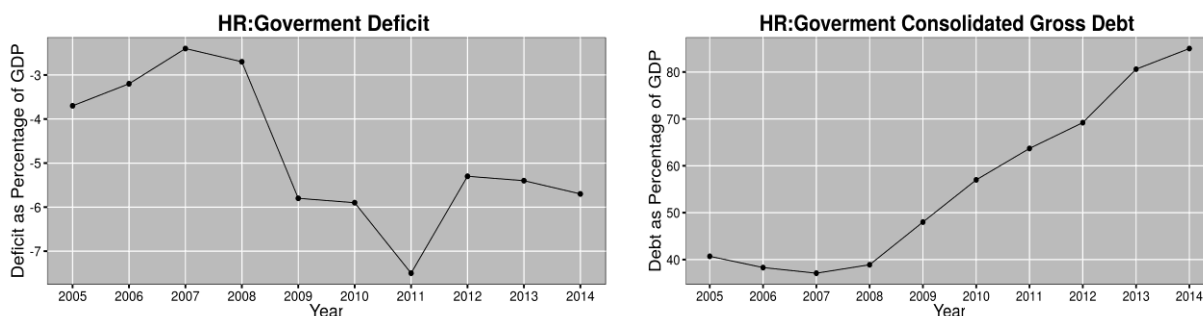


Figure 2 Government deficit and public debt
Data source: Eurostat

Total GERD in Croatia was €339.86 million in 2014. There are three main sources of R&D funding: the business sector (146 MEUR), the government (142 MEUR), and foreign funding (44 MEUR). Direct funding from the government goes to R&D units in the business enterprises (€0.76 million), the government (€76.6 million) and the higher education sector (64.4 MEUR).

Table 3. Key Croatian Public R&D Indicators

	2007	2009	2014
GBAORD, % of gov. exp.	n.a.	1.49	1.30
GERD, % of GDP	0.79	0.84	0.79
out of which GERD to public, % of GDP	0.47	0.50	0.41
Funding from GOV to, % of GDP			
Business	0.01	0.01	0.00
Public (GOV+HES)	0.39	0.43	0.33
Total	0.40	0.43	0.33
EU funding, % of GDP (2013)	0.00	0.00	0.01

Source: Eurostat

3.2.2 Direct Funding of R&D activities

Figure 3, below shows the historical evolution of GERD financing in current prices in the Croatia.

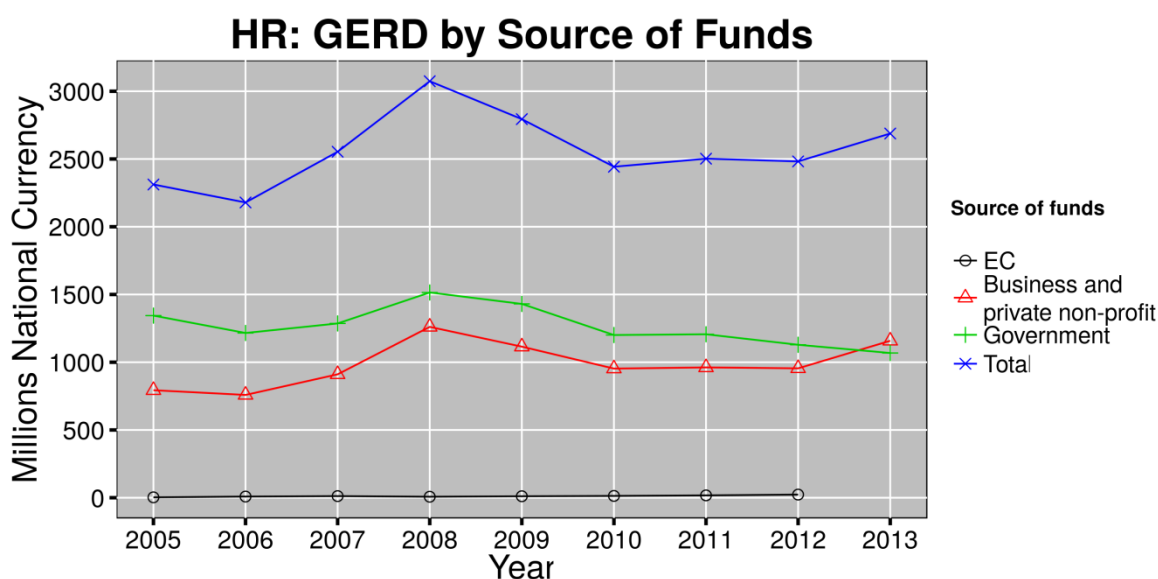


Figure 3. Funding of the total GERD
Data source: Eurostat

The total GERD in nominal values peaked in 2008 and later on settled on levels compared to those of 2007. This is due to a simultaneous decline in 2009-2010 of the funding from the government and the business sector. The government is traditionally the main funder of the Croatian GERD, but the gap with the private sector reversed in 2013. The contribution from the EC has been so far negligible as it amounts to only 2-3% compared to the GERD funded by the government.

3.2.2.1 Direct public funding from the government

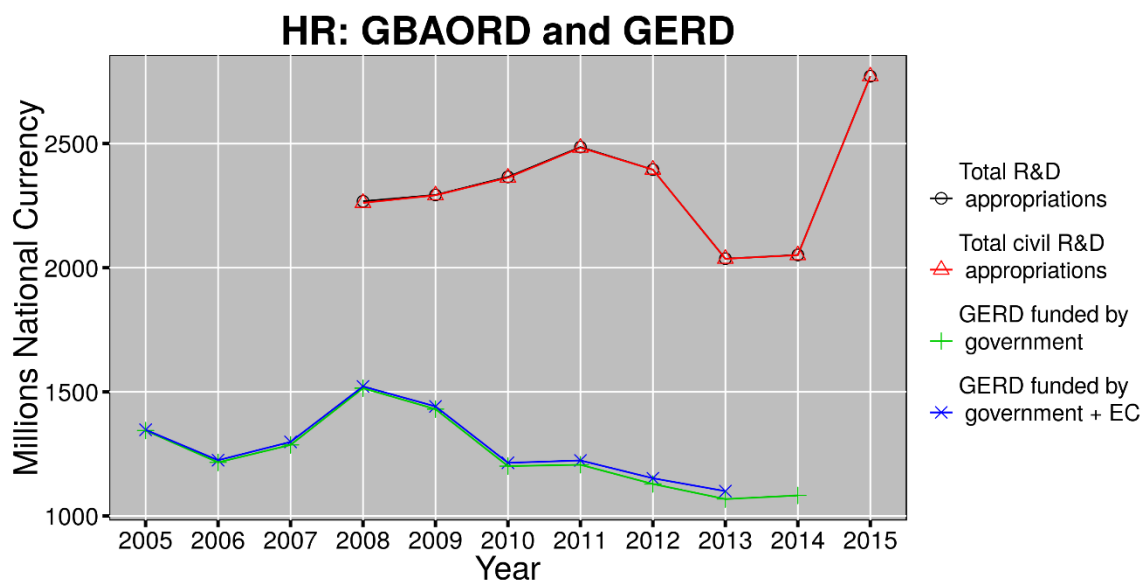


Figure 4 R&D appropriations and government funded GERD in millions of national currency
Data source: Eurostat

The GERD funded by the government has been following a declining trend since 2008. The total (civil) appropriations, on the other hand, peaked in nominal terms in 2011 and then declined stabilizing at a level about 20% lower. This is most probably due to the fact many of the existing funding instruments put in place and funded through a loan from WB were partly terminated and other measures were delayed. Structural reforms like merging funding institutions and transferring of financing activities between key institutions (MSES to CSF) also contributed to the overall shrinking of financing instruments. This negative trend is even stronger when the government GERD is expressed as percentage of GDP. However, this trend was reversed in 2014 and provisional data suggest a strong increase for 2015 (Eurostat).

One notices that in relative terms the gap between the appropriations and the expenditures is expressed way stronger compared to the most of the EU MSs.

3.2.2.2 Direct public funding from abroad

The business sector is the major (non-public) funder of the Croatian GERD from abroad (see Table 4). As pointed out before, the role of the EC is marginal. Two factors are important for the low levels of ESIF absorption: Croatia became full member of the EU in 2013 with limited IPA funds available and the unpreparedness of the administration and the overall system for EU funds absorption. The availability of funds is increasing: several grant schemes targeting businesses, PRO, HEI, CoREs and centres of competence have been prepared, but they are awaiting the approval of the S3 strategy.

Overall, the funding from abroad is an increasingly important contribution to the GERD whereof it represents a share fluctuating around 15-16% in 2012-2013.

Table 4 Public Funding from Abroad to R&D in Croatia (in millions of national currency - HRK)

Source from abroad	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	60	149	279.2	241.5	194.37	240.95	291.47	356.57	416.55	333.062
BES	27.8	37.5	229.2	204.4	135.41	197.98	221.03	269.19	302.81	
EC	3	8.6	12	7.3	10.94	13.34	17.39	23.11	32.00	
GOV	9.5	4.1	7.4	5.9	11.49	6.17	2.88	0.73	3.11	
HES	1.7	1.8	2.4	2.8	4.96	0.85	1.66	1.42	1.17	
International Organizations	8.6	10.3	10.9	18.1	28.11	18.57	37.55	47.38	67.64	
Total as % GERD	2.6	6.84	10.93	7.86	6.96	9.86	11.65	14.37	15.5	12.84
EC as % GOVERD	0.22	0.71	0.93	0.48	0.76	1.11	1.44	2.05	3	

Data source: Eurostat

The abroad contributions from the government and the international organizations play instead a minor role.

Figure 5, below shows how the distribution of public funding to sectors of performance evolved over time:

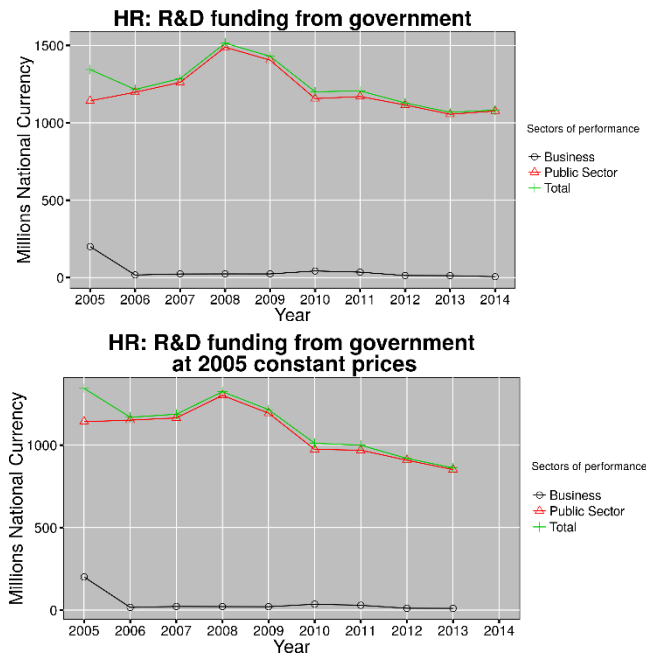


Figure 5 Government intramural expenditure by sectors of performance
Data source: Eurostat

Practically the public sector (GOV + HES) receives all the government funded GERD (Figure 5, left). This contribution has been following a declining trend since 2008 with some signs for recovery in 2014. The decline of the GERD funded by the government is further emphasized when resorting to 2005 constant prices (Figure 5, right).

3.2.3 Indirect funding – tax incentives and foregone tax revenues

Considering the absence of harmonisation of the tax regimes in EU law, data come directly from national sources, using domestic definitions. Attention should be paid when interpreting data from different sources.

In 2011, an analysis of R&D tax incentives (Aralica et al., 2011) resulted in a conclusion that tax incentives in Croatia are more generous form of state aid for R&D than subsidies. In year 2015 the income tax incentives have been discontinued because of the discrepancies of the Croatian legal framework and EU Commission Regulation No 651/2014 declaring certain categories of aid compatible with the internal market (GBER). State aid for research and development projects has been granted since 2007, pursuant to Articles 111 a-f of the Act on Science and Higher Education (Official Gazette No. 123/03, 198/03, 105/24, 174/04, 02/07, 46/07) and the Rules on State Aid for Research and Development Projects (Official Gazette No. 116/07). Given that this is an "older" state aid measure, it is not in line with the regulations of the European Commission on state aid. Namely, this measure is listed on the list of aid schemes and individual aid which were put into effect in Croatia before the date of accession and apply after that date as well, in accordance with the provisions of Section 2 ("Competition policy") of Annex IV of the Treaty of Accession of the Republic of Croatia (hereinafter: the Treaty, Official Gazette, International Treaties No. 2/2012, 28 March 2012). In accordance with Annex IV of the Treaty, the duration of the measure is limited to 31 December 2014 and no requests for state aid for research and development projects have been granted from that date on.

According to KPMG 2013 study⁵⁵ on incentives in Croatia, companies could have benefited from R&D incentives by decreasing their tax base as follows:

- 150% of eligible expenses incurred for basic research, aiming at expansion of scientific and technical know-how not linked to commercial and industrial goals;
- 125% of eligible expenses incurred for practical research, aiming at acquiring know-how that can be applied for development of new products, new production processes or services or significant improvements of existing ones; and
- 100% of eligible expenses incurred for developmental research, intended to convert results of practical research into plans, drafts or models for new or improved products, production processes or services intended for internal use or sale.

In the case of SMEs, the incentives are even more generous. 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 (OECD, 2014). In fact, although small firms represent the majority of the beneficiaries of R&D tax incentives, large firms receive most of the benefits; tax breaks are also highly concentrated by sector (WB, 2015)⁵⁶. In 2008, nine companies (3.3% of the recipients) consumed the first 90% of all tax incentives and in 2009, 27 companies (10.3%) got 90% of the total, according to Švaljek (2012).

⁵⁵ <https://www.kpmg.com/HR/en/Documents/Incentives%20in%20Croatia%202013.pdf>

⁵⁶ http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2015/06/17/090224b082f42acd/1_0/Rendered/PDF/SmartSpecialiProductivityOanalysis.pdf

Table 5 Foregone tax revenues due to R&D tax incentives.⁵⁷

Foregone tax revenues due to R&D tax incentives	
2011	2012
449.772.564**	505.445.547**
60.462-M€	67.237-M€

*in HRK; preliminary data from the Ministry of Finance - Tax Administration. 'Foregone tax revenues due to R&D tax incentives': the amount of tax revenue which is foregone on account of R&D tax incentives (beyond the standard deduction of 100% of business R&D expenditure from their tax base), including (a) tax/social contribution forgone due to R&D wages tax incentives, and (b) national and subnational R&D tax incentives.

3.2.4 Fiscal consolidation and R&D

Figure 6, below shows the scatterplot of the structural balance and a relevant measure of the R&D (GBAORD as % GDP, left panel and GERD as % GDP, right panel)⁵⁸:

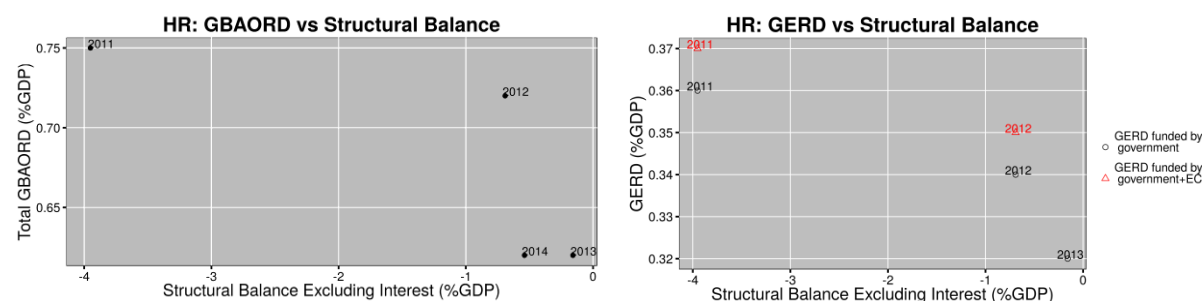


Figure 6 Fiscal consolidation and R&D
Data source: AMECO, Eurostat

Based on section 3.2.1 and the data concerning the structural budget balance of the Croatian country report (page 8) referenced in the same section (see also Table 4), the Croatian post-crisis fiscal adjustment has not started up until 2011 and it is still not accomplished, with 2011 being the year with the strongest fiscal adjustment. During 2011-14 both GBAORD and GERD funded domestically by the government decreased steadily both nominally and as a share of the GDP by 0.15% of GDP – GBAORD, and 0.04% – government financed GERD. Therefore we can conclude that direct public support to R&D expenditures decreased during the post-crisis fiscal adjustment period. As we have seen in Section 3.2.3, Croatia provides a very generous system of tax incentives.

Despite the plan to increase the public R&I funding, especially in the context of access to EU Structural funds since the mid-2013, most of the announced funding opportunities have not been realised so far. This primarily refers to several grant schemes that were announced to be published in 2015, but publications have been significantly delayed with no publicly available information on their expected publication. In addition, already scarce state budget resources have been announced to further decrease in 2016 and 2017.

⁵⁷ 2013 Questionnaire on R&D&I investments by EU Member States and Associated Countries, Croatia

⁵⁸ Structural balance data comes from the AMECO database the other indicators were taken from Eurostat.

To sum up, the Croatian post-crisis fiscal adjustment has come at an expense of direct public support to R&D expenditures through significant cuts in R&D budgets. Foregone tax revenues may have played a role in maintaining the total public support, although they tend to be disproportionately utilised by a relatively small number of companies. However, the quality of the data may not be sufficiently reliable.

3.3 Funding flows

3.3.1 Research funders

Ministry of Science, Education and Sports (MSES) is responsible for institutional funding of PROs and HEIs, which became performance-based in 2013. During the first half of 2013, institutional performance indicators have been evaluated and amount of annual funding has been agreed between the MSES and PRO/HEIs for the period of three years. The introduction of the multi-annual and performance-based institutional funding has been a major change in the overall public research system over the last years, since before it was based on block-grants awarded annually to PROs and HEIs. As indicated in Section 2.2, the new form of institutional funding significantly contributed toward increasing the autonomy and responsibility of both universities and other public research organisations, especially in the context of free internal distribution of financial sources for research activities.

Croatian Science Foundation (CSF) is responsible for competition-based funding of research activities. It administers several programmes aimed at funding research at PROs and HEIs, such as Partnership in Research, Installation Research Projects, Research Projects Programme and Young Researchers' Career Development Project. The role of administering competition-based R&D funding was transferred from MSES to CSF in 2013.

Ministry of Regional Development and EU Funding (MRDEUF) became the managing authority for the ESI funds in Croatia, which significantly increased its role in funding of R&I in Croatia, especially when it comes to absorption of significantly increased resources for R&D&I in the programming period 2014-2020. Its main responsibilities include management, implementation and monitoring of ESIF funding in Croatia.

Ministry of Entrepreneurship and Crafts (MoEC) is responsible for implementation of the Business Impulse Programme, which contains a number of different sub-programmes aimed at fostering competitiveness of Croatian SMEs, among which there are also measures aimed at fostering research and innovation activities in SMEs. Since 2015, several funding schemes administered by HAMAG-BICRO have also become a part of the Business Impulse Programme (e.g. IRCRO, RAZUM and Proof of Concept).

Croatian Agency for SMEs, innovation and investments (HAMAG-BICRO) administers several programmes aimed at fostering research and innovation activities in Croatian companies and research organisations, with an emphasis on science-industry cooperation. These primarily include IRCRO, RAZUM and Proof of Concept – programmes funded under the World Bank loan (STP II). Besides the innovation funding programmes, HAMAG-BICRO also administers credit guarantee schemes for innovation activities.

Ministry of Economy (MoE) also has an increasing role in research and innovation funding for businesses, since the MoE is responsible for design and implementation of several grant schemes aimed at promoting business investments in R&I, which are planned to be funded from the ERDF, under the Operational Programme Competitiveness and Cohesion 2014-2020.

3.3.2 Funding sources and funding flows

Croatia has set the goal of reaching R&D intensity of 1.4% by 2020. GERD has been continuously declining since 2004, with the exception of 2007 and 2008 when it experienced a slight increase. An increase was then recorded again in 2011, when GERD reached 0.76% of GDP, only to decrease again to 0.75% in 2012. In 2013, GERD reached 0.81% of GDP, which is still less than 0.85% reached in 2009 and significantly below the level from 2004 of 1.05% of GDP. In addition, GERD further decreased in 2014, amounting to 0.79% of GDP, as reported by Eurostat.

Research and innovation activities in Croatia are predominately funded from the state budget, and public R&D sector, led by universities, has a leading role in the overall R&I system, both in manpower and research performance. However, the share of GERD funded by the government sector has been continuously decreasing since 2009, while the share of GERD funded by the business sector has been increasing, as well as GERD funded from abroad. In 2013, business sector has funded 42.9% of GERD and exceed funding from the government sector, which amounted to 39.7% of GERD. In 2014, business sector funded about 43% of GERD, while the government sector funded about 42% of GERD. For comparison, GERD funded from the government sector amounted to 51.2% of GDP in 2009 and 48.2% in 2011, while GERD funded from the business sector reached 39.8% of GDP in 2009 and 38.2% in 2011.

Higher education sector funded 1.7% of GERD annually in the period 2011-2013, while the share increased to about 2% in 2014. The share of GERD funded from abroad has been increasing since 2009 when it amounted to 7%, reaching 11.6% in 2011, 14.4% in 2012 and 15.5% in 2013, but it decreased again in 2014, amounting to about 13%. Given the availability of funding from ESIF and grant schemes for research and innovation activities that are expected to be published, the share of GERD funded from abroad is expected to grow significantly over the next few years. For the period 2014-2020, allocation of €10.68b (3% of GDP on an annual basis) from ESIF has been planned, which is about ten times more than in the period 2007-2013. However, the absorption efficiency remains to be seen in the following years.

The Government finances around 74% of research activities at HEIs (75.8% in 2012) and 87% at public research institutes. On the other hand, in 2013 the Government financed only 0.94% of R&D performed in the business sector and the majority of R&D expenditures (65.6%) in the business sector were financed by the companies themselves, followed by 20% of resources that came from abroad. In 2014, the share of R&D in the business sector funded by the Government decreased to only 0.46%. In 2008, the government financed 81.2% of R&D at HEIs, 84.3% at public research institutes and 1.8% in the business sector. In the same period, the share of foreign resources for R&D has almost doubled, from 7.9% in 2008 to 14.4% in 2012, but further decreased to 12.8% in 2014, which is quite low, considering the overall availability of the ESIF funding for Croatian R&D projects. When it comes to R&D related FDI, the Strategy for Fostering Innovation in Croatia 2014-2020 has a goal of increasing the level of R&D related FDI from 14.7% to 25% until 2020. However, the exact data on the R&D related FDI are not adequately measured or publicly published on a regular basis.

In addition, the government still finances around 42% of all research activities in Croatia.

When it comes to available allocation from ESIF, total allocation for R&D&I in the period 2014-2020 amounted to €728.392.165, as indicated in the table below. Largest share (23.5%) has been allocated for research and innovation activities in public research organisations and centres of competence including networking, followed by research and innovation infrastructure (public) (22.4%). However, announced public calls have been significantly delayed, which could result in low overall absorption of available ESIF funding for R&D in Croatia.

