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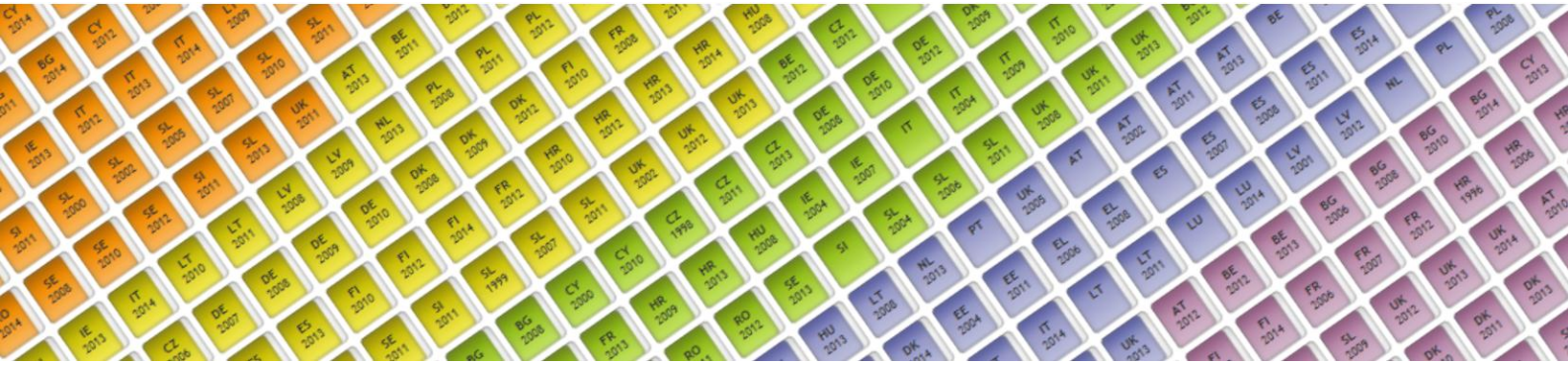

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Abstract

The report offers an analysis of the R&I system in Hungary for 2014, including relevant policies and funding, with particular focus on topics critical for two EU policies: 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 report identifies the structural challenges of the Hungarian research and innovation system and assesses the match between the national priorities and those challenges, highlighting the latest policy developments, their dynamics and impact in the overall national context.

Acknowledgments

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Executive summary

Hungary is a medium-sized European Union member state with a territory of 93,036 km^2 that had 9,908,798 inhabitants on 1 January 2013 (about 2% of the EU-28 total). The Hungarian GERD reached its highest value in the last two decades with a value of 1.41% of the GDP in 2013 according to Eurostat. This is a 22.6% growth compared to 2010. Business expenditures on research and development constitute the biggest share of the total R&D funding and stayed almost at the same level between 2010 and 2013 (47.3% and 46.9% respectively). The ratio of public funding within the financing sources for R&D decreased significantly from 39.3% in 2010 to 35.9% in 2013, as its growth could not keep up with the considerable aggregate growth rate of GERD. However, it should be noted that overall public funding for R&D expenditures increased from 0.45% to 0.51% of the GDP in the same period. These tendencies are in line with the target set by the government in its RDI strategy 2013-2020 accepted in June 2013. According to this strategy Hungary will increase its research and development expenditures to 1.8% of the GDP by 2020 and 3% by 2030.

Hungary is a unitary state with a centralised decision-making system with regard to major policy domains, including science, technology and innovation policies. Hungarian regions have neither democratically elected leaderships, nor any power to raise revenues, e.g. regional tax. Hungary has all the major elements of a potentially successful national innovation system (NIS). At operational level, the National Research, Development, and Innovation Office (NKFIH) is the governmental body responsible for research, development and technological innovation as of 1 January 2015[1]. This new office was established by Law LXXVI on "Scientific Research, Development, and Innovation" (approved on 25 November 2014) in order to integrate strategy-making and governance of research, development and innovation as well as to coordinate the major domestic RDI funding programmes. The NKFIH is the legal successor of the National Innovation Office (NIH) that was established in 2010. The new office is also responsible for the National Research, Development and Innovation Fund. This fund integrates the Hungarian Scientific Research Fund (OTKA) and the Research and Technological Innovation Fund (KTIA) programmes.