Table 6 ERDF allocation for R&D&I in Croatia, for the period 2014-2020

Categories of Intervention	EU Amount (€)	% R&D&I
002. Research and innovation processes in large enterprises	23.995.920	10,8
056. Investment in infrastructure, capacities and equipment in SMEs directly linked to research and innovation activities	17.185.000	7,7
057. Investment in infrastructure, capacities and equipment in large companies directly linked to research and innovation activities	21.425.000	9,6
058. Research and innovation infrastructure (public)	37.591.135	16,9
059. Research and innovation infrastructure (private, including science parks)	6.000.000	2,7
060. Research and innovation activities in public research centres and centres of competence including networking	29.243.183	13,1
061. Research and innovation activities in private research centres including networking	8.500.000	3,8
062. Technology transfer and university-enterprise cooperation primarily benefiting SMEs	14.900.000	6,7
063. Cluster support and business networks primarily benefiting SMEs	13.350.000	6,0
064. Research and innovation processes in SMEs (including voucher schemes, process, design, service and social innovation)	34.045.000	15,3
065. Research and innovation infrastructure, processes, technology transfer and cooperation in enterprises focusing on the low carbon economy and on resilience to climate change	16.550.000	7,4
Total R&D&I	222.785.238	100,0

3.4 Public funding for public R&I

3.4.1 Project vs. institutional allocation of public funding⁵⁹

Institutional funding has been a dominant mode of public funding of R&D activities and covered more than 90% of public funding for R&D until 2013, when the comprehensive reform of the overall R&I system has been initiated. Most important reform measures include the introduction of institutional funding on a three-year basis (compared to annual decisions made in the past), as well as a transfer of responsibilities for project-based allocation of public funding from the Ministry of Science, Education and Sports to the Croatian Science Foundation.

⁵⁹ "**Institutional funding** is defined as the total of national budgets in a given country, attributed to an institution, with no direct selection of R&D project or programmes and for which money the organisation has more or less freedom to define the research activities to be performed." Institutional funding can be in the form of non-competitively allocated **Block funding**. Institutional funding may also be allocated in a **variable/competitive** manner tied to institutional assessments. "**project funding** is defined as the total of national budgets in a given country, attributed to a group or an individual to perform an R&D activity limited in scope, budget and time, normally on the basis of the submission of a project proposal describing the research activities to be done". Steen, J. v. (2012), "Modes of Public Funding of Research and Development: Towards Internationally Comparable Indicators", *OECD Science, Technology and Industry Working Papers*, 2012/04, OECD Publishing. <http://dx.doi.org/10.1787/5k98ssns1gzs-en>. Assessments of the total share of competitive vs non-competitive funding can be a relevant starting point of the analysis, but the aim is to have the competitive funding separated between project funding and competitively allocated institutional funding. Competitive funding of research infrastructures through e.g. a research council can be labeled as project funding. However when infrastructure funding comes in the form of a lump sum budget or earmarked budget then it should be considered as institutional funding.

Despite the fact that the overall system of public funding for public R&I has been rationalised with the introduced changes, budget sources for competition-based funding are expected to further decrease in 2016 and 2017.

The process of awarding competition-based R&D grants now includes more rigorous project evaluation process aimed at selection of fewer high quality research projects (around 20%). Compared to the new system, allocation of funds through the Z-projects programme included a large number of smaller R&D projects, with very high rate of approval (around 80%).

Award of multi-annual block grants for HEIs and PROs from the State budget is awarded since 2013 at a three-year basis, with funding amounts determined on the basis of institutional performance indicators. For the period 2013-2015, indicators have been evaluated during the first half of 2013, after which the exact funding amounts have been agreed between MSES and HEI/PROs. Decision on multi-annual institutional funding of research activities in public research institutes and universities for the period 2013-2015 has been adopted in June 2013 (Official Gazette 69/2013)⁶⁰.

Unity through Knowledge Fund (UKF) was merged with CSF in February 2014. UKF was established in 2007 by the Ministry of Science, Education and Sports supported by the World Bank loan within the Science and technology project. It supported collaborative research with Croatian scientists living in Croatia and abroad and leading international scientific institutions to raise absorption capacity for EU funds, especially Structural and Horizon 2020. It was considered a highly successful Fund which established, for example, collaboration with 133 foreign research institutions including Mack-Planck Institute, Swiss Federal Institute of Technology, and Johns Hopkins University, etc. The projects financed within the Fund realized great success among the applications for call for proposals in the FP7 program for research and technological development – success rate thereof is in the 35% range. The Fund invested €3.6 million in the acceptance of projects, and an additional €9.03 million was extracted from the FP7 program, entitled to Croatian partners. In addition to the financing, success of the Fund's projects within FP7 provided Croatian research groups with international recognition, visibility and competitiveness in a worldwide scope.

The share of project based funding in GBAORD was rather low until 2013, and amounted to 6.2% in 2011 and 5.6% in 2012, while institutional funding amounted to 93.8% and 94.4%, respectively. The implemented reforms should significantly increase the share of project-based funding in total public funding of R&D activities in Croatia, which already increased to 8.5% in 2013.

3.4.2 Institutional funding

Up to 2013, 80 to 85% of the public (i.e. universities and research institutes) research activities were block-funded. The funding was allocated by the Ministry of Science, Education and Sport (MSES) and decomposed as such: 70% for salaries, 10% of direct organisational funding (overheads, phone, energy, etc.), 10% of research grants (material and operational costs) and remaining 10% other research-supporting activities (conferences, publishing, etc.).

Amendments to the Act on Science and Higher Education, adopted in 2013 (OG 94/2013 and 139/2013), introduced significant changes to the overall Croatian R&D system. Decision on multi-annual institutional funding of research activities in public research institutes and universities for the period 2013-2015 has been adopted in June 2013 and a new model for public R&D funding has been developed, focused on awarding multi-annual block grants for HEIs and PROs from the State budget by MSES. Funding is now awarded at a three-year basis, with funding amounts determined on the basis of institutional performance indicators.

⁶⁰ <http://public.mzos.hr/Default.aspx?sec=3521>

For the period 2013-2015, indicators have been evaluated during the first half of 2013, after which the exact funding amounts have been agreed between MSES and HEI/PROs.

The amount depends on the institutional performance indicators of scientific activity in the previous five-year period. They include four types of criteria with different values of weights depending on their importance for research evaluation, as follows:

- Scientific productivity (with the largest weight of 60%) which includes the number of scientific papers published in journals covered by the Web of Science and SCOPUS, number of citations and the number of employees who attained doctoral degree in a given period. The number and type of publications are further specified by the 6 scientific areas of natural, technical, biotechnical, biomedical, social sciences and humanities;
- National and international competitive research projects and mobility (25% of weight) includes the number of national competitive research projects (CSF and UKF) and the number of projects funded by foreign resources (FP6, FP7, ESF, HERA);
- Popularization of science (5% of weight) includes participations in actions like Festival of Science;
- Commercialisation of science (5% of weight) includes the number of contracted projects with businesses, government bodies and local authorities, civil sector and non-governmental organisations.

The allocation of total funds of € 6.6m per year to each institution depends on the institutional coefficient, calculated by a complex formula which includes given criteria and a number of other elements combined with the specific coefficients and ratios such as: an average and basic value of scientific area, the coefficient for a particular area of science (natural sciences = 2.7; engineering = 2.5; biomedical Sciences = 2.7; biotechnology = 2.6; social sciences = 1.2; humanities and arts = 1.2), number of researchers in full-time equivalent (FTE) by a field of science, etc.

Each institution is obliged to deliver the annual report about its scientific activities in standardised format. That report is evaluated following the criteria previously agreed upon and used for the calculation of the institutional coefficient, thus the organisational funding.

Another new form of institutional/project funding has also been introduced in 2014. This refers to the Centres of Research Excellence, whose establishment is funded by MSES from the State Budget. The aim of the activity is to increase research excellence based on the funding of specific research activities and research teams. For the period 2014-2016, €0.330m annually has been reserved within the State Budget. Additional financial resources for Centres are planned to be ensured from the EU Structural Funds.

3.4.3 Project funding

Croatian Science Foundation is responsible for allocation of project-based public funding of R&D activities in Croatia. Since this responsibility has been transferred from the MSES to the CSF in 2013, and more rigorous selection criteria have been introduced, the annual number of funded projects has decreased significantly, from 2,500 projects funded through the MSES' Z-projects programme, to the planned 200 projects planned to be funded from CSF programmes in the period 2013-2014.

In 2014 and 2015, several programmes have been implemented by the CSF:

- **Research Projects Programme**

Programme supports research groups that are working on internationally/ nationally competitive issues, and whose leaders have been recognized for their scientific achievements and mentoring skills. Main goal is to create a critical mass of research groups that will be competitive at the international level.

Maximum funding amount per one project was about €131,500, except for projects in the fields of social sciences and humanities, for which maximum funding amounted to about €79,000. Project funding duration is from 2 to 4 years. Overall budget for 2015 was €4.6m.

- **Installation research projects**

The programme enables scientists to establish their own laboratory and/or a research group during a 3-year period of funding. At the same time, the institution must support the work of the emerging research group, and demonstrate its support to the young researcher's group even after the completion of the funding period ensuring the transfer of specialised knowledge and the successful development of professionals in the internationally competitive issues.

Maximum funding amount per one project was about €131,500, except for projects in the fields of social sciences and humanities, for which maximum funding amounted to about €79,000. Project funding duration is 3 years. Overall budget for 2015 was €1.3m.

- **Partnership in Research**

Partnership in Research aims to support research partnerships between public universities or research institutes in Croatia and non-budgetary funding sources from Croatia and sources from abroad. The programme supports relevant scientific research that can accelerate the development of new and existing companies and attract those representatives of industry and entrepreneurship which will significantly contribute to the economic and technological development of the Republic of Croatia.

Maximum annual funding per one project is from €39,500 to €65,800, while total funding per one project cannot exceed €197,400. Project funding duration is 2 to 3 years. Overall budget for 2015 was €1.97m.

- **Scientific Cooperation Programme – “Across the Border” grant**

Scientific Cooperation Programme is the UKF's research programme which aims to encourage funding of medium-sized collaborative research projects from Croatia and include cooperation with Croatia scientific and professional Diaspora. “Across the Border” measure under the Programme has the goal to provide the excellent Croatian researchers and experts who live and work abroad to initiate and establish scientific cooperation with scientists who live and work in Croatia, enabling efficient knowledge transfer and attracting investments in Croatia, as well as to encourage return excellent Croatian scientists to their homeland. Funding per one project is from €98,700 to €197,400. Project funding duration is 1 to 2 years. Overall indicative budget for 2015 was €1.4m.

- **Young Researchers' Career Development Project – Training of Doctoral Students**

Main aims of the programme are to enable scientifically active mentors who are engaged in internationally and/or nationally significant issues to involve in their research projects young researchers who wish to participate in scientific research and focus their career towards cutting-edge science. The ultimate goal is the training of new doctoral students who will continue their career in competitive research and/or development of new technologies in the economy. The programme funds gross salaries of PhD students. The total funds of €3.5m in 2015 were allocated to CSF mostly for gross salaries of PhD students and their doctoral studies. The CSF approved so far 182 projects out of a total of 192 submissions.

The evaluation process of applications for funding from CSF programmes (grants) consists of four main evaluation stages. After an administrative check, proposals are evaluated by evaluation panels, consisting of Croatian experts. In this round, the evaluation process is focused on experience and achievement of the project manager, relevance and innovativeness of the proposal, clarity and argumentation of project goals, hypothesis and work plan, proposed research methodology and feasibility of the research plan. Successful project proposals are then subject to a peer review process, conducted by international and, in the case of projects in the area of humanities, domestic experts. Peer reviewers are proposed by the evaluation panel. Peer review is primarily focused on the importance of the research, quality and innovativeness of proposed research plan, publication potential and feasibility evaluation of the project proposal. After the project has satisfied the peer review, evaluation panels further evaluate financial plans, existence of any ethical doubts and support of the institution.

A significant set-back in the context of project funding R&I activities is the low absorption of ESI funds in Croatia. In the environment of constant decrease of state budget resources for R&I activities, great expectations have been put on the funding from EU funds. Two grant schemes for R&I have been published so far – one of them is “Strengthening capacities for research, development and innovation”, which has been administered by the MSES and has been launched in 2014. The focus of the call is on applied and industrial research projects, implemented cooperation between research institutions (applicant) and industrial/business partners in order to achieve results with potential commercial applications or the creation of new relevant knowledge. The total indicative budget of the Call is €9.3m out of which the contribution of the ERDF amounts to €7.9m and national contribution amounts to €1.4m. In this call the maximum grant amounts to around €1m and the minimum grant amounts €0,2m. Percentage of project financing is up to 100% of the total costs of the applicants and up to 80% of the total cost of partner. The other one is “Research scholarships for professional development of young researchers and post-doctoral students”. The total indicative budget of the Call is €4.9m out of which the contribution of the ESF amounts to around €4.17m and national contribution amounts to €0.73m.

The programme for support of the Technology transfer at universities (TTU) has been launched in February 2015. The programme has been funded by the World Bank loan (STP II) and coordinated by HAMAG-BICRO. The main goal of the programme is to strengthen the role of technology transfer offices at PROs and HEIs for fostering and implementing technology transfer. The overall indicative amount available under TTU Program is €1.5m. The programme funds 100% of the total eligible costs. The funding grants range between €10,000 and €75,000 per project. Project duration is 18 months.

The International Fellowship Mobility Programme for Experienced Researchers in Croatia – NEWFELPRO was launched in Croatia in June 2013 with a total budget of €7m, out of which 60% is financed from national sources. The project is co-financed through the Marie Curie FP7-PEOPLE-2011-COFUND program. Eighty-three fellowships are available as part of the NEWFELPRO project. There are specific schemes for outgoing and incoming fellows, including diaspora Croatians returning to the country. In addition, under the reintegration fellowship scheme within this programme, a total of nine two-year fellowships will be awarded. Project duration is from 2013 until 2017

3.4.4 Other allocation mechanisms

Currently, there are no additional funding programmes which cannot be classified as either project or institutional funding. Besides institutional funding resources allocated by MSES, most of R&D funding programmes allocate financial resources on a project basis.

3.5 Public funding for private R&I

3.5.1 Direct funding for private R&I

There are several main programmes aimed at stimulating research and innovation in the private sector, primarily administered by Ministry of Entrepreneurship and Crafts and HAMAG-BICRO within the Business Impulse Programme, and funded from the ERDF and the World Bank loan – STP II. Most of the mechanisms aimed at direct funding for private R&D are grant schemes, while other measures (such as innovation procurement, public-private partnerships, etc.) are still quite neglected in Croatia, despite the fact that the Strategy for Fostering Innovation in Croatia 2014-2020 envisages development of such mechanisms. As already discussed, implementation of the Innovation Strategy measures is still quite slow, and innovative public procurement measures are still not being actively used to improve public services, and additional efforts are required to ensure efficient design and implementation of measures stemming towards fostering innovation development through public procurement.

HAMAG-BICRO currently implements three programmes funded through the Second Science and Technology Project⁶¹ (STP II), which a joint project of the MSES and the World Bank supported by the loan of €20m from the International Bank for Reconstruction and Development (IBRD). The main aim of the project is to improve the capacity of Croatia's R&D and innovation institutions for absorption of the EU Structural and Cohesion funds. The STP began on July 31, 2013 and will last until July 30, 2017.

STP II funding is aimed at private R&I funding, including:

- **Development of knowledge-based companies – RAZUM Programme**, through which R&D activities in SMEs that will result in innovative product or service ready for market are funded. A total fund of €2.9m has been provided by the STP II. Financial aid is granted in the form of a conditional loan for a maximum of 70% of the costs, while the remaining 30% is financed from own resources. The largest amount of an individual project is €1.2m while the project duration is limited to a maximum of 24 months.
- **Collaborative research development - IRCRO Programme** funds the development of new products, services or processes undertaken by individual entrepreneurs or SMEs and involve cooperation between research institutions and private sector. A total fund for the programme of €1.8m has been provided by the STP II. Projects grants are aimed to co-finance 50% of eligible project costs. The maximum amount for co-financing of the project is €0.2m. Project duration is limited to a maximum of 24 months.
- **The PoC programme (Proof of Concept)** ensures pre-commercial capital for technical and commercial testing of innovation concepts. The PoC consist of two components: the PoC for entrepreneurs with a total funds of €1.9m and PoC for researchers with a total fund of €1.1m. So far, PoC has achieved significant results in terms of the number of applications and the quality of applied projects. Its evaluation procedures are transparent and effective, which is one of the reasons for the continuous increase in the number of applications.

Ministry of Entrepreneurship and Crafts also implements several measures aimed at private R&I funding, primarily through the Business Impulse Programme, which are co-funded through the Structural Funds. Besides the programmes administered by HAMAG-BICRO, Business Impulse 2015 envisages Innovation Programme, co-funded by the ERDF with a budget of €80m in the period 2015-2020, out of which €4m has been allocated for 2015. The programme aims at fostering development of new innovative products and services of micro, small and medium enterprises increase in the number of patent applications and development of know-how.

⁶¹ <http://www.worldbank.org/projects/P127308/second-science-technology-project?lang=en> (last access: 15 February, 2015)

MSES has launched a grant scheme Strengthening capacities for research, development and innovation in 2014, which has been co-funded by the ERDF. The focus of the call is on applied and industrial research projects, implemented cooperation between research institutions (applicant) and industrial/business partners in order to achieve results with potential commercial applications or the creation of new relevant knowledge. The total indicative budget of the Call is €9.3m out of which the contribution of the ERDF amounts to €7.9m and national contribution amounts to €1.4m. In this call the maximum grant amounts to around €1m and the minimum grant amounts €0,2m. Percentage of project financing is up to 100% of the total costs of the applicants and up to 80% of the total cost of partner.

Expected grant scheme of the Ministry of Economy aimed at increasing development of new products and services arising from R&D activities has not been published yet. The exact publication date is still unknown, with some announcements that the call for proposals should be published during 1Q of 2016. Total budget of the call is planned in the amount of €205m for the period 2014-2020, out of which €100 is allocated for the first phase of the call (2016), while additional €105 has been allocated for the second phase, announced for 4Q of 2017. The call will be financed from ERDF, while national private funding (share funded by the beneficiaries) has been estimated at €136.7m. Eligible costs will cover investments into R&D infrastructure and projects, from basic research to activities of prototyping and demonstration.

Another expected grant scheme managed by the MoE and funded through the ERDF is the call for funding of the centres of competence (CEKOMs). Total budget of €150m for the period 2016-2020 includes €105m from ERDF, €2.25 from national budget and €42.75m from beneficiaries (as own co-funding). Through this call, eligible costs will include construction and equipping of research infrastructure and co-funding of R&D activities in maximum duration of three years. Although the first call for expression of interest has been announced for 3Q of 2015, the call has been postponed for the 1Q of 2016.

R&I funding programmes in Croatia are generally not being evaluated and monitored at a satisfactory level. However, this is expected to improve with regular monitoring and reporting on implementation of Operational Programme Competitiveness and Cohesion 2014-2020, in line with the EC requirements

Public Procurement of Innovative solutions

Public procurement in Croatia amounted around HKR⁶²42b (€5.48b) or 12.8% of GDP in 2014, increasing from the amount of HKR⁶³39.5b (€5.15b) or 12% of GDP in 2013.

Legal Public Procurement framework

Croatia transposed the two 2004 Directives on public procurement (2004/17/EC and 2004/18/EC) into the national Public Procurement Act⁶⁴ in 2011.

The PCP/PPI landscape in Croatia

Public procurement procedures in Croatia are based on the Public Procurement Act, which does not define any special provisions for the purchase of innovative goods and services by the public sector. There are no innovation-oriented procurement policies or schemes in Croatia which may be partly explained with the relatively young R&I Croatian system in general.

⁶²

http://www.javnabava.hr/userdocsimages/userfiles/file/Statisti%C4%8Dka%20izvje%C5%A1%C4%87a/Godi%C5%A1nj a/Statisticko_izvjesce_JN-2014.pdf

⁶³

http://www.javnabava.hr/userdocsimages/userfiles/file/Statisti%C4%8Dka%20izvje%C5%A1%C4%87a/Godi%C5%A1nj a/Statisticko_izvjesce_JN-2013.pdf

⁶⁴ http://narodne-novine.nn.hr/clanci/sluzbeni/2011_08_90_1919.html

With the adoption of the national Strategy for Fostering Innovation of the Republic of Croatia 2014-2020, innovation has been acknowledged as a national priority. The document recognises the need of using specific procurement procedures to boost development of innovation. However, the Strategy has been adopted only recently (December, 2014), and specific measures enabling the development of public procurement procedures focusing on innovation have not entered into force yet.

3.5.2 Indirect financial support for private R&I

Most of the implemented mechanisms for private R&I funding in place are grant schemes, while the most important indirect financial support is provided in the form of tax breaks, which are mostly used by large R&D companies. Croatian system of tax breaks for R&D is relatively generous system of tax breaks for R&D, as compared to OECD countries, which corresponds to a subsidy of about 35% for US\$1 of R&D, which is right behind France (42% in 2008), as reported by the World Bank (2012b). According to Aralica et al. (2011), Croatian tax incentives are a more generous form of state aid for R&D than subsidies. Available tax incentives are based on the Act on Science and Higher Education (OG 123/03, 198/03, 105/04, 174/04, 02/07, 46/07, 45/09, 63/11, 94/13, 139/13, 101/14, 60/15), which enables deduction against corporate income tax base for eligible expenses related to R&D projects. The deduction depends on the type of research activities: fundamental research 150 %, applied research 125% and developmental projects 100 percent of eligible expenses. Eligible expenses include salaries of researchers, material costs of research activities, costs of services used during research, depreciation of buildings, equipment, patents and licences, as well as general expenses necessary for research activities. Maximum aid intensity cannot exceed 100% of total eligible expenses.

Namely, several large business R&D performers claim tax incentives that exceed the overall public R&D subsidies. Evidence can be found in corporate financial reports. For example, in 2009 subsidies amounted to less than a third of aid granted by the tax incentives. Although over 270 companies used tax incentives, 90% of the total tax incentives have been realised by a small number of companies: 9 in 2008 and 27 in 2009. This indicates that a few companies conduct large research projects and the concentration of tax incentives into a small number of users is present. However, tax incentives prove to be of large assistance to companies and have the effects of additionality (increase the investment of companies in R&D). It is estimated that each forgone HRK generates 1.19 HRK of R&D investments but a significant number of potential beneficiaries do not use it due to concerns about excessive red tape (Aralica et al. 2011). This measure has ended at the end of December 2014 and new legislative framework for R&D tax incentives is being prepared in line with GBER.

3.6 Business R&D

3.6.1 The development in business R&D intensity

As one can see from Figure 7, BERD intensity in Croatia remained low (in the range 0.3-0.4% of the GDP) in the period 2005-2014. It stagnated in the aftermath of the 2008-2009 financial crisis, with some signs of recovery in 2013, followed by a decrease in the next year. The Croatian R&D intensity (GERD as % of GDP) was 0.79% in 2014 (Eurostat data) and BERD amounted to less than the half of it, namely 0.38%.

The BERD expenditure in manufacturing, services and construction accounts for more than 95% of the total BERD in the period under scrutiny. We plot the intensities of the aforementioned sectors, together with the total BERD, in Figure 7.

While the BERD intensity in the services (G-N) sector remained essentially stable in the period 2007-2013, while the manufacturing (C) decreased in 2008-2009 which coincided with the crisis and the economic downturn and then started to recover. Indeed, only in 2013 it reached again the pre-crisis intensity.

Although it is the third sector in terms of R&D intensity in Croatia, the BERD intensity in construction is low and in the range 0.01 to 0.02% of the GDP.

The business sector is the main funder of the Croatian BERD (see Figure 8) and its intensity is indeed strongly correlated to the total BERD intensity. We also notice that, after 2009 the funding from abroad has followed a growing trend (with a small setback in 2014) and in 2014 it amounted to about 18% of the total BERD. The main source of funding within the abroad R&D is the foreign business sector.

The decrease in the intensity of the total BERD in 2014 is mainly due to the decreased direct funding from abroad. Some of the main mechanisms for private R&I funding depend on an World Bank loan under the Science and Technology Project II and ERDF and there was a certain lag in publishing the new calls in 2014 (new programming period).

The Croatian business R&D benefits from a system of tax breaks for R&D that is relatively generous as compared to other OECD countries. Indeed it corresponds to a subsidy of about 35% for US\$1 of R&D, which is right behind France (42% in 2008). According to the evaluation of the R&D tax incentives, they "have increased the number of firms having R&D expenditures, although not necessary the value of expenditures itself"(Aralica et al., 2011).

Despite its generosity, there are estimations that the tax breaks tend to be of little relevance to SMEs and to favour incumbent firms to the detriment of entrants (World Bank, 2012b). Also, several large business R&D performers claim tax incentives that exceed the overall public R&D subsidies. Namely, over 270 companies used tax incentives, 90% of the total tax incentives have been realised by 9 companies in 2008 and 27 companies in 2009 (World Bank, 2015).

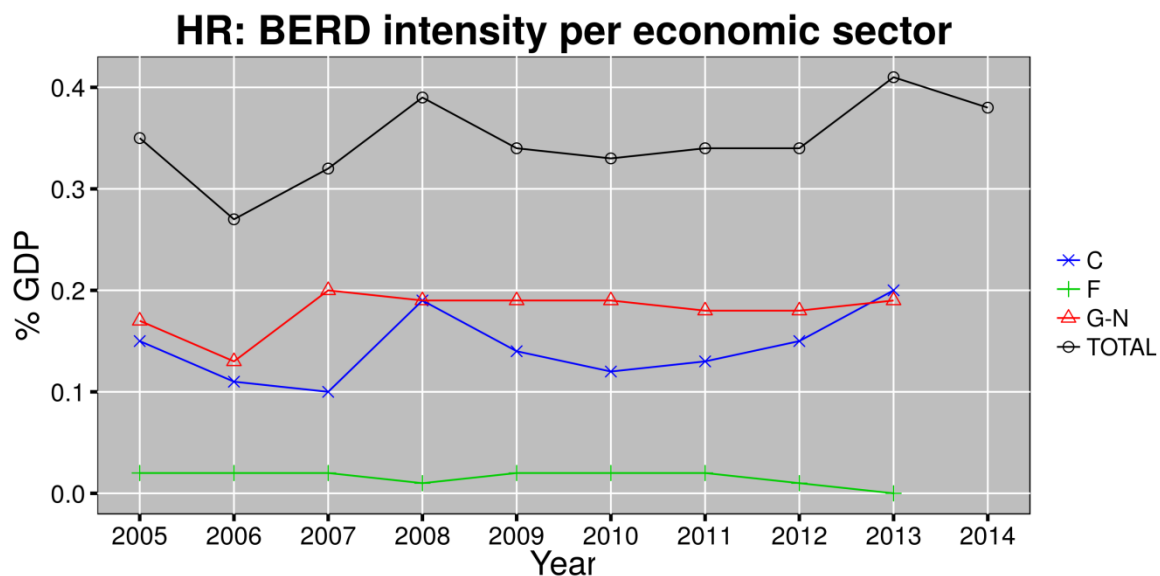


Figure 7 BERD intensity broken down by most important macro sectors (C=Manufacturing, G_N=services, F=Construction).

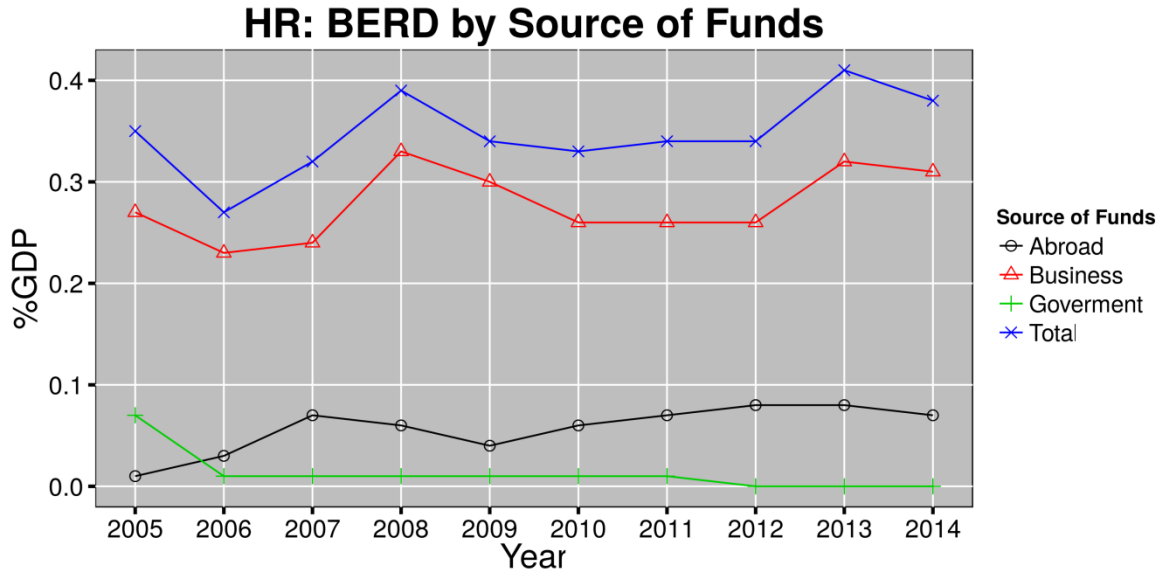


Figure 8 BERD by source of funds

3.6.2 The development in business R&D intensity by sector

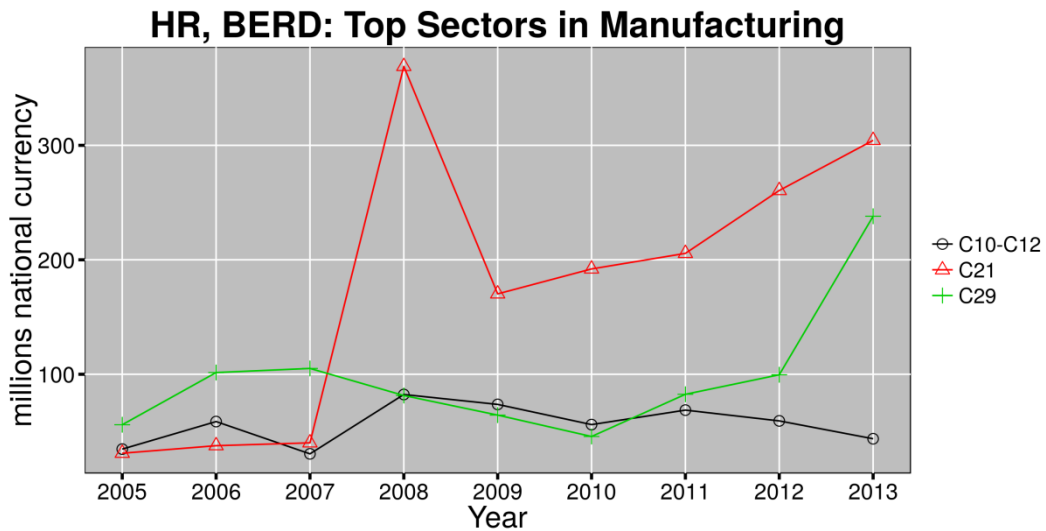


Figure 9 Top sectors in Manufacturing (C10-C12= Manufacture of food products; beverages and tobacco products, C21=Manufacture of basic pharmaceutical products and pharmaceutical preparations, C29= Manufacture of motor vehicles, trailers and semi-trailers).

The most important subsectors for BERD in Manufacturing are (Figure 9): manufacture of food products; beverages and tobacco products, pharmaceuticals and manufacture of motor vehicles, trailers and semi-trailers. We notice a spike in the R&D expenditure in the pharmaceutical sector in 2008. Despite a decrease in the following year, BERD expenditure in the pharma sector has been on the rise from 2009 onwards. We also observe an acceleration of the BERD in the automotive sector from 2010.

The automotive industry in Croatia relies on companies that produce and supply spare parts for the world's top automobile manufacturers (PSA, GM, Fiat, BMW, Audi – Volkswagen Group, Ford, Renault, Toyota, Volvo, etc). Croatia also boasts the production of electric cars XD (DOK-ING and Concept One – Rimac Automobili)⁶⁵. This is probably the main reason for the upward trend in most recent years.

There are a number of private companies operating in the pharmaceutical and food sectors: PLIVA (Teva), GlaxoSmithKline, Hospira, Galapagos Research Center, Teva, ACG Lukaps, Farmal (pharmaceuticals), Podravka, Meggle, Axereal, Coca-Cola, Lactalis (food industry). However, there is no reliable data on the actual R&D spending of these multinational in Croatia. Unlike the pharma sector, the food sector (much less R&D intensive) is in decline after the 2008-9 financial crisis.

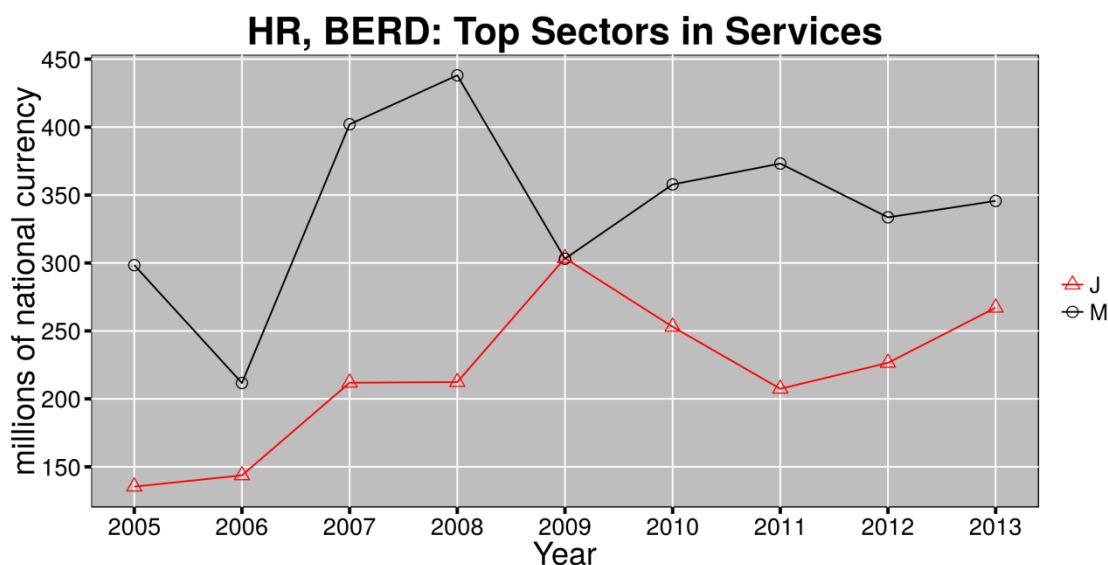


Figure 10 Top service sectors (J=Information and communication, M=Professional, scientific and technical activities).

In the services sector the main contributors to business R&D and its performance are the information and communication services and professional and scientific services (see Figure 10).

The information and communication sector has been increasing its R&D expenditure until 2009 and then started to decline. Croatia has long-standing traditions in the ICT sector, which was in decline in the post-crisis period but started to recover after 2011. International companies operating in the field are Siemens, Ericsson, IBM, SAP, Microsoft, ENVOX. Ericsson Nikola Tesla institute is the largest provider in the region of telecommunication products and services.

The BERD scientific and professional services dipped in 2009, but have partially recovered in the following years.

Employment in C10-12 (food & tobacco sector) and C29 (motor vehicles, trailers and semi-trailers) decreased compared to 2008. Pharmaceutical sector employment followed a fluctuating trend, but slightly increased compared to 2009. In the services, the largest service sector M (Professional, scientific and technical activities) increased the number of workers, whereas the J (Information and communication) shed some workers. However, in terms of the number of scientists and engineers we observe that all three big sectors (Manufacturing, Information and communication and Professional, scientific and technical activities), remained relatively stable throughout the years and managed to attract qualified labour force.

⁶⁵ <http://www.aik-invest.hr/en/sectors/automotive-industry/>

3.7 Assessment

Croatian system of public R&D funding has undergone significant changes since 2013, which introduced new model of institutional funding of PROs and HEIs, based on their performance and evaluation results. In addition, project-based funding has been transferred to CSF, rather than MSES, which resulted in provision of funds to fewer, but more promising, R&D project at Croatian HEIs and PROs. These changes should contribute to more rational allocation of already scarce budgetary resources for R&D. Overall, the implemented structural reforms of the Croatian research and innovation system should influence positively on the balance between project and institutional funding, primarily through increasing the share of project funding and award of funding based on clear and relevant criteria. However, additional decrease of budget resources has been announced for 2016 and 2017, while GBAORD decreased to only 1.3% of government expenditures in 2014.

Business sector has increased its R&D expenditures in Croatia, and for the first time in 2013 has exceeded the share of R&D funding provided by the Government sector. This could be partially contributed to the availability of EU funding for business sector, primarily through the support measures implemented by HAMAG-BICRO. Programmes administered by HAMAG-BICRO (previously BICRO) were ex-post evaluated in 2013 and it was concluded that these had significant impact on development of research and innovation infrastructure in Croatia, as well as on development of research projects and innovation activities of both research organisations and SMEs.

Additional funds for R&I, which should compensate scarce state budget resources, are expected from ESIF. The total funds for the Priority axis one „Strengthening the Economy through Application of Research and Innovation“ of the Operational Programme Competitiveness and Cohesion 2014–2020 (OPCC, 2014) amount to €664.7m. However, absorption of the available EU funding is currently at significantly low levels, primarily due to delays in adoption of Smart Specialisation Strategy (ex-ante conditionality), which could potentially indicate lack of specific experience and preparedness in parts of the system.

Despite the more rational distribution of state resources for public R&D and increased availability of EU funding compared to the previous programming period, current development can be expected to result in further decrease of both funding of R&I activities and performance of the research system. Main reasons for these expectations are additional decrease of budget sources for public R&I funding in 2016 and 2017, as well as delays in design and implementation of the planned measures co-funded from the ERDF. In addition, the implementation of measures envisaged within the Strategy for Fostering Innovation is very slow and unsatisfactory, which also refers to measures which should introduce new modes of innovation funding in Croatia (e.g. public procurement for innovation, innovation vouchers, etc.)

4. Quality of science base and priorities of the European Research Area

4.1 Quality of the science base

Table 7. Bibliometric indicators, measuring the quality of the science base

Indicator	Year	Croatia	EU
Number of publications per thousand of population	2013	1.37	1.43
Share of international co-publications	2013	33.2	36.4
Number of international publications per thousand of population	2013	0.45	0.52
Percentage of publications in the top 10% most cited publications	2014	3.2	11
Share of public-private co-publications	2014	27.4	52.8
Share of public-private co-publications (SciVal)	2011-2013	0.9%	1.8%
Public-private co-publications per million population (SciVal)	2011-2013	38.71	87.07
Public-private co-publications per million population (IUS) **	2011	27.4	52.8

Source: JRC IPTS RIO elaboration on Scopus data collected by Scienmetric in a study for the European Commission DG RTD (Campbell, 2013). The share of public-private co-publications is derived from the Scival platform and is also based on Scopus data (September 2015). SciVal ® is a registered trademark of Elsevier Properties S.A., used under license. The data on public-private co-publications is not fully compatible with the data included in the IUS, due to differences in the methodology and the publication database adopted.

According to the European benchmarking and comparative analyses (EC, 2015a; EC, 2014b; EC, 2015b) the quality of science base in Croatia is estimated as poor and unsatisfactory. By the European innovation scoreboard (EC, 2015a), Croatia is lagging behind the EU average on most key R&I indicators. They mainly refer to the weaknesses of the private sector in research and innovation capacities which include the lack of the innovation-based business, the low number of PCT applications, the low number of researchers in the business sector, the weak effects of research on economy, etc. Croatia performs well in human resources due to new doctoral graduates and youth with upper secondary level education. (EC, 2015a). The Innovation Union progress report (EC, 2014b) perceives additional advantages of R&I capacities in new graduates in science and engineering, well performing in FP funding and in the BERD financed from abroad, the categories in which Croatia performs better or close to the EU average.

The weakest performing dimensions are regularly identified in the lack of "open, excellent and attractive research system" and "intellectual assets". The number of patent applications from Croatia to the EPO according to EUROSTAT was 3.01 per million inhabitants compared to EU average of 113.27 in 2013 that is indeed rather weak. There are various reasons for such weak patenting activities of which a certain lack of research competence is probably not the crucial one. Rather, poor patenting is linked to the country's economic structure with a very small capital goods sector, lack of large manufacturing companies, which typically show high patenting activities and prevalence of the service sectors dominated by tourism which make over 70% of the Croatian service exports (EC, 2014b).

Another issue of the research sector is the low level of research excellence, mainly demonstrated by the weak share of the Croatian scientific publications in the top 10% most cited publications worldwide. In the period 2000-2013, this share was less than 5% of the Croatian scientific publications in comparison with 11.29% of top scientific publications produced in the EU28 (Science Metrix, 2015). In 2014 the share of the Croatian publications in the 10% of the top cited publications decreased to 3.2% against 11% of publications in the EU 28 (EC, 2015a). Although international orientation in publishing is still quite low in Croatia, with 453 publications internationally co-published per million inhabitants Croatia surpassed the average of the EU 28 with 363 such publications (EC, 2015a). The share of public-private co-publications per million inhabitants in Croatia is 27.4 in 2014 against 52.8 for the EU 28 while in the period 2011-2013 the share of Croatia was higher 38.71% against 87.7% for the EU28⁶⁶. However, the overall scientific production is close to the EU average: in 2013, Croatia produced 1.37 publications per thousand inhabitants on average, which is around the EU-28 average (1.43).

The international benchmarks of the efficiency the Croatian science are usually used to justify the necessity of the proposed radical changes to the system (see sections 1.2.2 Governance; 2.2. R&I policy initiatives and 2.3. European Semester 2014 and 2015). However, they do not take into account the national specific circumstances which considerably limit scientific efficiency of which the poor investments in R&I and the availability of human resources (the number of researchers) are the most prominent.

It is well known that total investments in R&D (GERD) in Croatia are among the lowest in the EU (0.79% of GDP in 2014 which is well below of EU average of 2.03% of GDP) with the projections of the further decrees of the State budget 2015-2017 (see section 2.2. R&I policy initiatives). It diminishes the scientific competitiveness and threatens the sustainability of the national science base which is expected to become internationally more competitive and efficient by tapping on the ESIF 2014-2020. Private sector investments in R&I, although slightly exceeded public investments for the first time in 2013 (see section 3.3. Funding flow), are far from sufficient to establish the knowledge-intensive sectors in economy.

The human resources in science are not numerous neither. The number of researchers in Croatia has slightly declined during the last decade (around 8.5%) and oscillates between 6,000 and 7,000 researchers (6,529 researchers in 2013, FTE, but declined in 2014 to 6,117). It accounts for 153 researchers per million inhabitants or 45% of average in the EU-28 (3,396 researchers per million inhabitants). By contrast, the number of researchers in the EU has grown in the same period for 28% from 1.34 million in 2004 to 1.72 million in 2013 and has doubled in some countries like the Czech Republic or Slovenia.

Per capita investment in research in Croatia achieved only around 14% of EU-27 average in 2014 (€558.4 vs. €80 per inhabitant) which points that the lagging of Croatia in R&I is primarily the result of insufficient R&I investments (OPCC, 2014). Despite this scarce resources and modest human resources the Croatian research community keeps the pace in research publishing with the most developed Member States and spends considerably less public resources per publication⁶⁷.

According to the Science Metrix analysis (Campbell, et al., 2013) Croatia scores high on the list of the number of publication for three R&D inputs: investments in HERD, PhD graduates and number of researchers.

⁶⁶ SciVal 2014, Scopus based publication indicators derived from Elsevier's SciVal platform, www.scival.com last accessed August 2015.

⁶⁷ Calculated by simple division of public resources (HERD+GOVERD) with a total number of publications provided by the SCHIMAGO.

Some other informal analyses (Herak, 2012) suggests that Croatian science is more efficient than in many other Member States, if scientific production is related to the factors such as research funds, GDP or number of researchers. Reforms of the scientific system should therefore take into account the local specificities of the scientific system rather than rely only on the international benchmarks with countries whose scientific systems are significantly different from the national one.

In order to improve the R&I system, the national Science and Technology Foresight Project (STF) was drafted during 2014 (NRP, 2015), in order to build the Croatian Research Information System (CroRIS) as an analytical base for systemic analysis of the long-term trends in science and technology (see Section, 2.2.1). According to the Draft of the Smart Specialisation Strategy, the assessment of the national research capacities and projections of the long-term trends in research and technology through STF complements the establishment of the Innovation Network for Industry (INI), creation of Thematic Innovation Platforms (TIPs) and the Centres of Competences (CEKOMs) planned by the National Strategy for Fostering Innovation (see section 2.1). These evidence-based analyses would contribute to the reform of the overall R&I system and its tighter integration with the business sectors under the S3 implementation.

4.2 Optimal transnational co-operation and competition

4.2.1 Joint programming, research agendas and calls

The transnational cooperation programmes which involve the joint programming, research agendas, calls and funding are not developed within the R&I system of Croatia. The Croatian Science Foundation (CSF) which was funding competitive research in Croatia, does not conduct programmes which would include funding of foreign researchers or cross-border flow of grants. The more intensive transnational cooperation is expected within the support of the EU Structural funds which include programmes of transnational cooperation such as INTERREG MEDITERRANEAN 2014–2020⁶⁸. This programme is carried out by 13 Mediterranean countries with a total fund of €265m (ERDF, IPA, national co-funds).

According to the Partnership Agreement (PA, 2014, p. 150) Croatia will be involved in 13 territorial cooperation programmes in the period 2014–2020, under the ESI funds, these are: /1/ Cross border cooperation with Italy, Hungary, Slovenia, Serbia, Bosnia and Herzegovina and Montenegro /2/ Transnational cooperation with the Central Europe, Danube Programme (EUSDR), Adriatic-Ionian Programme (EUSAIR) and Mediterranean, /3/ Interregional cooperation which include ESPON, URBACT, INTERACT and INTERREG EUROPE. These programmes include also different aspects of research and innovation cooperation. The transnational programmes include sharing information, joint research agendas, joint calls, joint programming, etc. Joint evaluation procedures are also envisaged.

The policy action at the national level is mainly focused on the establishing of the National Committee for Coordination of Participation of the Republic of Croatia in Programmes of Transnational and Interregional Cooperation and in the EU macro-regional strategies for 2014-2020 in order to coordinate the transnational and interregional cooperation. The Committee has been established in September 2013 (OG 60/13) and will also decide about the aims and priorities of the transnational programmes and allocation of financial resources allocated to Croatia. The Committee is an advisory body of the Croatian government co-chaired by assistant ministers of regional development and EU funds and European and foreign affairs, while its members are representatives of all the relevant participants (competent ministries, NUTS 2 regions, economic and social partners, civil society).