The main public research performers are the 16 institutes of the Hungarian Academy of Sciences that are responsible for 71.2% of all public research-development expenditures and employ 60.1% of all public research personnel (FTE). Among private research performers, multinational and large domestic companies have a clear dominance. More than half (56.6%) of the research-development expenditures are spent by foreign or foreign-dominated companies, and they employ 52.5% of all research personnel (FTE) in the private sector.

The innovation performance of Hungary improved between 2006 and 2013 as indicated by the Innovation Union Scoreboard reports. Despite some fluctuations, the performance relative to the EU average increased to 63% in 2013 from around 60% in 2006. Hungary performs below the EU average for most indicators analysing the performance of the Member States, especially for new doctorate students. High growth is observed for R&D expenditures in the business sector, at the same time R&D expenditures in the public sector declined.

[1] See at http://nkfih.gov.hu/

Concerning the new programming period 2014-2020, the Hungarian government will allocate similar amount of funding (€2,148.9m according to the Cohesion Policy database of the European Commission) for RDI purposes as in the past financial period 2007-2013. This means that 10.0% will be spent on RDI from the total budget available from the Structural Funds for Hungary. The largest new operational programme, the Economic Development Operational Programme (GINOP) will devote €2.3b (about HUF740b) to RDI.

By using the Innovation Union self-assessment tool, the following main strengths of the Hungarian RDI system and policy were identified:

- promotion of research and innovation is considered as a key policy instrument to enhance competitiveness and job creation and significant effort as reflected in the continuously growing GERD figure, is made to improve the performance of the RDI system;
- adequate and predictable public investment is secured through the RDI strategy and the Operational Programmes of the Structural Funds are intended to stimulate private investments so as to reach the R&D target set by the national RDI strategy;
- the largest PRO, the Hungarian Academy of Sciences (MTA) introduced several measures (e.g. Momentum programme, Visiting Scholars) in order to increase the efficiency and effectiveness of scientific research, as well as programmes to make researchers career more attractive for both foreign researchers and ex-pats working in research centres abroad;
- partnerships between higher education institutes, research centres and businesses, at regional, national and international level, are actively promoted and excellence is gradually becoming a key criterion in funding of the public R&D and the financing of the higher education organisations as envisaged by the most recent higher education concept published in October 2014;
- increasing attention is paid to building of a start-up ecosystem (i.e. the capital Budapest to become the start-up hub of Central-East-Europe by 2020) and several awareness raising events, competitions are organised in order to implement that vision.

The challenges of the Hungarian research and innovation system are still fairly similar to those of the previous year as the situation and framework conditions for RTDI have not changed much. Based on previous ERAWATCH country reports and the situation analysis of the most recent national STI policy documents, the following five major structural challenges could be highlighted:

1. Low level of innovation activities, especially those of the SMEs.
2. Low occurrence of co-operation in innovation activities between academia and business.
3. Insufficient quantity and supply of human resources for R&D and innovation.
4. Unfavourable framework conditions for innovation.
5. Deficiencies in the STI governance system and the institutional framework.

Even if no “quick fix” of the Hungarian STI governance system and institutional framework seems possible, there are a number of policy measures in place that address the low level

of research, development and innovation activities of companies (particularly SMEs), as well as their collaboration with public research institutions. Also, the exploitation of public research results including knowledge transfer and spin-off creation is not yet a well explored area, even if Technology Transfer Offices (TTOs) are established at all major HEIs. In addition, the attraction of young and mid-carrier professionals from companies to PROs and universities to introduce professional research management techniques, develop collaborations with companies and foreign R&D institutes, could significantly enhance institutional performance and excellence.