⁶⁸ <http://interreg-med.eu/en/what-is-the-interreg-med-programme/>

Although transnational cooperation includes research and innovation activities the MSES is not included in the work of the Committee.

Croatia participates in the transnational research programmes that include coordination of research priorities, plans and goals, but does not include cross-border flow of funds. It means that each country finances its own research teams and forms a sort of networking of funding. Such transitional programmers are EUREKA - industry-driven research and innovation projects and COST - one of the longest-running European programmes for transnational cooperation in science and technology. The transnational programmes include participation in the transnational large infrastructural projects like CERN, EMBO, EMBL, ALICE, etc. When comes to the ERA-NET type of projects Croatia participates in several ERA-NET initiatives such as ERACOBUILD, SmartGrids, HERA and ERA-NET ASPERA-2⁶⁹.

According to JRC-IPTS Synthesis report (Doussineau, 2013) Croatia has a share of 1.35% of its GBAORD in a transnationally coordinated way. It does not participate in ESA.

4.2.2 RI roadmaps and ESFRI

The national priorities for future research infrastructure (RI) are provided by the first Croatian Research and Innovation Infrastructure Roadmap 2014-2020⁷⁰ adopted on 1 April 2014 by the MSES. The document consists of the four main parts and three annexes. The first part provides general guidelines for the development of research infrastructure based on the existing national research e-infrastructure and respecting the principles of smart specialisation, new models of cooperation within ERA and the balanced financing of the research and innovation system; the second part provides the principles and criteria in project evaluation of research and innovation infrastructure; the third part identifies the national priorities in developing R&I infrastructure by research fields following the criteria of improving research base and scientific excellence and the fourth part describes participation of Croatia in the pan-European research infrastructure. It also provides three annexes: the plan of investment in RI on an annual basis for the period 2014-2020 (Table 3), the indicative list of research infrastructure project proposals for ESIF 2014-2020 and the list of capital equipment at purchase price higher than €150,000.

The national RI roadmap is also a national ESFRI roadmap. It recognises the importance of involvement in the pan-European research infrastructures and besides membership in DARIAH-ERIC, the document suggests participation in the following: CLARIN – ERIC, C – ERIC, ELIXIR, SHARE – ERI, ESS as well as CERN and ESA. The Roadmap recognises the need to establish the national RI in such a way that its components are organisationally and functionally connected within the local RI and along with ERA and with the preferences of key European policies.

Except for the lack of financial resources, other barriers participation of researchers in transnational networks are not known.

An integral part of the Roadmap is the Indicative list of infrastructures planned to be financed by the ESIF 2014-2020 (see section 2.2. R&I policy initiatives) that includes projects from different STEM fields and major Croatian research institutions.

The Roadmap identifies national priorities in developing R&I infrastructure in the following main research fields: biomedicine, biotechnology, natural sciences, engineering, social sciences and humanities and interdisciplinary sciences.

⁶⁹ <https://www.era-learn.eu/network-information/networks?cid=c497175ecce84f24a4bc910141e6bc25>

⁷⁰ <http://public.mzos.hr/fqs.axd?id=21801> (last access:15 February, 2015)

Coordinating and funding the development and maintenance of the e-infrastructure was conducted by the Croatian Academic and Research Network CARNet and the University Computing Centre – SRCE while Ruđer Bošković Institute made a significant contribution to the data infrastructure. The e-infrastructures are publicly available to researchers free of charge through the public research. The national research and education networks are integrated into the common Pan-European research and education network - GÉANT enabling connection of researchers to other international e-infrastructure components.

Revision of the Croatian Infrastructure Roadmap in compliance with the Smart Specialisation Strategy (S3) priorities started in October 2015 and it is expected to be launched in April 2016. This version will include S3 priorities and sub-priorities and some other prerequisites for strengthening science and technology system e.g. guidelines for participation in international research and technology bodies and networks. Draft of the revised document also includes a list of instruments to be financed from ESI funds e.g. through OPCC 2014-2020 (table 8) but other sources as well e.g. through Second Science and Technology project, Croatian Science Foundation etc.

Table 8 Envisaged national and European resources for RI 2014-2023 from the OPCC 2014-2020, TO 1, Investment priority 1a, in €m

	2016.	2017.	2018.	2019.	2020.	2021.	2022.	2023.
National contribution(€)	2.685.12 2	7.360.46 6	9.528.74 2	10.138.5 69	10.612.8 80	10.883.9 14	10.138.5 69	7.292.70 7
EU funds(€)	10.924.3 10	29.625.6 88	38.298.7 90	40.738.1 01	42.635.3 42	43.719.4 80	40.738.1 01	29.354.6 53

4.3 International cooperation with third countries

R&D cooperation of Croatia with the third countries is rather well developed despite the lack of formal strategies and developing of the multiannual roadmaps. Due to the long tradition of cooperation of Croatia with the third countries, Croatia follows the main recommendation for the implementation of the multiannual roadmaps given by the European Commission (EC, 2012), particularly in the area of common research and innovation projects and softer forms of cooperation such as networking through common societies. However, joint initiatives involving the Union and international partners through the coordinated or joint calls, evaluation and funding, are not in place.

International cooperation in scientific research and education with third countries in Europe, the Far and Middle East (Japan, China, Israel, India, Turkey, Serbia, Switzerland, etc.) and the USA, Canada and Russia is carried out through a number of bilateral agreements with a long tradition, which are coordinated by the MSES⁷¹. For example, an agreement on scientific and technological cooperation with the Republic of China was signed in 1994 while the last call for co-financing Croatian-Chinese scientific research projects for the period 2015-2017 was published in April 2015⁷².

Croatia participates in the Strategic Forum for International S&T Cooperation (SFIC) since signing the Accession Treaty on the 9th December 2011. Croatia is also an active member of the European Research Area and Innovation Committee (ERAC) which established SFIC as the one of its dedicated configurations.

⁷¹ <http://public.mzos.hr/Default.aspx?sec=2026>

⁷² <http://public.mzos.hr/Default.aspx?art=13706&sec=2044>

The most recent involvement in R&D cooperation with the third countries include Croatian participation in the EU Strategy for the Danube Region (EUSDR), the EU Strategy for the Adriatic and Ionian Region (EUSAIR), the South East Europe (SEE) 2020 Strategy adopted on 21 November 2013, and the Western Balkans Regional R&D Strategy for Innovation (WBRIS) for the period 2014-2020 which has been adopted on October 25th 2013. Besides this, the Danube-INCO.NET project started in January 2014 with the aim to support R&I networking and cooperation of the countries in the Danube Region.

All these initiatives are aimed at regional cooperation, which should contribute to the cross-border interoperability of national programme, permit joint financing of innovation, and R&D and tackle grand challenges such as supply of energy, water and food, ageing societies, public health, environmental protection, etc. For example, the Western Balkans Enterprise Development & Innovation Facility (WB EDIF)⁷³ is an international initiative that will contribute to realisation of some of the goals envisaged by the Western Balkans Regional R&D Strategy. Croatia participates in one of the four of these facilities - the Regional innovation fund of the Western Balkan countries (ENIF) - with a total national contribution of around €0.5m per year.

4.4 An open labour market for researchers.

4.4.1 Introduction

Recruitment and career paths of researchers in Croatia are regulated by national legislation at the level of the central state that classifies Croatia as a country with regulated market for researchers (Doussineau, 2013).

Croatia has inherited a rather rigid labour system of researches and implemented since 2010 many reforms to establish more flexible labour in terms of international openness, transparency of procedures and following meritocracy. The employment practices and the system of scientific promotions have also been subjected to reforms to support competitiveness among researchers, relocation among institutions and scientific excellence.

Young researchers are employed on temporary short-term contracts to accomplish their PhD. An employment contract for a post-doctoral position lasts for a maximum of four years after which postdoc must apply for the first-stage permanent scientific position. The transition from post-doc position to the scientific position which provides a permanent job status is increasingly demanding because the number of permanent posts is limited, competition among candidates is growing while selection criteria are tightening. Due to the economic crisis, budget cuts and recent reforms of research sector prevent post-docs to get permanent job position in the public sector which was previously a regular practice for rejuvenation of the scientific community. Senior researchers enjoy the status equivalent of civil servants which implies permanent position and job security. However, they are subjected to the re-election every five years to keep their current job position. A share of researchers with the fixed-term contract in Croatia in 2011 was 45% compared to the EU 28 average of 34.3%. Some other countries reached much higher share, e.g. Germany (53.9%) or Finland (63.1%) (Deloitte, 2014).

⁷³ <http://www.wbedif.eu/about-wb-edif/enterprise-innovation-fund-enif/>

In order to recruit new researchers the state established new programme for young researchers during 2014⁷⁴ (see section 2.2. R&I policy initiatives) which turned out to be insufficient to enable them to access career development. The programme has also not compensated the lack of new teaching staff at universities after the programme for young researchers administered by the MSES was abolished in 2013. On 31 July 2015 the Government announced a new programme⁷⁵ for funding around 1300 position (see section 2.2. R&I policy initiatives) and enable young researcher to compete for them.

The number of researchers in Croatia is rather modest and accounts for 6,117 researchers (FTE, 2014) in total. It makes 153 researchers per million inhabitants or 45% of average in the EU-28 (3,396 researchers per million inhabitants) (see Section 4.1. Quality of the science-base). The share of researchers (FTE) per 1,000 labour force in Croatia is only 4% compared of the EU 28 average of 6.7%, while in Nordic countries this share is around 13-14%. Especially warning is the low number of researchers in the business sector (around 15% of a total) due to the low demand for researchers in the business sector that diminishes the research and technological capacities of the nation economy.

4.4.2 Open, transparent and merit-based recruitment of researchers

A labour market for researchers in Croatia is highly regulated by a number of laws and regulations. The main regulations include the Labour Act (OG 93/14), Acts on Amendments to the Act on Science and Higher Education (OG, 123/03, 198/03, 105/04, 174/04, 02/07, 46/07, 45/09, 63/11, 94/13, 139/13, 101/14, 60/15) and Collective agreements for science and higher education (currently repealed and the new one has not been adopted yet), which determine the general working conditions and researchers' rights and benefits. The regulations which influence hiring of researchers and their career progression by stipulating conditions for promotion into the higher scientific grades and hiring on corresponding job positions include the Ordinance on conditions for scientific titles adopted by NCSHETD (OG 84/05) (with sequential amendments) and decisions of Rectors' Conference on conditions for the acquisition of scientific-educational-teaching positions. Besides, universities or university departments (faculties) and institutions authorised for elections usually determine their internal regulations for electing teachers, scientists and collaborators in scientific titles and corresponding jobs.

The labour market for researchers was partially reformed in 2013 based on the Act on Science and Higher Education due to the separation of scientific titles from job positions and by introduction of the temporary employment contract for researchers. Candidates appointed to scientific job positions at HEIs and PROs conclude an employment contract with the obligation of re-election or promotion every five years. Three months before the expiry of this five-year period, the competition for the same scientific position is announced by the scientific organisation. If another person is selected as a result, the employee who had previously worked in this position will be offered other suitable positions, or, if there are none, will start the process of termination of employment. The division between election in scientific title and corresponding job position significantly reduces the possibilities for rapid academic upward career to the highest scientific grades and, more importantly, it limits the multiplication of jobs in the high-ranks high-wage jobs.

The labour market for researchers is shrinking due to the economic crisis which reduced the number of researchers' post in the public sector and the need for research in the private sector. The measures to attract foreign researchers within and outside the EU existed within the "Brain gain" programme of CSF but was abolished before 2010.

⁷⁴ The Research scholarships for professional development of young researchers and post-doctoral students and the Young Researchers' Career Development Project – Training of Doctoral Students

⁷⁵ <http://drum.hr/vlada-ce-zadržati-mlade-znanstvenike-u-hrvatskoj-i-omogućiti-povratak-onima-koji-su-otisli/>

At present, the UKF programme of CSF has crossing border programme and MSES manages NEWFELPRO programme. Both of these programmes enables foreign researchers to work in Croatia. Also, law proscribes that all calls for recruitment must be publicly announced on Euraxess job portal. But Croatia is still not considered as an attractive destination for development of research careers. The main obstacles are: low international competitiveness or research groups which is of little relevance for foreign researchers, non-accessibility to national research grants, wages which are below the average of the most EU countries and language barriers.

In the area of open, transparent and merit based recruitment (henceforth OTM) Croatia has made a big progress in the last two years by adoption of the Action Plan for Mobility of Researchers 2011-2012, Action Plan for Overcoming Obstacles and Enhancing International Mobility in Education for the Period 2010-2012 and the Action plan to Increase Absorption Capacity for Participation in the Framework Programmes (FP7) of the European Union 2013-2015. The main aim of the first Action plan is to remove obstacles for the international and inter-sectorial mobility, while the second one recommends granting work permit for teachers within LLL programme of the EU. The third Action Plan adopted in February 2011 went a step further and recommends by the Measure 9 granting the scientific jobs for exceptional scientists from abroad regardless their nationality and citizenship.

Temporary employment and residence for hosting third-country researchers in Croatia is regulated by the Ordinance on Determining the Requirements for Granting Temporary Residence to Foreigners for the Purpose of Scientific Research (OG 92/12 and 22/13) which significantly simplified participation of third country researchers in research activities in Croatia compared to other foreign workers.

Foreign researcher is also entitled to apply for permanent position at public research organisations what is enabled by the Ordinance amending the Ordinance on the Register of scientists (Official Gazette 82/2010) which removed the Croatian citizenship as a requirement for entry into the Registry of researchers stipulated by the article 6 of the previous Ordinance (Official Gazette 72/2004).

A foreign candidate should undergo the process of recognition of foreign higher education qualifications by the ENIC/NARIC office by the ASHE if required by the public scientific organisation and a full process of election into a scientific title and corresponding job position described above. Besides, as prescribed by the Rectors' Conference a candidate who was first elected to the academic title and teaching position must have inaugural lecture (habilitation) positively assessed by an expert committee appointed by the institution of the employment. However, foreign researchers are usually employed at the first stage scientific position (assistant professor at universities and research associate at research institutes) even though they have already obtained higher scientific titles abroad. The 2013 Law on Science and Higher Education (Article 32, paragraph 8) partially amended the regulation allowing recognition of scientific title obtained abroad.

The rules towards OTM are mostly defined by the Act on Amendments on the Act on Science and Higher Education adopted by the Government of Republic of Croatia in July 2013. The article 40 stipulates that the procedures on recruitment have to be carried out based on public competition and published in the Official Gazette of the Republic of Croatia, on the organisations' websites and on the official web portal for jobs of the European Research Area (EURAXESS Job portal). The vacancy announcement includes the job profile, skills and competences required, and eligibility criteria. Information on the selection process and criteria is usually available for the candidates. A minimum time period between vacancy publication and deadline for application is 30 days. Applicants have the right to receive feedback on the results.

Procedural details of public competition are prescribed solely by the internal acts of the scientific organisation and are based on a general provision from Article 25 of the Basic Collective Bargain Agreement for Public Servants and Employees. In a case of election to a scientific research grade (regulated by the Act on Science and Higher Education, Article 35) the candidate does not have right to appeal against decision but can initiate an administrative dispute. The institution shall set up the expert committee which will decide about recruitment. The committee consists of three members of which at least one member cannot be an employee of the scientific organisation which carries out the process of recruitment. The composition of the committee is not published and it usually does not include international external members.

Despite Croatia made a great progress towards OTM, some analyses (Technopolis, 2014) state that there is greater room for Croatia (as well as for Italy, Bulgaria, Slovenia etc.) in becoming more open and transparent. The random check of published advertisements in Official Gazette and EURAXESS Jobs Portal showed that Croatian vacancies often ask for national citizenship and/or native speaker level that does not reflect OTM principles. However, a random analysis of research jobs published in the Official Gazette of the Republic of Croatia in the period 1 September to 24 December 2014 carried out by the Agency for Mobility and EU programmes showed the following results: out of 781 published vacancies, only 8% asked for the Croatian citizenship as prerequisite for employment. Regarding Croatian language, in 38.5% of vacancies some level of the Croatian language was required (mostly justified and in accordance with the Anti-Discrimination Act (Official Gazette 85/09, 112/12)).

According to Deloitte analysis (Deloitte, 2014), Croatia and Ireland rank best for the share of jobs posted on the EURAXESS Jobs portal. The share of research posts advertised on the EURAXESS Jobs portal per thousand researchers in the public sector was in Croatia 110.4% in 2013 compared to the average of the EU 28 of 43.7%. It was for Croatia an increase of 435%. In 2015 Croatia's research organisations announced 2 763 vacancies for research position. In 2014 the number of vacancies was 1 880. In comparison that is the increase of announced vacancies of 47% (46.9%).

The inward and outward mobility of researchers in Croatia is rather weak due to traditional closeness of the Croatian scientific community. According to the Deloitte report (Deloitte, 2014), researchers in Croatia, as well in some other new member states like Latvia, Romania or Czech Republic, were the least mobile in the EU. In 2012, less than 20% of researchers in the post-PhD phase in Croatia had spent a period of at least three months as researchers in another country over the last 10 years, while the average in EU was above 30%. Slightly less than 70% has never been mobile comparing to around 50% of such researchers in the EU in average. The main reasons for low inward mobility are low wages and working conditions in comparison to the EU. The main motives for outward mobility is a lack of permanent positions for young researchers and poor working conditions in terms of research equipment, career progression and research grants.

During the five years of economic crisis Croatia has lost around 170,000 jobs. High unemployment is combined with the high level of youth unemployment. While the total unemployment remained stable between 2013 and 2014, the youth unemployment has increased from 34% in 2013 to 45.5% (Eurostat, 2015). However, youth unemployment rates were particularly high also in Spain (53.2%), Greece (52.4%) and Italy (42.7%)⁷⁶. A share of unemployed persons with higher educational level in Croatia is around 12% of the total number of unemployed, which indicates a strong need for reforms not only of labour market, but also in the higher education sector. The labour market for researchers is shrinking due to the economic crisis, while the higher education system does not contribute to reductions in skills mismatch.

⁷⁶ http://ec.europa.eu/eurostat/statistics-explained/index.php/Unemployment_statistics (last access:8.1.2016).

It is difficult to assess how many researchers have left Croatia due to lack of jobs, poor working conditions and reduction in wages during the crisis. The position of young researchers (post-docs) related to permanent job contracts have worsened due to the budget cuts and economic crisis (see Section 4.4.1) which harms their job and social security.

4.4.3 Access to and portability of grants

Publicly funded grants or fellowships in Croatia are not portable to other EU countries. The national legislation or government measures do not address the issue of access to and portability of grants. The rules on portability within the transitional and regional cooperation programmes in the period 2014–2020 under the ESI funds are not fully outlined. Only the programme Unity through Knowledge Fund focused on international cooperation with the Croatian scientific Diaspora allows accessibility of the programme's funds to researchers from foreign institutions if the researchers from Diaspora are also engaged. Foreign researchers are welcome to participate in the "national" projects funded by the CSF but these funds do not cover fee for researchers what is an important obstacle for the involvement of foreigners in project realisation.

4.4.4 Doctoral training

Organisation of doctoral studies in Croatia is completely autonomous. A doctoral study can be founded by public or private higher education institution in scientific/artistic areas in which the institution responsible for the study is internationally recognised. Establishment of a study programme begins with an initial accreditation conducted by the public higher education institution. In case of a private institution, establishment of the study programme begins with the initial accreditation conducted by the Agency for Science and Higher Education (ASHE) in accordance with the respective regulations⁷⁷ and the "Procedures of initial accreditation of study programs" adopted by the ASHE in December 2010. It begins by receiving a request to perform a new study programme submitted to the Ministry of Science, Education and Sports (MSES). The request should contain a detailed elaboration of the proposed doctoral study programme in accordance to the Act on Science and Higher Education and the Instructions for assembling the study programme. The proposal is evaluated by the Expert Committee appointed by the National Council of Science, Higher Education and Technology assisted by the ASHE. The process of initial accreditation, when forwarded to the Agency, includes evaluation and a visit by external experts, and they produce a final report. The final report shall be adopted by the Accreditation Council of the Agency, and the Agency then sends a final recommendation to the Minister, who shall issue the license. It should be noted that so far neither one doctoral study has been established at private HEI in Croatia.

Each public university adopts its internal rules on the process of initial accreditation, setting up and implementation of the doctoral study programmes in accordance with the national regulations.

Doctoral studies in Croatia can take several forms. The most common is the one for which doctoral study is implemented by the one constituent part or the University which is responsible for it. Other forms include dual doctorate, collaborative study programme, joint study programme, etc. The Doctoral study council, whose composing is determined by the institution(s) responsible for the study, manage the programme in accordance with the regulations issued by the Senate of the University.

Some of the formats of work in a doctoral study programme are research seminars, workshops and discussion groups, designed for the purpose of developing research work, critical thinking, acquisition of methodology and acquisition of generic skills.

⁷⁷ Quality Assurance in Science and Higher Education (Official Gazette, 45/2009) and the Ordinance on the content of license and conditions issuing license to perform activities of higher education, implementation of study programs and re-accreditation of higher education institutions (Official Gazette, 24/2010)

Enrolment quotas are determined on the basis of availability of research, teaching and mentorship capacities, according to the interest of candidates. Full time doctoral study takes as a rule three years, and it can be extended to five years if there are justified grounds, which is determined by the Doctoral study council. Part time doctoral study takes in principle five years, and it can be extended to seven years.

A doctoral candidate receives a mentor to supervise and direct the research work. The mentor as well as the candidate is required to submit an annual report on the work of the doctoral candidate/mentorship to the Doctoral study council.

Funding of the doctoral students can be provided by the state (only for research assistant or teaching assistant), Croatian or international scholarship, legal person of his/her employer or a doctoral candidate may pay for the study costs by himself/herself.

The doctoral candidate initiates the procedure of doctoral dissertation topic by submitting a request to a committee appointed by the responsible institution that includes three or five members. The proposed topics should be defended publicly before the evaluation of dissertation.

The special measures addressing the Innovative Doctoral Training (IDT) are not carried out in Croatia. However, the main principles of IDT (research excellence, attractive institutional environment, exposure to industry, international networking, transferable skills training and quality assurance) are an integral part of the elaboration submitted to the MSES for establishing the study programmes. It has to be said that only private HEI has to undergo the process of initial evaluation. Public universities can and they do establish study programmes in accordance to their internal procedures which are different on different universities. They are not obliged to undergo the evaluation at national level. The principles of IDT are also integrated in the regulations for initial accreditation (evaluation) (only private HEI) and re-accreditation of the study programmes as a part of the quality assurance system of HEIs and PROs in Croatia. All HEI, private and public, have to be re-evaluated. The evaluation should pay special attention to the relevance of the proposed doctoral study with regard to the promotion of social and economic development, needs of private sector and employment opportunities; the merits of the proposed doctoral study on competitive scientific research, and to new ideas, knowledge and skills; innovativeness, i.e. the ability of the proposed doctoral studies for the creation of new and relevant knowledge or artistic practices; previous experience, international recognition and comparability with similar doctoral programmes in foreign countries.

In order to improve the system of evaluation of the doctoral study programmes and to get high-quality and extensive information about the programmes for policy makers and strategic planning, the AHSE has carried out the thematic evaluation of the all 125 doctoral study programmes in Croatia (ASHE, 2014) with the main conclusion that many study programmes do not meet the criteria of innovative doctoral training. The evaluation exercise suggests a need for an urgent and fundamental reform of doctoral studies, which will cover all universities.

The University of Zagreb initiated a project in the period 2013-2015 to provide Croatian universities with the human resources programmes for sustainable skills development. The project was called Modernising Doctoral Education through Implementation of CROQF (Croatian Qualification Framework) (MODOC, 2015). The project created the conditions for improving the professional and personal competencies of doctoral students in accordance with the new labor market requirements and standards of the Croatian Qualifications In 2016 the ASHE will begin re-accreditation of doctoral studies, and plans to evaluate all of the studies by the end of 2017.

The four basic standards of evaluation are scientific facilities, internal quality assurance appropriate to the doctoral level, monitoring the progress of doctoral programme and doctoral studies in compliance with the Croatian Qualifications Framework and good international practice. A study within the project on personal and professional competencies of current doctoral students and on Croatian employers' expectations of doctoral graduates and their competencies were used to carry out the Guidelines for Enhancement of Doctoral Candidates' Professional and Personal Competences.

4.4.5 Gender equality and gender mainstreaming in research

The main policies that promote the equal treatment for men and women in science -were formulated in the framework documents – the National policy for the promotion of gender equality 2006-2010⁷⁸ and the Gender Equality Act passed in July 2008⁷⁹. It means that there is no specific parliamentary law addressing equality in research but the governmental actions or research councils' decisions tackle the issue of gender representation in decision making committees, focussing specifically on scientific recruitment and evaluation (Doussineau, et al., 2013). The specific measures encouraging cultural and institutional change on gender are not common. However, the Action plan Science in Society⁸⁰ indicates the gender inequalities in research system such as professional lag of women researchers in scientific progress, awards and prizes, poor representation of women in the leading organisational and political functions and reduced availability of research funds for women. It therefore proposes two measures: first, balancing the gender composition of researchers in the management structures (min. 1/3 of women in the national councils, regional councils, councils, scientific and political bodies), and second, establishing the programmes for stimulation female scientists. Since 2007, the Croatian UNESCO Committee, the Ministry of Culture and L'Oreal Adria have handed out yearly awards "For Women in Science", in an effort to raise awareness of excellent young female scientists and reward them for their contribution. The announcement for a competition for a scholarship in the amount of € 5,000 (in HRK equivalent) was opened till December 2015.

The only research funding agency which sets up research agendas is the CSF. These research agendas are set up very broadly by the main scientific disciplines and allows integration of research in gender without restriction within relevant scientific field.

Regarding access to education and research occupation no gender gap has been recorded. There are slightly more women with high education in total population than men (16.7% of women compared to 16% of men). With 50% women employed in the research and development sector, Croatia made significant progress in reaching gender parity. In 2013 there were 9,787.6 persons in full- and part-time employment engaged in R&D-related jobs expressed in full-time equivalent, out of which 50.8% were women. The share of women among researchers was 50.10%; women dominate in the Biomedicine and health and Social sciences. The share of women in the new doctors of sciences in 2014 was 42.9% and in masters of sciences 62% (CBS, 2015).

Male and female students are equally represented at all levels of education. However, women do prevail in the total number of students who enrol at universities (with 56.8% in 2103), as well as in the total number of students who graduate (with 58.9%). This is a big progress compared to 1960-ties when the share of women in both enrolled and graduate students was about 33% (CBS, 2015). It is important to add here that 52% of doctorates of science degrees (PhD) are held by women. This increasing trend of highly educated women has been continuous for the last forty years. If this development continues, significant changes in the labour market-for the benefit of women can be expected.

⁷⁸ http://www.lda-sisak.hr/uploads/lda-sisak/dokumenti/national_policy_gender_equality.pdf

⁷⁹ <http://digured.srce.hr/arhiva/263/33321/www.nn.hr/clanci/sluzbeno/2008/2663.htm>

⁸⁰ <http://web.efzg.hr/dok/UMS/Akcijiski%20plan%20Znanost%20i%20drustvo%20-%20final.pdf>

The fastest growth of female participation in the research sector has occurred in the business sector where they account for around 40% in 2013. In the public research sector women prevail, representing 52% in total employment. Turning to higher education, with 48.7% of the total number of academic staff being women, Croatia nearly reached equal representation. However, female representation at the full professor rank is lower (around 32%) and increases from the rank of lecturers and assistants where women make up 57% (CBS, 2015). In higher education institutions only 14% of women hold rector, and 17% dean positions. Despite this, the number of women holding leading positions in public research institutes is notably better, where 40% of directors are women.

According to Deloitte analysis (Deloitte, 2014) the ratio of women in top-level positions of the academic hierarchy (grade A) between 2007 and 2010 increased in nearly every MS but unevenly. The proportion of women in top research positions was highest in Romania (35.6%), followed by Latvia (32.1%), Turkey (28.1%), Croatia (26.4%), Switzerland (25.9%) and Bulgaria (25.9). By contrast, the average percentage of women academic Grade A staff in the EU increased from 18.7% to 19.8%.

Nevertheless, the choice of occupation for many women in Croatia is still influenced by traditional gender roles. For instance, among university graduates, women are still underrepresented in the field of computer sciences (16.2%) and engineering (20.4%), although data shows a slow, but growing trend in this area.

4.5 Optimal circulation and Open Access to scientific knowledge

4.5.1 e-Infrastructures and researchers' electronic identity

National measures related to the development and provision of e-infrastructures are performed by the University Computing Centre⁸¹ (SRCE). It was founded in 1971 as one of the key subjects in planning, designing and maintenance of the e-infrastructures at the national level. SRCE is today the main computing centre and the architect of e-infrastructure, covering the whole Croatian research and higher education system.

In order to develop and provide digital research services the Croatian Academic and Research Network⁸² (CARNet), a network of Croatian academic, education (all level) and research community, was established by the Croatian government in 1995. It provides more than 60 different services for the academic community such as e-library, electronic identity, e-mail, e-learning, etc. CARNet and SRCE coordinate and implement government measures and activities related to research e-infrastructures and e-services in cooperation with other public research institutions (such as the National and University Library). The private partners usually are not involved in these activities.

The main requirements needed to be fulfilled in order to ensure development and the sustainability of the national research e-infrastructure are provided by the Croatian Research Infrastructure Roadmap 2014-2020⁸³. The following requirements, among others, include: adequate network of common high-reliability data centres, systems for cloud computing, including those using the grid paradigm, cloud computing services, high performance computing resources, use and expansion of the existing authentication and authorization infrastructure AAI@EduHr, establishment of the institutional digital repositories and promotion of open access to research data. Revision of the Croatian Infrastructure Roadmap in compliance with the Smart Specialisation Strategy (S3) priorities started in October 2015 and it is expected to be launched in April 2016.

⁸¹ <http://www.srce.unizg.hr/en/> (last access:15 February, 2015)

⁸² <http://www.carnet.hr/> (last access: 16 February, 2015)

⁸³ <http://public.mzos.hr/fqs.axd?id=21801> (last access:15 February, 2015)

This version is expected to include S3 priorities and sub-priorities and some other prerequisites for strengthening science and technology system e.g. guidelines for participation in international research and technology bodies and networks. Draft of the revised document also includes a list of instruments to be financed from ESI funds e.g. through OPCC 2014-2020 (table 8) but other sources as well e.g. through Second Science and Technology project, Croatian Science Foundation etc.

The implementation, maintenance and development of digital archives and data services are of significant importance for SRCE, together with supporting the open access initiative. Several digital archives were implemented by SRCE alone or in partnerships, such as: Portal of Croatian scientific journals (Hrčak⁸⁴), Croatian repositories and archives aggregator (Ara⁸⁵) and the Croatian web archive (HAW⁸⁶).

In 2015 SRCE has built a national digital repositories infrastructure Digital Academic Archives and Repositories (DABAR⁸⁷). This infrastructure enables institutions to build their own repositories ensuring easy-to-use, secure, sustainable and reliable service enabling at the same time content aggregation and creation of virtual collections in order to build national and subject-based repositories. The DABAR was released on 17 August 2015, and the first content that supports are electronic theses and dissertations. More than 80 institutions from higher education and research system established their institutional repositories on DABAR platform. Also National and University Library in Zagreb established two national repositories on DABAR: Electronic dissertations repository (DR⁸⁸) and Electronic theses repository (ZIR⁸⁹).

The NSK, in collaboration with SRCE and several faculty libraries develop the Croatian ETD program as a part of DABAR: Croatian e-theses repository which gathers, permanently stores and allows open access to digital versions of students' M.A. and B.A. theses, the Croatian e-dissertations repository which gathers, permanently stores and allows open access to digital or digitised versions of dissertations and scientific master' thesis. NSK established an infrastructure for assigning and managing URN:NBN – unique identifiers for digital objects. The namespace used by NSK for Croatian digital objects is "urn:nbn:hr".

In the near future, a significant part of SRCE's activities will be related to the implementation of the Croatian scientific and educational cloud (HR-ZOO). HR-ZOO project will establish new broadband backbone of the national academic network connecting computing sites in four major university towns in the Republic of Croatia (Osijek, Rijeka, Split and Zagreb). HR-ZOO is recognized as an important prerequisite for the development of the Croatian research and higher education area, as well as a common infrastructure for the needs of modern science and education and internationally relevant research, but also as an instrument of integration into the ERA and the EHEA. Project entered the indicative list of MSES projects which may be financed through ERDF under Croatia Croatia's Operational Programme Competitiveness and Cohesion Operational Programme 2014 – 2020 (investment Priority 1.1)).

The authentication and authorization infrastructure of the Croatian research and education community is developed within the AAI@EduHr⁹⁰ project in 2006 carried out and maintained by SRCE. AAI@EduHr today covers complete Croatian research and education community with 229 identity providers with over 830.000 electronic identities and over 510 services that utilise those identities⁹¹.

⁸⁴ <http://hrcak.srce.hr/> (last access: 16 September, 2015)

⁸⁵ <http://ara.srce.hr/> (last access: 25 September, 2015)

⁸⁶ <http://haw.nsk.hr/en> (last access: 27 September, 2015)

⁸⁷ <http://www.srce.unizg.hr/dabar/http://www.srce.unizg.hr/en/dabar/> (last access: 27 September, 2015)

⁸⁸ <https://dr.nsk.hr/en/> (last access: 11 March, 2016)

⁸⁹ <https://zir.nsk.hr/en/> (last access: 11 March, 2016)

⁹⁰ <http://www.aaiedu.hr/> (last access: 15 February, 2015)

⁹¹ <http://www.aaiedu.hr/statistika-i-stanje-sustava>

It provides a uniform, reliable, easy to use and secure access to network and networked resources. AAI@EduHr is opened for international cooperation and cross-federation connections. Furthermore, any organisation providing services to the target community might join AAI@EduHr as a partner service provider.

The concept, structure, organisation model of the AI@EduHr are defined by the Regulations on the organisation of authentication and authorization infrastructure of science and higher education in Croatia - AAI@EduHr⁹². The Regulations also define the obligations of all subjects involved in the infrastructure as well as the operational procedures. AAI@EduHr is an official member of the inter-federation platform eduGAIN⁹³ which intends to link services and users worldwide. The eduGAIN service enables the trustworthy exchange of information related to identity, authentication and authorisation between the GÉANT (GN4) Partners' federations. AAI@EduHr is also a member of the global roaming service eduroam⁹⁴ which secures world-wide roaming access service developed for the international research and education community. The eduroam allows students, researchers and staff from participating institutions to obtain Internet connectivity across campus and when visiting other participating institutions by simply opening their laptop.

In 2003, Croatia adopted the Act on Personal Data Protection (Official Gazette, 106/2012) which regulates collecting, processing and use of personal data in Croatia in order to protect the personal data, the privacy of individuals, as well as other human rights and fundamental freedoms. The Act closely tracks the principles of the EU Data Protection Directive 95/46/EC in order to be aligned with the *acquis communautaire* and was subsequently amended in 2006, 2008 and 2011. For example, international data transfers outside of Croatia are only allowed when an adequate level of protection of personal data is ensured (unless derogation applies). Additionally, the Act requires data controllers to maintain records of their processing activities, which must be submitted to the Personal Data Protection Agency for compilation in a Central Register.

In addition, Croatia has enacted several specific laws and regulations. For example, the Electronic Communications Act (Official Gazette 71/2014) implements the e-Privacy Directive 2002/58/EC, as amended by Directive 2009/136/EC, and the Regulation on the Procedure for Storage and Special Measures Relating to the Technical Protection of Special Categories of Personal Data sets forth detailed information security measures. The Croatian Personal Data Protection Agency monitors compliance with the Act on Personal Data Protection.

Besides the standard services to citizens and scientists like technical support to public data collections and repositories SRCE also provides the Cloud Virtual Private Server (VPS⁹⁵) (virtual machines for academic and research institutions) and Virtual Computing Lab (VCL⁹⁶) (reserve virtual machines or laboratories with predefined or custom sets of applications and remotely access it over the Internet). SRCE has established the Croatian National Grid Infrastructure - CRO NGI⁹⁷ as a distributed computer environment which is accessible for the purpose of any scientific or research projects that is wholly or partially funded from the state budget. Besides, the most notable is the computer cluster "Isabella" founded in 2002.

⁹² http://www.aaiedu.hr/sites/default/files/content_files/docs/AAI%40EduHr-pravilnik-ver1.3.1.pdf

⁹³ <http://www.geant.net/service/eduGAIN/Pages/home.aspx> (last access: 15 February, 2015)

⁹⁴ http://www.eduroam.hr/?locale=en_EN (last access: 15 February, 2015)

⁹⁵ <http://www.srce.unizg.hr/vps/> (last access: 29 September, 2015)

⁹⁶ <http://www.srce.unizg.hr/vcl/> (last access: 29 September, 2015)

⁹⁷ <http://www.cro-ngi.hr/> (last access: 15 February, 2015)

The "Isabella" is a shared resource of all Croatian scientists which allows the use of important computer possibilities when dealing with difficult data processing as part of scientific-research projects. The "Isabella" is currently being used by 207 scientists from 66 projects⁹⁸. CRO NGI is connected with the biggest world grid project EGI (European Grid Initiative), meaning that users have access to EGI resources as well.

Croatia participates in the MERIL project⁹⁹ (Mapping of the European Research Infrastructure Landscape) which provides through the MERIL portal an inventory of the most excellent research infrastructures (RIs) in Europe. The five infrastructures from Croatia are included: Cloud Infrastructure Services (IaaS): Virtual Computing Lab/Virtual Private Servers, Croatian National Grid Infrastructure, Data Infrastructure Services, Institute of Oceanography and Fisheries, and Isabella Cluster.

4.5.2 Open Access to publications and data

National policies on access and preservation of scientific information (both publications and data) are under the responsibility of the Ministry of Science, Education and Sports. The Ministry strongly supports the open access to scientific information to provide maximum impact from the research they support by ensuring the widespread accessibility. Although there is no special policy of mandate at the national level (Science Metrix, 2014), the Ministry supported the establishment of the Croatian scientific portal,¹⁰⁰ a project that marked the beginning of open access in Croatia in 2006 carried out by the Library of the Rudjer Boskovic Institute and SRCE. The Portal combines, in one place, all information about Croatian scientists, their papers, research projects, Croatian journals and scientific instruments. The portal has grown into an indispensable source of relevant information about science and it generated more than 20.000 visits per day on average. The Portal provides several information services which allow open access to all scientific information resulted from public funding research, as follows: the Croatian scientific bibliography – CROSBİ,¹⁰¹ the Croatian scientific journals portal – HRČAK (eng. HAMSTER)¹⁰², the Who's who in Croatian science¹⁰³ and the Registry of the large scientific equipment at HEIs and PROs –Šestar (eng. Caliper).¹⁰⁴

CROSBİ is the digital repository which has been collecting bibliographic data of the publications written by Croatian researchers since 1996. The repository currently has over 482,971 bibliographic records¹⁰⁵ with an average of 20.000 records per year. CROSBİ serves also as a central open access (OA) repository for more than 5.000 publications which are archived by the authors themselves. It allows immediate deposit of publications in the national journals.

HRČAK was released in the year 2006 and offers access to 408 digital versions of the Croatian scientific and professional journals, which follow the initiative of Open Access and support meta-data exchange according to OAI PMH Protocol (Protocol for Metadata Harvesting). OA publishers have, thanks to the HRČAK, a high quality platform for publishing their journals while researchers have the access to the full-text database of scientific publications, published in the Croatian journals. HRČAK has more than 36.000 visits per day on average and currently holds more than 139.000 articles with full-text which are regularly downloaded by other thematic and interdisciplinary OA repositories and metadata aggregators (OpenAIRE, OALster, Base, Google Scholar and Scopus).

⁹⁸ <http://www.srce.unizg.hr/isabella/projekti-i-korisnici/>

⁹⁹ <http://portal.meril.eu/converis-esf/publicweb/startpage?lang=1> (last access:15 February, 2015)

¹⁰⁰ http://www.znanstvenici.hr/index_en.php (last access: 15 February, 2015)

¹⁰¹ <http://bib.irb.hr/index.html?lang=EN> (last access: 15 February, 2015)

¹⁰² <http://hrcak.srce.hr/> (last access: 5 February, 2015)

¹⁰³ <https://tkojetko.irb.hr/en/>

¹⁰⁴ <http://sestar.irb.hr/> (last access: 15 February, 2015)

¹⁰⁵ https://bib.irb.hr/skupni_podaci

Due to the CROSBİ and HRČAK which offer full-text databases prior or in time of publishing (authors' uploading), the Croatian model is the closest to the "Immediate Deposit/Optional Access model" of open access.

Who's Who in Science in Croatia unifies in one place structured data about more than 6.000 Croatian scientists and provides links to the CROSBİ bibliographic data. The main goal of the project is to promote Croatian scientists in the country and abroad, and to improve communication and information exchange between scientists themselves.

An examination of OA availability (Science Metrix, 2014a) revealed that Croatia is among four EU28 countries which have reached an aggregate availability score above 70% together with the Netherlands, Estonia, and Portugal. However, Croatia is one of the member states with the least proportion of green OA (5.2%) while the proportion of Gold OA journal is rather high (23%) and other OA is 38.9%. The higher proportion of green papers in Croatia is in the field of Physics & Astronomy (44%), ICT (6%) and Mathematics & Statistics (6%). The higher proportion of gold papers is in Philosophy and Theology (95%), in General Science and Technology (74%), Physiology and Cognitive Sciences (57%) and Economic and Business (55%).

5. Framework conditions for R&I and Science-Business cooperation

5.1 General policy environment for business

Success of the economic activity highly depends on the rules that encourage firm start-up and growth and avoid creating distortions in the marketplace. Accordingly, this chapter will analyse which national regulations support or discourage entrepreneurial activity in Croatia. According to the last World Bank *Doing Business* 2015 report, of altogether 189 countries, Croatia's rank is 65, which represents an improvement in comparison to 2014 results (rank: 67). The foremost progress was achieved in the area of construction permits issuance, since the number of applications decreased and fees for construction permits and final construction inspection declined. This is a result of the new legal framework in the area of construction, spatial planning, and construction inspection, which came into force on January 1, 2014. Amendments now recognise circumstances where no location permit issuance is necessary, the procedure of proving legal interest has been simplified, IT system for location information has been developed, and electronic system for construction permits has been introduced. With regards to start-ups, public notary fees decreased, which facilitates the process of company registration. Another mitigating circumstance which improves business environment in Croatia is a new electronic system for customs clearance, which includes electronic system for cargo handling in ports and digitalized risk analysis. Other specific improvements include less administrative barriers, e.g. start-ups are no more obliged to publish their establishment in the national official gazette, layoff and hiring procedures are simplified, as well as the restructuring procedure for firms in (pre)bankruptcy stage, flexible organisation of working hours will be possible, as well as flexible schemes of employment, etc. Specifically, restructuring procedures will be changed in terms of shorter and simplified procedure of the redundancy program, accelerated notice period which accounts during holidays or paid leaves. The most aggravating circumstances for doing business include paying taxes (higher contribution rates for health insurance and more complicated file tax returns) and getting credit for business undertakings.

With regards to resolving insolvency, Croatia holds the same rank as in 2014 (56th place). Its main instrument for supporting the financial reorganisation of enterprises is the pre-bankruptcy settlement. In 2012, Croatian Government adopted the Act on Financial operations and Pre-Bankruptcy Settlements. The Act regulates financial operations of undertakings, terms of fulfilment of financial obligations and legal consequences of delays, process of pre-bankruptcy settlements, financial control of companies and legal persons with public authorities and other issues. Under this Act, business undertakings as debtors are granted the possibility to request commencement of pre-bankruptcy settlement proceedings in order to avoid regular bankruptcy proceedings and to get the possibility to ensure a going concern of the business. Therefore, there are some measures supporting the financial reorganisation of enterprises. However, there are almost no possibilities for SMEs to reprogram their debts towards the Tax Administration, which usually lead to account blocking, regardless of the size of the debt. Tax debts can be paid in instalments, from 2 to 60 months, depending on the amount of the tax debt, with a possibility to write-off the interest rate debt. With regards to the history of doing business, pre-bankruptcy settlement is not possible if previously concluded pre-bankruptcy settlement is still in force, or if a two year period from the fulfilment of obligations from previous pre-bankruptcy settlement did not pass.

5.2 Young innovative companies and start-ups

Although Croatia missed the early waves of investment in Central and Eastern Europe, the Government has been working to improve investment climate with macroeconomic stabilisation measures. From the microeconomic perspective, micro, small and medium sized enterprises represent over 99.7% of all enterprises in Croatia and a supporting pillar for the Croatian Economy. In 2013, SMEs achieved a share of 52% of total income, 68% of employment and 48.2% of Croatian exports. Key developmental problems related to Croatian SMEs include insufficient level of new business venture start-up activity, small share of growing enterprises, limiting administrative barriers to implementation of entrepreneurial activity, insufficient development of the financial market, and lack of education focused on the development of entrepreneurial knowledge and skills. (CEPOR, 2015)

SMEs invest very scarce resources in research and development, and only 1/3 of Croatian SMEs is focused on innovations. The Act on Supporting Investments and Improving Investment Climate (OG 111/12, 28/13), as well as the Strategy for Entrepreneurial Development of the Republic of Croatia for the period 2013 - 2020 have improved these statistics by encouraging SMEs' investment in R&D&I based on available financing schemes, entrepreneurial network, and positive entrepreneurial climate. Public policy instruments designed to provide support to young innovative companies include grant schemes, loan guarantees programs, interest rate subsidy programs, and funds of economic cooperation. The legislative framework is harmonized with EU acquis communautaire in terms of state regional supports for investment, however sufficiently attractive and competitive in comparison to other EU national legislative frameworks focused on supporting direct investments. In two years period (2012 - 2014), it resulted in the increase of applications for investment supporting measures: 144 applications in 2013 and 94 applications in 2014, in comparison to approximately 40 applications per year during the previous legislative framework¹⁰⁶.

Through "Business Impulse" programme the Ministry of Entrepreneurship and Crafts supports entrepreneurial growth and development, technological improvement, competitiveness, balanced regional development and smart use of EU financial funds. The program emphasizes instruments which support start-ups, new employment, internationalization of business, which is expected to encourage SMEs entrepreneurial, innovative and exporting capacity. As part of the Program's first priority - Strengthening competitiveness of small economy - measure B2 was intended for innovations in entrepreneurship. The objective was to increase the share of innovative companies in the overall entrepreneurial community, to support employment in innovative enterprises, to support innovative business models in business entities, to improve commercialisation of innovative products and services, as well as to improve the survival rate of start-ups focused on knowledge creation, making them a going concern companies. The measure provided an opportunity for physical entities (prior to the establishment of a legal entity) to apply for support an innovative business idea with a high market potential, which acquired a positive opinion from an entrepreneurial supporting institution, science and research institutions or other competent body related to the field in subject. According to the Ministry of Entrepreneurship and Crafts data (MoE, 2015) In 2014 altogether €826 thousands were allocated to innovative entrepreneurs. Average intensity of support was 71.64%.