1. Overview of the R&I system

1.1 Hungary in the European RDI landscape

Hungary is a medium-sized European Union member state since 2004, with a territory of 93,036 km^2. According to the Eurostat database Hungary had 9,908,798 inhabitants on 1 January 2013 (about 2% of the EU-28 total). This means a slight decrease of 1.4% in the past 5 years, i.e. compared to the 2008 figure of 10,045,401. Hungary has a medium-sized, structurally, politically, and institutionally open economy. The Hungarian GDP per capita was €16,100 in 2010 and €17,200 in 2013. Compared to the EU28 average, the Hungarian GDP in terms of PPS (purchase power standard) was 66.9% in 2013. Between 2011 and 2013, the Hungarian real GDP growth rate in PPS compared to the previous year was 1.6%, -1.7% and 1.1% respectively. The Hungarian GERD reached its highest value in the last two decades with a value of 1.41% of the GDP in 2013 according to Eurostat[2]. This is a 22.6% growth compared to 2010. The trend is in line with the target set by the government in its RDI strategy accepted in June 2013. According to the National Research-Development and Innovation Strategy (2013-2020) Hungary will increase its research and development expenditures to 1.8% of the GDP by 2020 and 3% by 2030. Based on the data of the national statistical office (KSH), Hungarian small- and medium-sized companies originate 16.7% of their income from new or improved products. This ratio is 24% at large companies.

1.2. Main features of the R&I system

Business expenditures on research and development constitute the biggest share of the total R&D funding and stayed almost at the same level between 2010 and 2013 (47.3% and 46.9% respectively). The ratio of public funding within the financing sources for R&D decreased significantly from 39.3% in 2010 to 35.9% in 2013, as its growth could not keep up with the considerable aggregate growth rate of GERD. This decrease is even more remarkable if we consider a longer period as the government sector funded half (49.6%) of the total R&D expenditures in 2005. However, it should be noted that overall public R&D funding increased from 0.45% to 0.51% of the GDP between 2010 and 2013. Research and development funding from abroad has a quite high and increasing share of the GERD, i.e. 16.5 % in 2013, the growth was 24.3% compared to the previous year. Hungary is a unitary state with a centralised decision-making system with regard to major policy domains, including science, technology and innovation policies. Hungarian regions have neither democratically elected leaderships, nor any power to raise revenues, e.g. regional tax. In effect from 1 January 2013, new territorial administrative units, districts (NUTS3 level) were created within the 19 counties with no significant role regarding STI policy-making.

[2] This figure is 1.44% according to the publication of the Hungarian Central Statistical Office. (see KSH, 2014b)

1.3. Structure of the national research and innovation system and its governance

Hungary has all the major elements of a potentially successful national innovation system (NIS). At operational level, the National Research, Development, and Innovation Office (NKFIH) is the governmental body responsible for research, development and technological innovation as of 1 January 2015[3]. The new office was established by Law LXXVI on "Scientific Research, Development, and Innovation" (of 25 November 2014) in order to integrate strategy-making and governance of research-development and innovation as well as to coordinate the RDI funding. The NKFIH is the legal successor of the National Innovation Office (NIH) that was established in 2010 and its tasks included strategy-making and programme planning as well as international RDI collaboration. The new office is responsible for the National Research, Development and Innovation Fund. This fund integrates the Hungarian Scientific Research Fund (OTKA) and the Research and Technological Innovation Fund (KTIA) pogrammes. This integrated fund has a budget of HUF74.1b (about €247m) for 2015. In addition, the president of the NKFIH has the role to coordinate the RDI strategy-making, including the Operational Programmes supported by the Structural funds and elaborate the RDI funding instruments of the Hungarian government in collaboration with respective ministers and the president of the Hungarian Academy of Sciences (MTA).