¹⁰⁶

<http://www.minpo.hr/UserDocImages/PRESS%20Ministar/19022015%20Poduzetnicki%20Impuls/PODUZETNI%C4%8CKI%20IMPULS%20-%202015.pdf> (p. 22)

In order to facilitate establishment of innovative companies, the Program's second priority was to improve entrepreneurial climate through providing support for entrepreneurial supporting institutions (i.e. technology parks, business incubators, entrepreneurial accelerators), development agencies, entrepreneurial centres and initiatives related to the internationalization of business.

Business Impulse also includes measures dealing with education for entrepreneurship, in order to improve key competences among future entrepreneurs, to support entrepreneurial climate in the society, to develop positive attitude towards the concept of lifelong learning, and to increase the rate of self-employment through entrepreneurship.

Apart from grants, the Program's financial support schemes include micro-crediting, intended for young companies which are doing business up to 24 months (in 2014 46 micro loans were allocated, worth €12.800 on average), guarantee schemes (in 2014 €44 m worth guarantees were issued resulting in new loans worth €85m and in over a billion euros worth investments), interest rates subsidies for entrepreneurial loans (in 2014 almost €4m was allocated for subsidized interest rates, and altogether 33 applications were approved for Croatian Bank for Renewal and Development loans), and funds of economic cooperation (i.e. venture capital funds). In 2015 these measures are expanded with guarantees for investments in equity capital, venture capital fund, Croatian seed fund and with a program to encourage investment in the equity of innovative small business entities. Moreover, the Business Impulse 2015 includes additional funds for manufacturing activities which register the highest added value in the Croatian economy and encompass large number of SMEs. Also, the Program is in particular directed to SMEs based on knowledge, innovations and new technologies.

Based on the financial strength of the Ministry of Entrepreneurship and Crafts, the Croatian Agency for SMEs, Innovations and Investments (HAMAG-BICRO) supports entrepreneurs in research and development activities, as well as in the phase of results commercialisation. The Agency supports investments in small economy, and establishment of SMEs and their business via loan and guarantees schemes, as well as through R&D grant schemes. It also provides support for innovative companies focused on technological development. The Framework for Supporting the Innovation Process was established as part of the second Science and Technology Project, under which approximately €2m is allocated for projects in 2015, €4m for projects in 2016 and €2m for projects in 2017. Funds are intended for R&D&I projects in order to maintain stable market demand, to increase the number of SMEs and researchers able to apply projects for EU funds.

HAMAG-BICRO administers programs for supporting investment in R&D from both private and public sector, including the pre-seed capital program which supports projects at the level of idea/concept, prototype and/or intellectual property rights protection; seed capital program (RAZUM) which supports product development by eliminating developmental risks; IRCRO program which supports cooperation between SMEs and scientific-research community - its focus is on R&D activities where experience of science-research community and innovations of young companies intertwine and result in innovative products with high market potential; TEHCRO program focused on the development of efficient supporting initiatives which should strengthen technology transfer and success of start-up or spin-off companies; TEST program intended for research projects of Croatian scientists which result in new technologies and their commercialisation; TTU program which supports the establishment of transfer technology offices. The TEHCRO and TEST are currently inactive. The Agency also helps project applications for EUREKA, EUROSTARS and HORIZON 2020 programs. Co-operation, knowledge sharing and more favourable business environment for SMEs is also supported via "STARTCO - realize your own business idea" program (started in September 2015) which provides funds for the procurement of IT equipment and for web site development for entrepreneurs beginners. Funds are being allocated in the form of a voucher.

5.3 Entrepreneurship skills and STEM policy

The share of the workforce in the sector of science and technology as a proportion of the total labour force (HRST) is constantly increasing in the last decade from 27.9% in 2004 to 35.1 in 2014. This share is comparable to the most new EU MS but still lags behind the average of the EU 28 countries (44.45%). The educational structure of the population in terms of attaining the tertiary education has also significantly improved in the last decade, from 13.4% persons with higher education in 2005 to 18.5% in 2014 (EU 28 =26%). Most importantly, the share of people aged 30-34 holding a higher education degree has almost doubled since 2006, from 16.8 to 32.2 in 2014 which is still lower than the national and Europe 2020 target of 40%. The oldest cohort of workers with low educational attaining are being replaced by younger better educated workforce. The bulk of the unemployed population in Croatia is composed of people with three-to-four-years of vocational/secondary education or elementary school. However, a share of unemployed persons with higher educational level in Croatia is still rather high (9.6 in 2014) as reported by Eurostat while the rate of youth unemployment is one of the highest in Europe.

The analyses of the structural unemployment as the result of the mismatch of skills, whether vertical (mismatch in the level of education) or horizontal (mismatch in type of education) are somewhat ambiguous. Some analysts suggest that there is a mismatch in qualifications in supply and demand especially in manufacturing industry, wholesale and retail trade, and other social and personal service activities with significant regional disparities (Obadić, 2005). Matković (2011), indicates that there exists horizontal mismatch in the Croatian labour market between field of education and acquired job (occupation). By contrast, Tomić (2014) concludes that mismatch between supply and demand in the labour market is not a predominant factor in explaining unemployment in Croatia, especially not among white collars. Rather, this is the result of deficient demand driven by economic crisis that burst out in 2008.

Nevertheless, structural unemployment represents a big problem in Croatia and the labour market is not fully functional. It especially refers to researchers who are mainly concentrated in the public research sector (81%) while business sector employs remaining 19% or only 0.13% of the workforce in the business sector (around half of the EU 28 average). The demand for graduates, especially for doctors of science is low and less high-skilled jobs are more easily available meaning that highly-educated persons have limited possibilities to pursue their career development. Currently, relatively few doctoral graduates in Croatia work in the business sector (around 5%). A recent study (MODOC, 2015) indicates that many employers felt that current doctoral programmes do not prepare very well the candidates for the wider job market in Croatia. However, a lack of awareness in the business sector of their potential could also be a reason of low employment rate.

The educational orientation of graduates by education field does not differ significantly from the EU-28 trends in 2012¹⁰⁷. More than one third (34.4%) graduated students in the EU 28 have studied social sciences, business and law while this share in Croatia is 40.3%. The number of graduates in science, mathematics and computing in Croatia (8.4%) is slightly below the EU 28 (9.1%) while the share of graduated students in engineering, manufacturing and constructions (15.4%) is above European average of 13.5%. Croatia has significantly lower graduates in health and welfare (7.95%) compared to 15.5% in average in the EU 28.

There is estimation that 47% of youth have their first job in occupation that is not compatible with their field of education. The Operational programme Efficient human resources 2014-2020 (OPEHR, 2014) plans to use the ESIF resources to enlarge the number of students in STEM fields.

¹⁰⁷ Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Tertiary_education_statistics (last access:7.9.2015.)

There is a high rate of dropping out among Croatian students and the highest drop-out rate has been registered in the STEM fields. The main reasons include the lack of adequate competences and insufficient resources. The financial problems are planned to be solved by the scholarships scheme co-funded by the ESIF while measures addressed to improve students' competences (only 59% of students successfully continued the second year of their studies in the STEM and ICT field) are complementary to Youth Guarantee¹⁰⁸ Implementation Plan (YGIP). YGIP was submitted to the EC in April 2014, together with NRP and contains two sections aimed at educational reforms and measures: first in the domain of preventing early school leaving, and second is focused on labour market integration through stronger involvement of the education system, in particular with respect to apprenticeships, linkages between education system and employers and establishing vocational curricula.

The Croatian Qualification Framework (CROQF) was adopted in 2013 based on the Act on CROQF (Official Gazette 22/13) and the Rules on the Register of CROQF (Official Gazette 62/2014) in order to align education with labour market needs, and to develop a new set of occupational and qualification standards and education programmes. The purpose of the CROQF is to reduce the skill gaps on the labour market thereby improving employability and mobility of the working population. Most prominently, the CROQF should link together the qualifications in Croatia with the qualification levels of the European Qualifications Framework (EQF) and the Qualifications Framework of the European Higher Education Area (QF-EHEA). CROQF allows thus the mobility of human resources for continuing education or employment within Europe, and contributes to economic development.

Croatia invested many efforts in order to reform the system of vocational education and training (VET) and adult education system which are based on the Vocational Education and Training System Development Strategy of the Republic of Croatia 2008-2013 and the Vocational Education Act (OG 30/2009). The Agency for Vocational Education and Adult Education was established in 2010 by the Act on the Agency for Vocational Education and Training (OG, 24/2010) which follows the previous Agency established in 2005. The Agency is a key stakeholder in the system of vocational education with a task to reform and develop a modern VET system in Croatia.

The analysis carried out by the National Centre for External Evaluation of Education (NCEEE) about the prevalence of the entrepreneurial contents in programmes of secondary schools (NCEEE, 2012) revealed that entrepreneurship education is incorporated in the most important documents in this area - the "National Curriculum Framework for pre-school education and general compulsory and secondary education" adopted in 2011 and Strategy for Entrepreneurial Learning 2010 - 2014.

The Ministry of Science, Education and Sports' Action plan for Mobility of Researchers 2011-2012 contained a chapter dedicated to the development of researcher competences, recognising that professional development and training programmes must be created with the goal of sharpening researcher competences in management, entrepreneurship, research, presentation, communication and administration. It is anticipated that the same will be acknowledged in the Action Plan for the Mobility of Researchers 2016-2018. However, the entrepreneurship education and training is not widely included in higher education curricula and partnerships between formal education and other sectors is not actively promoted.

There is no national office for PHD. Each university has its own offices for research which often include offices for PHD studies and students. For example, the Office of Doctoral Studies and Programmes of the University of Zagreb is in charge of providing the necessary tools for the implementation of a skills agenda, and supporting PhD candidates in developing transversal competences and skills.

¹⁰⁸ <http://www.gzm.hr/>

Its aim is to develop communication, management and business skills that will allow PhD candidates to take advantage of their scientific potential during their doctoral training and later in the development of their academic and professional career.

Staff training in young SMEs as well as other forms of entrepreneurial training is mostly part of the programme for the development of the entrepreneurship and crafts "Business impulse" (Priority 3 - Promotion and education for entrepreneurship and crafts) carried out by the MoEC. The educational training for start-ups is mainly organised by business innovation or entrepreneurship centres and various similar agencies for entrepreneurship support.

5.4 Access to finance

Access to finance is one of the greatest challenges of Croatian innovation system, with underdeveloped venture capital funding. This problem has been recognised in Strategy for Fostering Innovation in Croatia 2015-2020, which envisages a number of measures which should facilitate access to finance, especially for young innovative companies. These include provision of grants or loans for R&D activities, grants for commercialisation, grants for innovations which do not include R&D (service innovations, eco-innovation, etc.), grants for international innovation projects, etc. However, the implementation of the measures foreseen by the Strategy for Fostering Innovation is quite slow, which reflects on the amount of measures providing access to funding implemented so far as well.

HAMAG-BICRO implements two credit-guarantee schemes for innovation activities. In the case of the "EU Beginner" programme, guarantee cannot exceed 80% of the credit amount, while in the case of the "Let's grow together" programme, the guarantee cannot exceed 70% of the credit amount.

Country attractiveness for investment in Venture Capital and Private Equity assets is low. The Venture Capital and Private Equity Country Attractiveness Index¹⁰⁹ (VC&PE index) ranked Croatia at the 64th place out of 118 countries in 2014. Low ranks were recorded in the dimensions Economic activities (89th place; weak performance in Expected Real GDP Growth and Unemployment), Human and Social Environment (82nd place; particularly due to Labour Regulations) and Investor Protection and Corporate Governance (79th place). Better ranking was achieved in the dimensions of Taxation (31st place) and Entrepreneurial Opportunities (47th place; due indicators of Innovation, Scientific and Technical Journal Articles and Corporate R&D).

5.4.1 Venture capital and business angels networks

There were also several different initiatives aimed at enabling venture capital funding in Croatia, but these were not successful. Foreign venture capital funds sometimes invest in start-ups and early stage ventures in Croatia, but this is quite rare and does not present a significant opportunity for a large share of Croatian start-ups. In 2011, several Economic Cooperation Funds have been established on the Government initiative. Economic Cooperation Funds (ECFs) are open-end venture capital investment funds with private offering that have been established and operate in accordance with the Alternative Investment Funds Act. ECFs have been established on the *pari passu* principle – investor in each ECF with 50% is the Republic of Croatia, while other 50% are invested by private investors. In the case of ECFs these are pension funds, banks and companies. Croatian Bank for Reconstruction and development (HBOR) is a qualified investor appointed by the Government of the Republic of Croatia, which participates in the implementation of ECFs' activities together with private investors.

¹⁰⁹ <http://blog.iese.edu/vcpeindex/croatia/>

ECFs have mainly operated as private equity funds that have invested in restructuring of existing enterprises temporarily affected by the economic crisis, although there have also been some investments into early stage ventures. Beneficiaries are companies with the seat in Croatia, active predominately in Croatia, with a high growth potential and competitive advantage.

In 2015 HAMAG – BICRO and MoEC became beneficiaries of World Bank loan, the aim of which is to establish seed capital fund (value around €2m) and venture fund (value around €15m). The value of the loan is €20m and the objective of the Project is to strengthen risk capital financing in the territory of the Borrower for innovative SMEs and Start –Ups. Also, under the TO3 OPCC several measures are envisaged the objective of which is to establish Small equity investments based on business angels concept in seed and early start-up phases of technology incubation and acceleration with high growth prospects, especially in the priority areas identified in S3 strategy.

The Enterprise Innovation Fund is the newest initiative aiming towards facilitating access to finance for innovative SMEs in Croatia. EIF is a venture capital fund operating focused on SMEs from seed to expansion phases in the Western Balkans (Albania, Bosnia and Herzegovina, Croatia, Kosovo, FYR Macedonia, Montenegro and Serbia), which provides equity and quasi-equity finance to stimulate and support commercially viable research in innovative SMEs. The fund is set up as an independent entity and is managed by South Central Ventures, while investors include the European Commission (EC), the European Investment Fund (EIF), the European Bank for Reconstruction and Development (EBRD), Kreditanstalt für Wiederaufbau (KfW) together with institutional and private investors from the Western Balkans. Budget allocated for seed investments currently amounts to €1.5m, and is focused on investments of up to €100,000 per company. Early stage and growth investments are limited on €3m per company. The fund has been launched in October 2015, and Croatia invested €2m in the initiative.

5.5 R&D related FDI

There are no policies in Croatia aiming at attracting specifically R&D related FDI.

The Act on Investment Promotion was adopted in 2015 (OG 102/15). The Act regulates the granting of state aid to encourage investment with the aim of stimulating economic growth and the achievement of Croatian economic policy, its inclusion in the international trade and investment and strengthening competitive capabilities of Croatian enterprises. Grants include:

- Tax support for micro-entrepreneurs;
- Tax support for small, medium and large enterprises;
- Grant for eligible costs of new employment linked to the investment project;
- Support for the eligible costs of training linked to the investment project;
- Support for: a) development and innovation activities, b) business support and c) the activities of services with high added value;
- Support for the capital costs of the project investment;
- Support for labour-intensive investment projects;
- Support for investment in the minimum amount of €13m (in HRK equivalent), with the criteria of opening a minimum of ten new jobs, which demand university degree and are related to the investment project: a) support to ensure the immutable conditions of business, b) investment aid, c) half – half incentives, d) grace period of payment of tax liabilities.

Strategy for Fostering Innovation in Croatia 2014-2020 has a goal of increasing the level of R&D related FDI from 14.7% to 25% until 2020, and envisages several measures for its accomplishment, such as introduction of advance business services for investors and promotion of high and medium technology sectors in Croatia.

5.6 Knowledge markets

The development course of the intellectual property system in Croatia has been set by the National Strategy for the Development of the Intellectual Property System of the Republic of Croatia for the period 2010 – 2012¹¹⁰. Intellectual property protection in Croatia falls under the responsibility of the State Intellectual Property Office (SIPO)¹¹¹. It is rather well regulated and efficient compared to international benchmark.

In order to provide efficient and user friendly services the SIPO established the Information Centre for Intellectual Property – INCENTIV which is a member of the European network of PATLIB centres. It provides various specialised information services in the field of intellectual property to the users of the intellectual property protection system and to the all interested parties. In addition to the information support for users, INCENTIV provides expert services of search and analysis of information related to registered industrial property, specialised library and reading room services in the field of intellectual property and other expert services developed by the Office. The INCENTIV's employees participate in informative and promotional activities of the Office.

The basic services of the SIPO include information activities and on-line search of databases on patents, trademarks and industrial designs which include a range of various services such as: novelty search, technology watch, competition watch, infringement search, bibliographic databases, etc. It also produces three main information products to inform and users about IPR: Official Gazette, Official, Informative and Promotional Publications and the Website.

The SIPO provides the following information services and products (SIPO, 2014): User Support Services (IP help-desk); Industrial Property Information Search and Analysis Services; Assessment of the potentials of intellectual property; other services (e.g. assessment of the IP for small and medium-sized enterprises).

As part of the informational and promotional activities in 2014, the Office participated, according to the SIPO Annual report (SIPO, 2014¹¹²), in six public events and eleven professional and promotional events, at nine of which representatives of the Office held expert presentations on various aspects of protection and enforcement of intellectual property. In addition to a series of promotional events all around Croatia, the Office co-organised three public and three professional and promotional events. Furthermore, it organised three round tables: /1/ European Patent Reform and Expected Benefits for Users in cooperation with the European Patent Office; /2/Toward the Industrial Renaissance – Does Croatia Need a National Strategy of Intellectual Property and /3/ From an Idea to the Commercialisation of Innovations.

In the field of education and professional training on intellectual property in 2014 the Office held 20 seminars, workshops and lectures for students, scientists, representatives of small and medium-sized enterprises, as well as state institutions and judicial bodies.

In order to develop knowledge markets in intellectual property rights the SIPO participates in the mechanism of implementation established by the European policies and instruments for patents and licencing. The SIPO concluded in 2014 the Cooperation Agreement with the Office for Harmonization in the Internal Market (OHIM) pursuant to which the SIPO and OHIM cooperate in activities, joint projects and convergence programmes for the harmonization of practice concerning different intellectual assets on internal European market.

¹¹⁰ http://www.dziv.hr/files/File/strategija/Strategy_IP_2010_12.pdf, (last access: 25 February, 2015)

¹¹¹ <http://www.dziv.hr/en/> (last access: 25 February 2015)

¹¹² http://www.dziv.hr/files/File/go-izvjesca/godisnje_izvjesce_2014.pdf (last access:6.1.2016)

5.7 Knowledge transfer and open innovation

5.7.1 Indicators

Funding: BES-funded/publicly-performed R&D

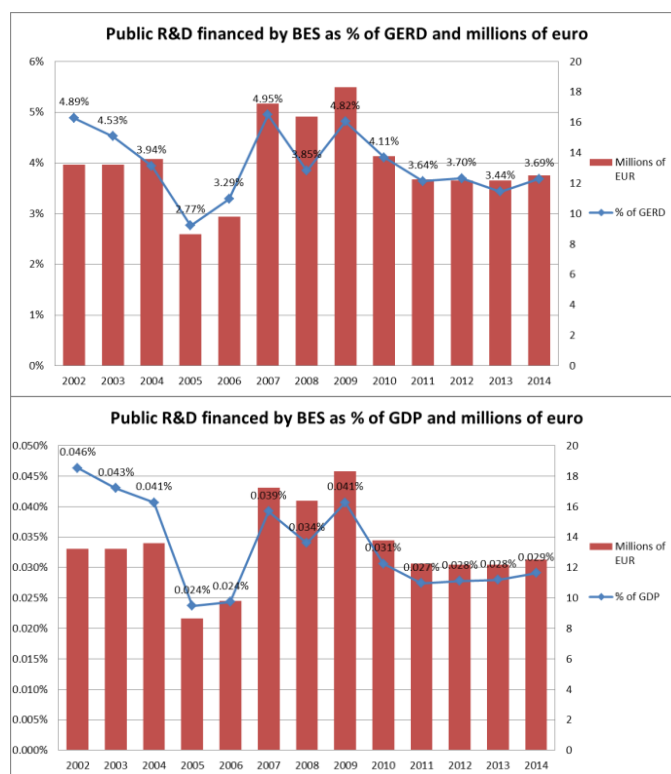


Figure 11 BES-funded public R&D in Croatia as % of GERD (in €m) and % of GDP

The level of the business enterprise (BES)-funded public R&D expenditure in Croatia expressed both as a percentage of GERD and percentage of GDP followed a similar trend. It decreased from 2002 to 2005, then increased to 2007 and started fluctuating thereafter.

In the period after 2009 it started to decline and stabilised with some minor fluctuations in 2011-2014 years. While when expressed as a share of the GERD, Croatia seems to perform rather well in comparison to the majority of the new Member States, but when expressed as percentage of GDP the indicator stabilised around small values.

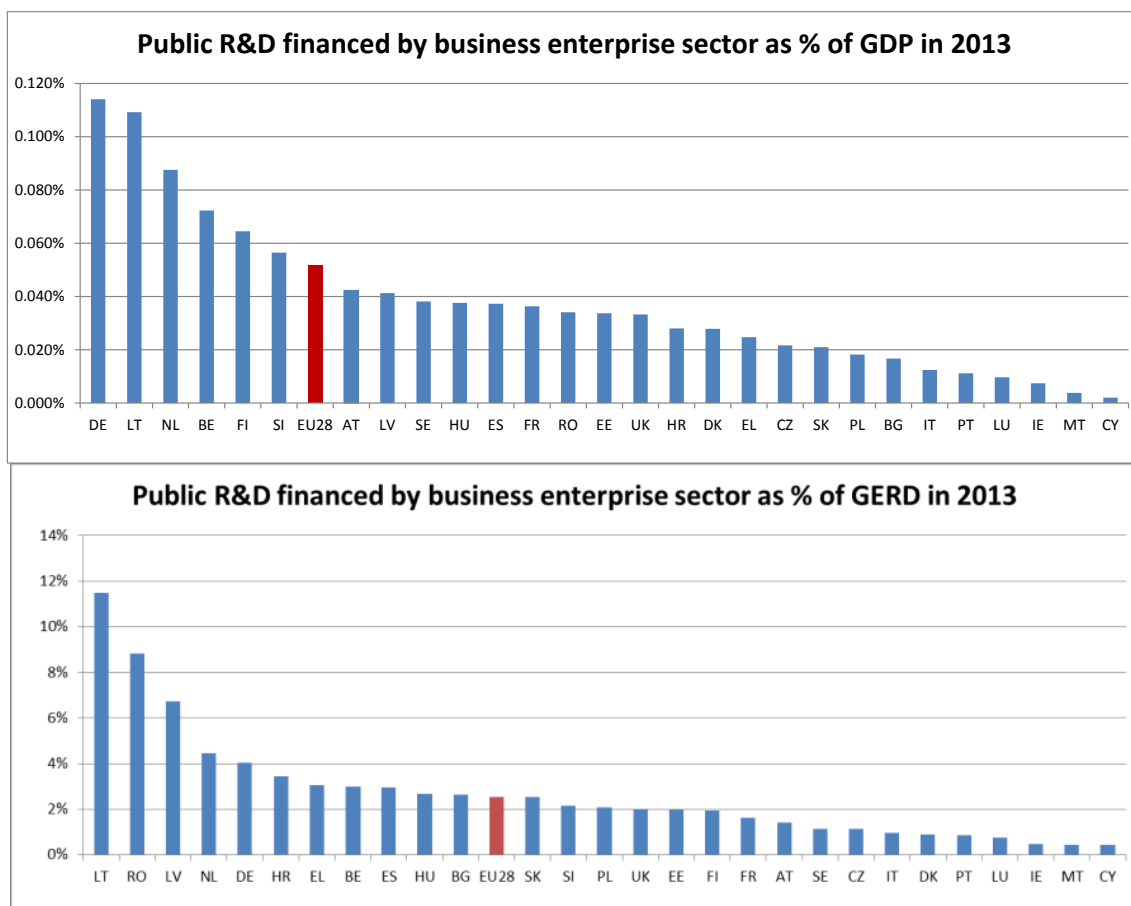


Figure 12 BES-funded public R&D as % of GERD and as % of GDP in 2013 in Member States¹¹³

The two charts in Figure 12 show the values of BES-funded public R&D in all EU-28 as percentages of GERD and GDP respectively. Croatia's is ranked above EU-28 average levels when the indicator is expressed as a share of the GERD, but is far behind the best performers and the EU-28 average when measured as percentage of GDP.

On the other hand this represents only 0.03% of GDP, which reflects the relatively low level of the national R&D intensity. The relatively high share (in GERD) of business funded R&D activities performed by the public sector could be explained by several factors. On one hand, R&D performance was traditionally dominated by public sector institutions (54% of GERD in 2012 and 49.9% in 2013). In other words, business sector had a low participation in research activities for decades and only recently has the BES started gaining pace, but it also tends to commission research to public sector. Yet, from the Figure 12 one can see that Croatia is far away from the EU-28 average of BES funded publicly performed R&D as % of GDP. However, the newest EU member state performs better in this indicator than a number of other Member States (with Malta and Cyprus at the far end of the scale). Still, one of the main funding agencies (HAMAG-BICRO) has put in place several measures incentivising the cooperation between private and public R&D organisations, which is also in line with the third main objective of the main national strategic documents.

Despite the relatively high share of privately funded public R&D, the science-industry link remains weak, due to the low absorption capacity of the firms and with the R&I investment concentrated in a small number of companies¹¹⁴.

¹¹³ 2011 was chosen as the latest data series providing a full comparison within EU-28.

¹¹⁴ SWOT analysis of Croatian Innovation Strategy 2013-2020, <http://www.oecd.org/investmentcompact/croatia.pdf>

Funding: Structural funds devoted to knowledge transfer

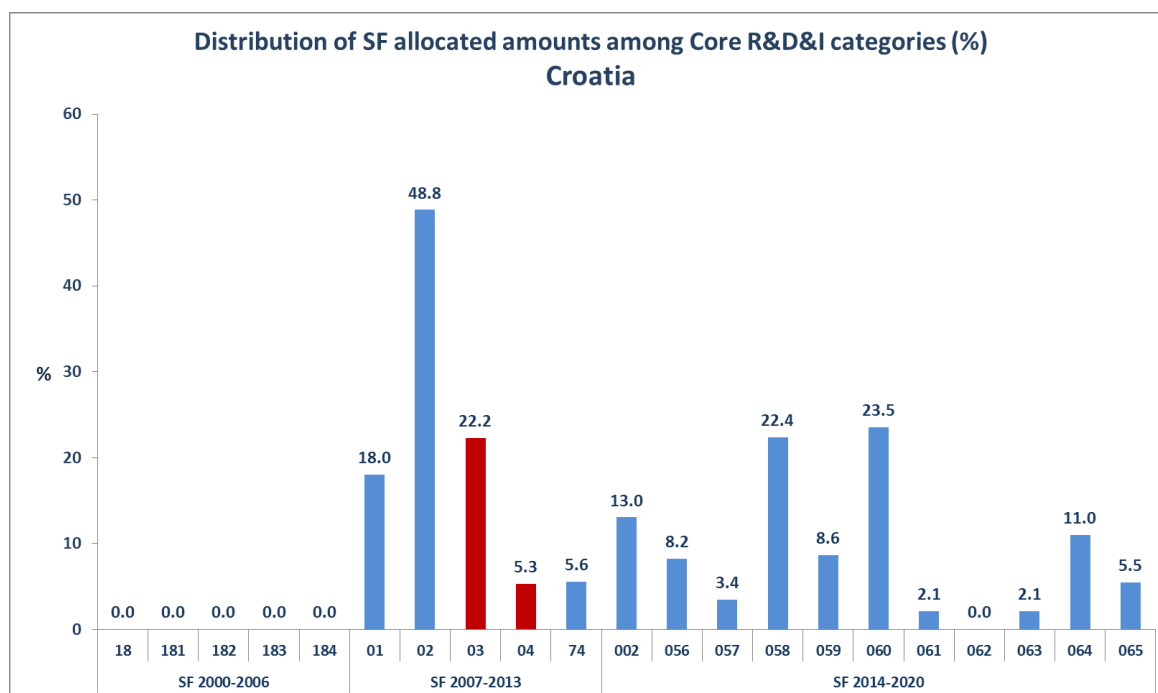


Figure 13 Structural Funds for core R&D activities 2000-2006, 2007-2013 and 2014-2020¹¹⁵. We use the categories: 182 (2000-2006), 03 and 04 (2007-2013) and 062 (2014-2020) as proxies for KT activities.

Croatia has not allocated yet any funds from ESIF for core R&D activities to "Technology transfer and university-enterprise cooperation primarily benefiting SMEs" (compared to 27.6% in the 2007-2013 programming period). This raises some questions to what extent KT measures can be co-funded by the ESIF and how effectively these measures will be implemented.

¹¹⁵ Figure 13 provides the Structural Funds allocated to the Czech Republic for each of the above R&D categories. The red bars show the categories used as proxies for KT. Please note that the figures refer to EU funds and they do not include the part co-funded by the Member State.

The categories for 2000-2006 include: 18. Research, technological development and innovation (RTDI); 181. Research projects based in universities and research institutes; 182. Innovation and technology transfers, establishment of networks and partnerships between business and/or research institutes; 183. RTDI infrastructures; 184. Training for researchers.

The categories for 2007-2013 include: 01. R&TD activities in research centres; 02. R&TD infrastructure and centres of competence in specific technology; 03. Technology transfer and improvement of cooperation networks; 04. Assistance to R&TD particular in SMEs; 74. Developing human potential in the field of research and innovation.

The categories for 2007-2013 include: 01. R&TD activities in research centres; 02. R&TD infrastructure and centres of competence in specific technology; 03. Technology transfer and improvement of cooperation networks; 04. Assistance to R&TD particular in SMEs; 74. Developing human potential in the field of research and innovation.

The categories for 2014-2020 include: 002. Research and Innovation processes in large enterprises; 056. Investment in infrastructure, capacities and equipment in SMEs directly linked to Research and Innovation activities; 057. Investment in infrastructure, capacities and equipment in large companies directly linked to Research and Innovation activities; 058. Research and Innovation infrastructure (public); 059. Research and Innovation infrastructure (private, including science parks); 060. Research and Innovation activities in public research centres and centres of competence including networking; 061. Research and Innovation activities in private research centres including networking; 062. Technology transfer and university-enterprise cooperation primarily benefiting SMEs; 063. Cluster support and business networks primarily benefiting SMEs; 064. Research and Innovation processes in SMEs (including voucher schemes, process, design, service and social innovation); 065. Research and Innovation infrastructure, processes, technology transfer and cooperation of enterprises focusing on the low carbon economy and on resilience to climate change.

Cooperation: Share of innovative companies cooperating with academia

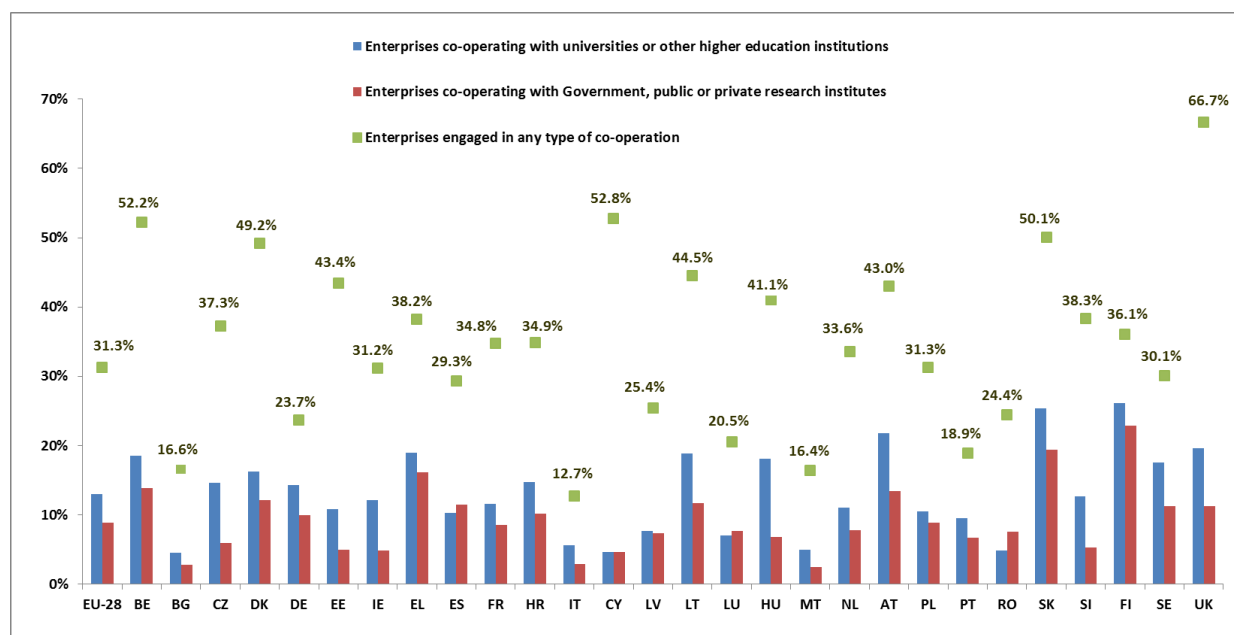


Figure 14 CIS survey 2012 – share of enterprises cooperating with academia

Figure 14 depicts the level of cooperation activities of innovative companies in the EU-28, according to the CIS 2012 (Eurostat). In Croatia, 34.9% of innovative companies are engaged in any type of cooperation, which is slightly above the EU average (31.3%). A third of them (i.e. 14.7% of total sample of innovative companies) cooperates with universities and higher education institutions and 10.2% cooperates with government or public or private research institutes. Both indicators are above EU-28 average, which are 13.0% and 8.9% respectively.

Cooperation: Technology Transfer Offices (TTOs), incubators and technological parks

In 2014 there was a total of 95 Business Support Organisations in Croatia, comprised of 45 regional and local development agencies, 1 entrepreneurial learning organisation, 27 business incubators, 3 technology parks and 18 business centres¹¹⁶. There are 4 Technology Transfer Offices at the universities of Split, Zagreb, Osijek and Rijeka. Though big in number, these organisations did not contribute as much as expected to the transfer of knowledge. This fact is also acknowledged in the Partnership Agreement 2014-2020 and thus one of the strategic objectives related to R&I to be achieved through the ESI Funds is improving science industry collaboration and technology transfer.

¹¹⁶ Partnership Agreement for Croatia:

http://www.mrrfeu.hr/UserDocImages/EU%20fondovi/HR_PA_FINAL_ADOPTED_30_10_2014.pdf

Cooperation: Share of public-private co-publications

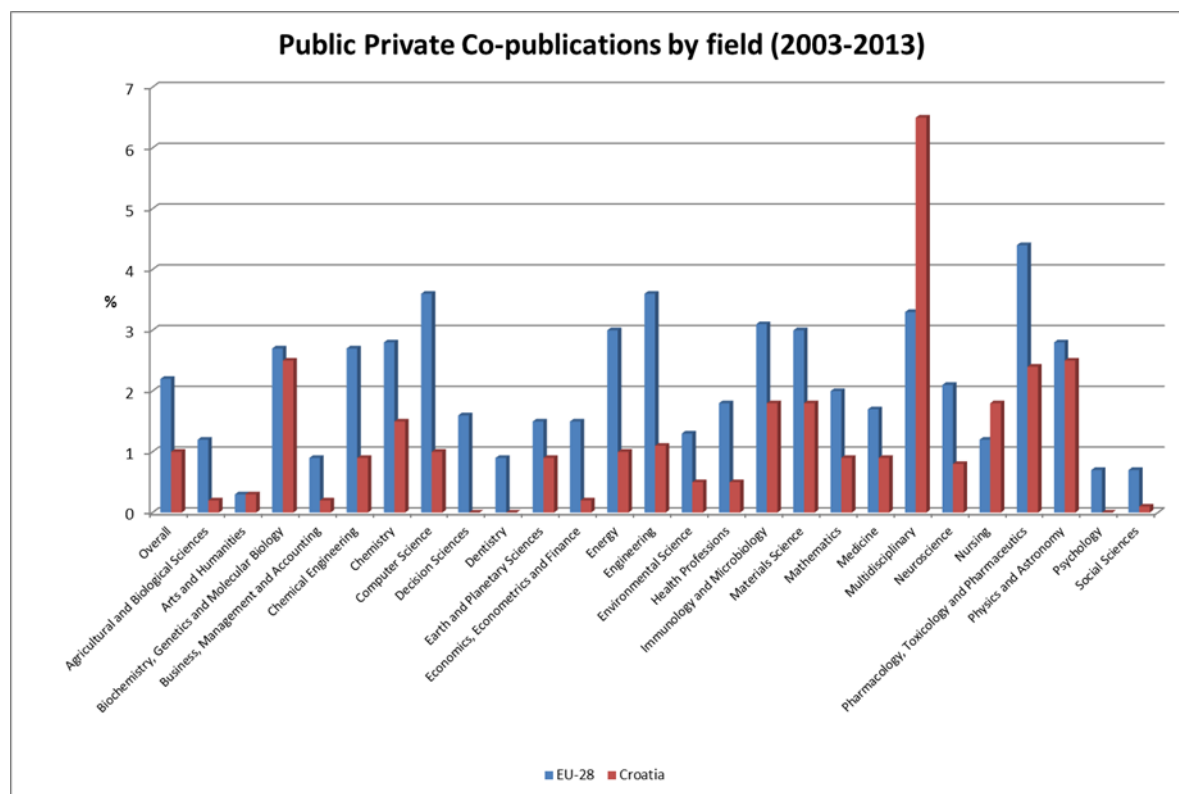


Figure 15 Co-publications by field 2003-2013 in Croatia¹¹⁷

Figure 15 shows the 2003-2013 average percentages of academia-industry co-publications by field in Croatia compared to the European average. The overall score for 2003-2013 is 1% and in 2013 the country recorded 0.8% which is well below the EU-28 average of 2.2%. In 2013 Croatia had only 9.9 public-private co-publications per million of inhabitants¹¹⁸, compared to EU-28 average of 29 (4.4 in BG, 39.3 in SI and 75.4 in AT). The highest number of co-publications was registered in areas such as pharmacology and pharmaceutics, physics and astronomy, biochemistry, genetics and molecular biology.

Cooperation: Inter-sectoral mobility

In 2012, researchers employed by business sector in Croatia were 17%, which is far from the EU-28 average of 47% (Eurostat). The PhD holders employed in the private sector amounted to 5% in Croatia in 2009¹¹⁹. It should be also mentioned that the share of R&D personnel and researchers in Croatia is 0.97% of the total workforce (2012)¹²⁰. More2 study reports on a close to the average researchers' intersectoral mobility in Croatia (33% compared to 30% of the EU-27 average) and the flows are larger to the government/public sector (19%) than to industry (14%) or private non-profit (7%).

¹¹⁷ The share of public-private co-publications is derived from the Scival platform and is also based on Scopus data. (Scival © 2016 Elsevier B.V. All rights reserved. SciVal® is a registered trademark of Reed Elsevier Properties S.A., used under license).

¹¹⁸ RIO elaboration based on Scopus data.

¹¹⁹ Eurostat: Employed doctorate holders working as researchers by sex, fields of science and sectors of performance (%).

¹²⁰ Eurostat: Total R&D personnel and researchers by sectors of performance, as % of total labour force and total employment, and by sex

Cooperation: Patenting activity of public research organisations and universities together with licensing income

In 2012 in Croatia, HEIs applied for 3 patents and were granted 2 domestically (out of 8 in total). Croatian HEIs' applied for 16 patents abroad (46 in total for Croatian entities) and there were no patents granted that year. In the same year the Croatian PROs applied for only 2 patents abroad¹²¹.

According to the Knowledge Transfer Study in 2011-2012, Croatia produced the least patent grants and the least license agreements per 1,000 research staff amongst the countries in the study sample. In terms of generating license income Croatia ranks again among the least productive countries. The country produced on average 3.5 research agreements with companies per 1 000 research staff. This ranks Croatia 18th (out of 22) and far from the best scores (NL – 300.2; FI – 231.3) as well as the EU average 82.8¹²².

Cooperation: Companies

According to the Knowledge Transfer Study Final Report¹²³, Latvia, Croatia and Slovenia produced the least start-ups per 1,000 research staff.

5.7.2 Policy measures

Development and promotion of academia-industry cooperation is considered as one of the main national priorities for the development of Croatian economy, and has been included in the [Strategy for Education, Science and Technology](#)¹²⁴, [Industrial Strategy 2014-2020](#)¹²⁵, [Strategy for Fostering Innovation of the Republic of Croatia 2014-2020](#)¹²⁶ etc.

Most important programmes aimed at knowledge transfer are programmes administered by HAMAG-BICRO and include [Technology-oriented projects \(TEST\)](#)¹²⁷, [Collaborative research development programme \(IRCRO\)](#)¹²⁸, [Development of the knowledge-based companies programme \(RAZUM\)](#)¹²⁹ and [Science and Innovation Investment Fund administered by MSES](#)¹³⁰.

TEST programme provided funding for applied research in the field of (high) technologies. Eligible applicants were scientific organisations registered at MSES. It was previously managed by the Croatian Institute of Technology (HIT), which was merged with BICRO. Today, TEST is managed by HAMAG-BICRO. All projects financed by TEST are completed and there are currently no public calls opened.

The Research and Development Programme (IRCRO) aims at encouraging SMEs to establish R&D activities and cooperate with PROs. The programme was designed to encourage and stimulate the demand for services of public research institutions, as well as to encourage SMEs to invest in R&D activities.

RAZUM Programme is oriented towards supporting commercialisation of products and services developed as results of R&D activities. The Programme provides funding to technology oriented knowledge-based start-ups and SMEs for development of projects in pre-commercial stage – so called pre-commercial projects.

¹²¹ [Croatian Bureau of Statistics \(2014\). "Research and Development, 2012: Statistical Report 1524". Zagreb.](#)

¹²² [Knowledge Transfer Study 2010-2012 Final Report](#)

¹²³ Ibid

¹²⁴ <https://www.azvo.hr/hr/novosti/1061-strategija-obrazovanja-znanosti-i-tehnologije> (last access: 25 February 2015)

¹²⁵ http://www.mingo.hr/userdocsimages/industrija/Industrijska_strategija.docx (last access: 25 February 2015)

¹²⁶ http://www.mingo.hr/public/documents/Strategija_poticanja_inovacija_18_12_14.pdf (last access: 25 February 2015)

¹²⁷ <http://www.hamagbicro.hr/inovacije/javni-sektor/test/> (last access: 25 February 2015)

¹²⁸ <http://www.hamagbicro.hr/inovacije/privatni-sektor/ircro/> (last access: 25 February 2015)

¹²⁹ <http://www.hamagbicro.hr/inovacije/privatni-sektor/razum/> (last access: 25 February 2015)

¹³⁰ <http://siif2.com/siif/eng/> (last access: 25 February 2015)

Through RAZUM, commercial projects have also been evaluated, but funding for these projects has been awarded by [Croatian Bank for Reconstruction and Development \(HBOR\)](#)¹³¹.

Science and Innovation Investment Fund (SIIF) is a project implemented by MSES and funded through EU IPA IIIc. The project supports technology transfer and commercialisation of universities' research results. SIIF has been divided in two phases. Within the first phase, five projects received funding of €5 million. In second phase, which ended in December 2015, 19 new HEI/PRO's projects received grant worth more than €11,2m (EU funding €7,6m).

The Business Impulse Programme, which also includes the programmes listed above, foresees investing into business infrastructure in the amount of €70m in the period 2015-2020, aimed at investments into business infrastructure, advanced business support services and quality increase. In addition, the programme increasing the capacities of the business supporting organisations, with a budget of €10m (2015-2020), aims to ensure funding for business support organisations and facilitate development of specialised centres for business support. The Business Impulse Programme also envisaged funding for consulting services through business support institutions in the amount of €43m (2015-2020), aiming at development of business supporting institutions and their networks.

In December 2014, the Croatian Science Foundation published a call under the Partnership in research programme. The programme supports relevant scientific research that can accelerate the development of new and existing companies and attract those representatives of the industry and entrepreneurship which will significantly contribute to the economic and technological development of Croatia. Total value of allocated funds was €660,000.

BISTEC – Building innovation support through efficient cooperation network¹³² is a comprehensive project worth €794 000 that was implemented over two years (April 2013 – March 2015). The overall objective of the project was to improve the capacity of higher education and research institutions for technology transfer and innovation thereby enabling them to collaborate with industry, investors, public authorities and other stakeholders in commercialization of the University's research potential. The project was coordinated by the University of Zagreb.

The programme for establishing the centres of research excellence (CoREs) was launched in June 2013 with the aim to identify research groups of international relevance with the potential in developing the frontier research and cutting-edge science. An amount of €0.26m per year was earmarked in the State budget for 2016, 2017 and 2018 while the additional funds will be provided by the EU Structural funds 2014-2020 (primarily, ERDF). First seven CoREs were established in November 2014, and additional six in November 2015. CoREs are to bring together innovative interdisciplinary networks of scientists and scientific teams as well as commercial and public entities that are systematically carrying out research on topics of great importance to science and society.

A grant scheme funded by the SF 2007-2013 called "Strengthening capacities in research, development and innovation"¹³³ was launched in January 2014 with a focus on applied and industrial research. The projects should be realized in cooperation between research institutions (applicant) and industrial/business partners in order to achieve results with potential commercial applications or the creation of new relevant knowledge.

¹³¹ <http://www.hbor.hr/Sec1237> (last access: 25 February 2015)

¹³² <http://cirtt.unizg.hr/en/about-us/projekti/project-bistec/>

¹³³ <http://public.mzos.hr/Default.aspx?art=12962>

The programme is co-financed by the European Regional Development Fund (ERDF) within the Operational Programme for Regional Competitiveness (RCOP) 2007-2013, Measure 2.2. - Research, development and technology transfer. The grant scheme is administered by the MSES. The selection and contracting of projects has been completed by the end of 2014 followed by the initial implementation of 19 projects. The total indicative budget of the Call is €9.3m out of which the contribution of the ERDF amounts to €7.9m and the national contribution amounts to €1.4m. In this call the maximum grant amounted to around €1m and the minimum is €0.2m. The percentage of project financing is up to 100% of the total costs of the applicants and up to 80% of the total cost of the partnering organisations.

Other measures which could result in development of knowledge transfer and open innovation development include Proof of Concept Programme (see section 3.5.1), programme for support of the Technology transfer at universities - TTU (see section 3.4.3) and Scientific Cooperation Programme – “Across the Border” grant (see section 3.4.3).

5.8 Regulation and innovation

As reported in the section 2.1, assessment of the impact of public policy measures, in particular at the research programme level, is relatively scarce and weak in Croatia. Ex-post evaluations of research programmes funded by the national resources, e.g. by the CSF or MSES have been carried out mostly for administrative purposes of funding institutions and focused on project activities rather than on the fulfilment of the specific goals of science policy designed by a programme. Therefore, they are usually not publicly available and are not used either for international benchmarking, policy learning or improvements of the programmes.

The innovation programmes co-funded by the Loan Agreement for Second Science and Technology Project (STP) such as RAZUM, IRCRO or PoC have been subjected to ex-post evaluation and results were usually available to interested public. The results are often interpreted in the way that they provide the accurate and comparable information about the quality and efficiency of funding through R&I programmes and to estimate their success in meeting the programmes' overall goals. The results were used in the preparation of Second Science and Technology Project (STP II), specifically aiming at the improvement of the Croatian innovation system, particularly the enhancement of public research organizations' capacities to commercialize research results and to substantially improve the process of technology transfer and the exploitation. However, the role of this evaluation in science policy development can be estimated as largely very modest.

The macroeconomic models which assess the impact of R&I on economic growth and support the budgetary policies have not been not developed, and there is no indication that available models have been implemented. However, the development of the integrated data base – the Croatian Research Information System (CroRIS) has been initiated in 2014, with the development of project documentation for the national Science and Technology Foresight Project (STF). STF involves systemic analysis of the long-term trends in science and technology in order to create and implement tools and methods for development and sustainable execution of evidence based policy in the area of RDI, specifically for development and monitoring of Smart Specialisation Strategy and other strategic documents, as well as to competitiveness, economic development and society.

5.9 Assessment of the framework conditions for business R&I

Croatia ranked as 65 of 189 economies in the World Banks' Doing Business report for 2015, which represents an improvement in comparison to 2014 results (rank: 67). The foremost progress was achieved in the area of construction permits issuance, since the number of applications decreased and fees for construction permits and final construction inspections declined. Other improvements include decrease of some administrative barriers and increasing digitalisation of public services.

In general, business environment in Croatia is not conducive to innovation. Demand-side policies and instruments oriented towards increasing business investments in research and innovation practically do not exist. Public procurement which is at the centre of demand side innovation policy is based on the Public Procurement Act, which does not distinguish innovative goods and services from other goods and services.

In addition to several programmes aimed at funding of research-based innovation activities (e.g. RAZUM, PoC and IRCRO), main support measures stemming towards increasing the levels of R&D activities were indirect measures provided in the form of tax incentives. In 2011, an analysis of R&D tax incentives (Aralica et al., 2011) resulted in a conclusion that tax incentives in Croatia are more generous form of state aid for R&D than subsidies. Several large business R&D performers claim tax incentives that exceed the overall public R&D subsidies, as it can be seen in corporate financial reports. This indicates that the a few companies conduct large research projects and the concentration of tax incentives into the small number of users is present. Since this programme expired in December 2014, the new Programme for state incentives for research, development and innovation for the period of 2016-2020¹³⁴ was drafted during 2015. It follows the standardisation of criteria for granting incentives in accordance with EU directives (GBER), changing procedures and rules on state incentives and definitions for monitoring, evaluation and recovery of state incentives.

Although it is expected that different forms of demand-side policies will be introduced in the coming period (as presented in the recently adopted national Strategy for Fostering Innovation 2014-2020), currently there are practically no demand-side policies in place in Croatia so far, which significantly influences innovation performance of both public and private institutions.

¹³⁴ <http://public.mzos.hr/Default.aspx?art=13861&sec=2127>

6. Conclusions

This chapter provides an assessment of the performance of the national research and innovation system and identifies the main structural challenges faced by the national innovation system.

6.1 Structural challenges of the national R&I system

Main structural challenges of the Croatian R&I system have dominantly remained as in the previous years, and can be identified as follows:

- **Lack of coherent and integrated R&I policy framework**

Considering financial constraints and state budget savings, the public research sector faces the challenge of expenditure rationalisation and at the same time the challenge of scientific research quality improvement. Ambitious agendas that aim to provide some entirely new possibilities for science in economic recovery and socio-cultural changes are not a subject of the current policy. Although new industrial policy should provide a framework for science and technology strategic role in the overall economic development, it seems that policy makers do not take research and innovation as the essential instrument for boosting productivity, exports and economic growth. Meaning, the share of the Government Budget appropriations for the R&D in GDP reached 0.62% in 2014. Improvements should result from several strategic documents which are being implemented in practice, such as the Strategy for Education, Science and Technology (through national curricular reform), the Strategy for Fostering Innovation of the Republic of Croatia 2014-2020 (through strategic guidelines for innovations in specific areas, and through strengthening the Croatian national innovation system (NIS)), and in future the Smart Specialisation Strategy of the Republic of Croatia (still not officially adopted).

Coordination between relevant bodies of state administration (Ministry of Science, Education and Sport, Ministry of Economy, Ministry of Entrepreneurship and Crafts and Ministry of Regional Development and European Funds) is still insufficient, particularly in terms of non-harmonized strategic policies and supporting measures, and overlaps of responsibilities in the coordination of ESIF priorities and projects. This could lead to the ineffective management of EU Structural funds which presents, within restricted budget resource, as a crucial investment resources for structural reforms including strengthening of R&I. Croatia needs to absorb the SF allocation 2007-2013 by the end of 2016 and, at the same time to launch the new 2014-20 programmes which will challenge the management capacities of administration. Besides, the programmes under ESIF include a number of new sectors (ICT, energy, climate change, health and social inclusion, education) which will require specific technical capacities in the management bodies and support for project beneficiaries. Croatia will need to make major efforts to ensure adequate capacities for absorption of ESIF for the benefits of national development (EC, 2015b). In answer to that, the operational programmes for each fund were made at the national level and clearly state aims, targets and indicators for each sector (regardless of different public bodies). Also, during the preparation of Calls, each body organises a working group whose members are representatives of relevant ministries and this is also to avoid overlaps.

- **Strengthening private sector's R&I capability and improving the business innovation environment**

Overall business environment in Croatia generally creates disincentives to innovation, especially in the context of lack of coordination at policy design and implementation levels, access to finance and inadequate framework conditions. According to the results of the Global Competitiveness Report for 2014-2015 (WEF, 2014) Croatia is positioned at 77th place out of 144 countries.

The most problematic factors for doing business in Croatia include, according to WEF, inefficient government bureaucracy, policy instability, corruption, tax regulations, tax rates, access to financing and restrictive labour regulations, etc. According to the last World Bank Doing Business 2015 report, of altogether 189 countries, Croatia's rank is 65, which represents a slight improvement in comparison to 2014 results (rank: 67). Country Specific Recommendations for 2015 indicate that main disincentives to business innovation include "*[L]ow transparency and predictability in the working of administrative bodies, unevenly developed electronic communication channels, and lengthy judicial proceedings, in particular in commercial courts*".

Despite the fact that the share of GERD funded by business enterprise sector increased in 2013 compared to the years before, volume and investment of private businesses R&D remains at low levels, with low interest in cooperation with the public R&D sector. As reported by the European Commission Country Report Croatia 2015 (EC, 2015b), R&I activities are hindered by scarce capacities, unfavourable structure of available incentives and limited internationalisation. Economy is dominated by the large and un-reformed public companies that are not exposed to market competition which would urge them to innovate. A new layer of SME is composed of sectors which are not based on research and innovation and consists largely of micro companies with less than 10 employees, having modest capacities to perform or absorb research. The wholesale and retail trade sector, construction, accommodation and restaurants make nearly 50% of all SMEs (MEC, 2012).

There are also an apparent mismatches between labour demand and supply and skills profile that is unfavourable to innovation, since "*[b]usiness innovation capability depends crucially on specialised skills in design, engineering, marketing and information technology, among others, and on the Technological innovation demands and activities that the presence of such skills generates in firms*" (OECD, 2014).

As a result of unfavourable environment and weak capacities for R&D, Croatia underperforms in several output indicators, such as designs and trademarks, SMEs innovating in-house, SMEs introducing any type of innovation etc. Low innovation capacities are also caused by low and decreasing public expenditures on R&D, as well as public policies in support of innovation which are "characterised by weak commitment, slow reform pace and inefficient governance structures", as reported by the European Commission (EC, 2015). These trends contribute to the current situation of "low-level equilibrium" innovation system. As stated in the SWD 2015 "[i]n a low-level equilibrium, business sector's weak innovation capabilities and low investment in R&D&I leads to little effective demand for and supply of innovation-related services and research". This represents also an important obstacle to public-private collaboration.

- Strengthening public R&I capacity

Croatian universities are mostly fragmented and faculties are usually organised as individual legal persons, rather than departments of one legal person, i.e. university. This leaves individual faculties with significant autonomy which negatively affects the level of integration of Croatian universities, especially when it comes to possibility of fast adaptation to international competition and achieving excellence - Research excellence composite indicator score is still very low with only 2 EU Member States performing worse than Croatia (18.89 compared to EU28 47.8 in 2012). Consequently, there are also significant obstacles when it comes to commercialisation of research results and development of science-industry linkages.

The reform of the science and higher education has been initiated in 2013 with the adoption of the Act on the Amendments to the Act on Science and Higher Education. The Act introduced significant changes in the science system, aimed at improvement of the international recognition and competitiveness of the Croatian research groups and institutions, as well as to gain the value for the invested public resources by increasing the social responsibility and economic accountability of PROs and HEIs.

A new funding model of scientific activities is now based on institutional funding for multi-annual research programmes based on performance indicators and allocation of competitive research grants by CSF. Allocation of funding is based on rigorous evaluation procedures to finance a smaller number of high quality projects.

However, availability of budget resources for R&I activities continued to decrease and additional constraints have been announced for 2016 and 2017. This could lead to additional downturn in research and innovation performance of Croatian HEIs and PROs, especially in the context of inadequate planning and design of measures aimed at absorption of available EU funds for research and innovation activities.

Table 8 Summary of challenges

Challenge	Summary
Lack of coherent and integrated R&I policy framework	<ul style="list-style-type: none"> • public research sector faces the challenge of expenditure rationalisation • coordination between relevant bodies of state administration is still insufficient, particularly in terms of non-harmonized strategic policies and supporting measures, and overlaps of responsibilities in coordination of ESIF priorities and projects • potentially inefficient management of available EU funds, which could lead to further decrease of R&D performance
Strengthening private sector's R&I capability and improving the business innovation environment	<ul style="list-style-type: none"> • Croatia generally creates disincentives to innovation, especially in the context of lack of coordination at policy design and implementation levels • volume and investment of private businesses R&D remains at low levels, with low interest in cooperation with the public R&D sector • most problematic factors for doing business in Croatia include, according to WEF, inefficient government bureaucracy, policy instability, corruption, tax regulations, tax rates, access to financing and restrictive labour regulations • apparent mismatches between labour demand and supply and skills profile • low and decreasing public expenditures on R&D • inadequate public policies in support of innovation
Strengthening public R&I capacity	<ul style="list-style-type: none"> • mostly fragmented universities with faculties usually organised as individual legal persons, rather than departments of one legal person • low levels of integration of Croatian universities, especially when it comes to possibility of fast adaptation to international competition and achieving excellence • obstacles when it comes to commercialisation of research results and development of science-industry linkages • introduction of new, performance-based, institutional funding should lead towards more rational allocation of public funds and increase in performance of HEIs and PROs • trend of decreasing public funding sources for R&I activities

6.3 Meeting structural challenges

The issue of weak of coordination in design and implementation of R&I policies, significant developments have occurred since 2013. Namely, previously separated National Science Council (NSC) and the National Council for Higher Education (NCHE) were merged into the National Council for Science, Higher Education and Technological Development, which became the highest advisory body in the system. Also, the Business and Innovation Agency of Croatia (BICRO) has been merged with the Croatian Agency for Small Businesses and Investments (HAMAG) into a single agency called the Croatian Agency for Small Business, Innovation and Investment – HAMAG-BICRO. It supports investments in small economy, and establishment of SMEs and their business via loan and guarantees schemes, as well as through R&D grant schemes. It also provides support for innovative companies focused on technological development.

Several strategic documents have also been adopted during 2014, primarily Strategy for Education, Science and Technology and Strategy for Fostering Innovation of the Republic of Croatia 2014-2020. While the Strategy of Education, Science and Technology offers recommendations for the comprehensive reform of the Croatian education system, the Strategy for Fostering Innovation of the Republic of Croatia 2014-2020 has brought about 40 guidelines oriented towards facilitating development of innovations in Croatia. These highly anticipated strategic documents have introduced some new insights that can improve the policy approach to fostering innovation and productive use of knowledge, but their implementation remains to be observed.

Smart Specialisation Strategy has been adopted in 2016. The thematic areas identified within the preliminary competitiveness analysis underlying the Strategy remain very broad, covering the following specialisation areas: (1) Health and quality of life; (2) Energy and sustainable environment; (3) Transport and mobility; (4) Security; (5) Food and bio-economy. Within these five priority areas, 13 priority sub-areas are defined. Croatia's research capacities coincide with the industry's competitiveness in areas of telecommunications, electrical equipment, food processing, pharmaceuticals, engineering (machinery) and ICT.

In addition, the development of the integrated data base – the Croatian Research Information System (CroRIS) has been initiated in 2014, with the development of project documentation for the national Science and Technology Foresight Project (STF). STF involves systemic analysis of the long-term trends in science and technology in order to create and implement tools and methods for development and sustainable execution of evidence based policy in the area of RDI, specifically for development and monitoring of Smart Specialisation Strategy and other strategic documents, as well as to competitiveness, economic development and society.

The importance of the strengthening of the national innovation system has also been emphasised in the National Reform Programme 2015 Croatia and the Partnership Agreement with the EU and set as a national development priority.

The challenge of Strengthening private sector's R&I capability and improving the business innovation environment has mostly been tackled with fragmented and partial policy response. Government has tried to initiate many reforms in order to improve business climate, but reforms have so far been insufficient to eliminate the structural problems that hamper the country's growth potential. Most important developments include adoption of already mentioned Strategy for Education, Science and Technology and Strategy for Fostering Innovation of the Republic of Croatia 2014-2020, which introduced planned activities and measures which could foster development of innovations in the business sector and contribute to the overall improvement of the business innovation environment. However, the implementation of the Strategy for Fostering Innovation is quite slow and has not resulted in relevant improvements so far. Other developments include re-launch of several HAMAG-BICRO programmes aimed at innovation development in business sector and fostering science-industry linkages (see section 3.4.3).

Measures aiming to facilitating the access to capital have been envisaged within the Business Impulse 2015 Programme. There have been some improvements in this area, however, this challenge requires deep structural changes of the Croatian economy and national innovation system, which will require significant government efforts in the future.

As already mentioned, reforms of the higher education system have been initiated during 2013 and 2014. The Decision on multi-annual institutional financing radically changed the system of financing research activities from the State budget which has been in force since 1991. The awarding of project research grants is entrusted to the CSF and assumes a rigorous evaluation process that should end up with a smaller number of high quality research projects, up to 250 per call per year. This can put at risk significant segments of the national scientific base since Croatia has a relatively narrow financial base for scientific research due to low interest of private sector and a lack of diversified resources for competitive research funding. Strategy for Education, Science and Technology, adopted in October 2014, recommends significant reforms of the overall education system, ranging from preschool to higher education. However, proposed reforms can seem somewhat radical and their actual implementation remains to be seen in the future.

Several new funding mechanisms have been introduced during 2014 and 2015, including Centres of Research Excellence, Technology transfer offices (TTO) support programme and several re-launched programmes by CSF and UKF. At the same time, however, state budget resources for R&I funding have been announced to decrease in 2016 and 2017. In the context of low and inefficient absorption of EU funds and weak international competitiveness of Croatian HEIs and PROs, additional efforts need to be invested into development of integrated approach to innovation development and funding at public research institutions in Croatia.

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Abbreviations

ASHE	Agency for Science and Higher Education/Agencija za znanost i visoko obrazovanje
BERD	Business Expenditures for Research and Development/ Izdaci poslovnog sektora za istraživanje i razvoj
CASA	Croatian Academy of Sciences and Arts/Hrvatska akademija znanosti i umjetnosti
CBS	Croatian Bureau of Statistics/Hrvatski zavod za statistiku
CERN	European Organisation for Nuclear Research/Europska organizacija za nuklearna istraživanja
CIS	Community Innovation Survey
COST	European Cooperation in Science and Technology/ Europska suradnja u znanosti i tehnologiji
CSF	Croatian Science Foundation/Hrvatska zaklada za znanost
EHEA	European Higher Education Area/Europski prostor visokog obrazovanja
ERA	European Research Area/Europski istraživački prostor
ERA-NET	European Research Area Network/ Mreža europskog istraživačkog prostora
ERDF	European Regional Development Fund/Europski fond za regionalni razvoj
ERP Fund	European Recovery Programme Fund/ Fond Europski program za obnovu
ESA	European Space Agency/Europska svemirska agencija
ESIF	European Structural and Investment Funds/Europski strukturni i investicijski fondovi
ESF	European Social Fund/Europski socijalni fond
ESFRI	European Strategy Forum on Research Infrastructures/ Europski strateški forum za istraživačku infrastrukturu
EU	European Union/Europska unija
EU-28	European Union including 28 Member States/ Europska unija uključujući 28 država članica

FDI	Foreign Direct Investments/Direktna strana ulaganja
FP	European Framework Programme for Research and Technology Development/Europski okvirni program za istraživanje i tehnološki razvoj
FP7	Seventh Framework Programme/Sedmi okvirni program
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
GOVERD	Government Intramural Expenditure on R&D/ Izdaci državnog sektora za istraživanje i razvoj
GUF	General University Funds/ Fondovi visokih učilišta
HAMAG-BICRO	Croatian Agency for Small Business, Innovation and Investments/Hrvatska agencija za malo gospodarstvo, inovacije i investicije
HEIs	Higher education institutions/Institucije visokog obrazovanja
HERD	Higher Education Expenditure on R&D/ Izdaci sektora visokog obrazovanja za istraživanje i razvoj
HES	Higher education sector/Sektor visokog obrazovanja
HIT	Croatian Institute of Technology/Hrvatski institut za tehnologiju
IP	Intellectual Property/intelektualno vlasništvo
IPA	Instrument of pre-accession/Predpristupni instrumenti
IPR	Intellectual property rights/Prava intelektualnog vlasništva
IRCRO	Collaborative research development Programme
KET	Key enabling technologies/Ključne tehnologije
MEC	Ministry of Entrepreneurship and Crafts/Ministarstvo poduzetništva i obrta
MLPS	Ministry of Labour and Pension System/Ministarstvo rada i mirovinskog sustava
MRDEF	Ministry of Regional Development and European Funds/Ministarstvo regionalnog razvoja i EU fondova
MoE	Ministry of Economy/Ministarstvo gospodarstva

MSES	Ministry of Science, Education and Sports/Ministarstvo znanosti, obrazovanja i sporta
NCEEE	National Centre for External Evaluation of Education/Nacionalni centar za vanjsko vrednovanje obrazovanja
NCSHETD	National Council for Science, Higher Education and Technological Development/Nacionalno vijeće za znanost, visoko obrazovanje i tehnološki razvoj
NGO	Non-governmental organisations/Nevladine organizacije
OECD	Organisation for Economic Co-operation and Development/Organizacija za ekonomsku suradnju i razvoj
CROQF	Croatian Qualification Framework/Hrvatski kvalifikacijski okvir
PoC	Proof of Concept programme/ Program provjere inovativnog koncepta
PROs	Public Research Organisations/Javne istraživačke organizacije
RAZUM	Development of the knowledge-based companies Programme/Program razvoja na znanju utemeljenih poduzeća
RI	Research Infrastructures/Istraživačke infrastrukture
R&I	Research and innovation/Istraživanje i inovacije
R&D	Research and development/Istraživanje i razvoj
RTDI	Research Technological Development and Innovation/Istraživačko-tehnološki razvoj i inovacije
RTO	Research and Technology Organisation/Istraživačko-tehnološke organizacije
S&T	Science and technology/Znanost i tehnologija
SF	Structural Funds/Strukturni fondovi
SIIF	Science and Innovation Investment Fund/Fond za ulaganje u znanost i inovacije
SIPO	State Intellectual Property Office/ Državni zavod za intelektualno vlasništvo
SME	Small and Medium Sized Enterprise/Mala i srednje velika poduzeća
TEST	Technology Oriented Projects Programme/ Program Tehnološki orijentirani projekti
UKF	Unity through Knowledge Fund/Fond "Jedinstvo uz pomoć znanja"

VC	Venture Capital/Rizični kapital
VET	Vocational Education and Training System/Sustav strukovnog obrazovanja i osposobljavanja
YGIP	Youth Guarantee Implementation Plan/Plan implementacije Grancije za mlade

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Annex 1 – List of the main research performers¹³⁵

1. Pliva Hrvatska, Ltd;
2. Ericsson Nikola Tesla, Inc;
3. Končar- Electrotechnical institute, Inc;
4. Croatian Telecommunication, Inc;
5. Belupo drugs and cosmetics, Inc;
6. Podravka Food Industry, Inc;
7. INETEC- Institute for Nuclear technology, Ltd;
8. Privredna banka Zagreb, Inc;
9. King ICT, Inc.
10. M San Grupa, Inc. (wholesale).

¹³⁵ Authors' estimation

Annex 2 – List of the main funding programmes

Name of the funding programme	Timeline	Budget (in €m)	Target group
Research projects	2015	€4.6m	HEIs, PROs
Installation research projects	2015	€1.3m	HEIs, PROs
Partnership in research	2015/2018	€2m	HEIs, PROs, private companies
Young Researchers' Career Development Project – Training of Doctoral Students	2015	€3.5m	Young researchers/university teachers
Research scholarships for professional development of young researchers and post-doctoral students	2014	€4.9m	Young researchers/university teachers
The new programme for young researchers at universities	2015-2021/2025	€266m	Young researchers at universities
UKF-Crossing border grants	2015-	€1.4m	Croatian and foreign researchers from public and private sectors
Strengthening capacities for research, development and innovation	2015-2020	€9.3m	HEIs, PROs, private companies, public sector
RAZUM	2015-2017	€2.9m	Innovative companies
IRCRO	2015-2017	€1.8m	HEIs, PROs, private companies
PoC for researchers	2015-2017	€1.1m	Researchers
PoC for entrepreneurs	2015-2017	€1.9m	Entrepreneurs
Technology transfer at universities	2015-2017	€1.5m	Technology transfer offices at universities
Centres of research excellence	2015-	€0.33m	Centres of research excellence
NEWFELPRO	2013-2017	€7m	Experienced researchers

Euro exchange rate (as of 24 August, 2015) 1€=7.5HRK

Annex 3 – Evaluations, consultations, foresight exercises

- Industrial Strategy of the Republic of Croatia 2014-2020 (OG 126/2014), available at: http://www.mingo.hr/userdocsimages/industrija/Industrijska_strategija.docx (Last access: 25 July 2015);
- Draft of the Smart Specialisation Strategy (S3) ;
- Project documentation for the national Science and Technology Foresight Project (STF) was drafted during 2014 while the whole project will be developed in the period 2016-2018 supported by the EU funds (NRP, 2015).

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