With regard to research funding, OTKA used to be an independent national institution which, for more than twenty-five years since its establishment in 1986, supported internationally outstanding discovery research (i.e. basic research) at Hungarian institutions in a peer review system involving domestic and international reviewers. The activities of OTKA were primarily financed from the state budget and its grants provided extra resources to the best researchers and research institutions in Hungary.

Until the end of 2014, the other major funding source for RDI used to be the Research and Technological Innovation Fund (KTIA) that was based on innovation levies (i.e. 0.3% of the tax base) to be paid by medium-sized and large companies. From 1 January 2015 the newly established National Research, Development, and Innovation Office manages the National Research, Development and Innovation Fund that is responsible for all national public funding for research and innovation. According to the Law LXXVI (25 November 2014) on Scientific Research, Development, and Innovation the new fund is mainly based on the innovation levies (same rate as previously, 0.3% of the tax base) paid by companies with more than 50 employees and the contribution paid by the central budget (see further details of KTIA in Section 2.2).

Apart from provision of competitive funding for R&D activities by the KTIA, various Operational Programmes of the New Széchenyi Development Plan co-financed by the EU Structural Funds (2007-2014) used to be the main RDI funding sources. Both KTIA and the OPs were managed by the National Development Agency (NFÜ) until the end of 2013. From 1 January 2014 dedicated ministries became the successors of the managing authorities that were working under NFÜ. In the new programming period 2014-2020, the Prime Minister's Office and four ministries (i.e. Ministry for National Economy, Ministry of Human Capacities, Ministry of National Development and the Ministry of Agriculture) are

[3] See at http://nkfih.gov.hu/

responsible for the implementation of the Operational Programmes of the EU Structural Funds.

Regional innovation agencies were established in all seven regions in Hungary in 2005. These agencies established a network called RIÜNET in the same year in order to generate regional innovation processes, to harmonise and coordinate those actions, to organise technological innovation networks and to provide innovation services to SMEs and start-ups. Nevertheless, the regional innovation agencies receive minimal government support and their operation is mainly based on international funding programmes such as FP7 and INTERREG.

In the past few years there were a number of STI policy advisory bodies established. The most recent one is the National Science Policy and Innovation Board (NTIT) that was established by government decree 116/2013 (IX.25.)[4]. The president of the NTIT is the prime minister, and the co-chairman is the president of the Hungarian Academy of Sciences (MTA). The mandate of the board is to provide advice, evaluate and make recommendations on strategic issues of scientific, research and development and innovation programmes, the sustainable finance of these programmes and the evaluation methodology to be carried out at scientific institutions.

According to the Central Statistical Office (KSH, 2014b), there were 3,159 research units in Hungary in 2013. Companies operated 54.2% of all research units while higher education organisations hosted 41.7% of them. The main public research performers are the 16 institutes of the Hungarian Academy of Sciences that are responsible for 71.2% of all public research-development expenditures and employ 60.1% of all public research personnel (FTE). Among private research performers, multinational and large companies have a clear dominance. More than half (56.6%) of the research-development expenditures are spent by foreign or foreign-dominated companies, and they employ 52.5% of all research personnel (FTE) in the private sector. Hungarian research performers are relatively small at international level, only the pharmaceutical company Richter Gedeon appears in the 2014 EU Industrial R&D Investment Scoreboard ranked 166th with €141.4m invested in research and development in fiscal year 2013.

In 2013, more than 80% of total research-development expenditures (GERD) were spent in the fields of engineering sciences (54%) and natural sciences (26%). Pharmaceutical companies have the most intensive research-development activities (19% of BERD) followed by ICT, machinery and transport sectors.

[4] The new law LXXVI (of 25 November 2014) on scientific research, development and innovation does not mention this advisory body and no public information is available about its meetings since its establishment.

Main changes in 2014

- *Approval of the new Law LXXVI (of 25 November 2014) on "Scientific Research, Development, and Innovation"*
    - *Establishment of the National Research, Development and Innovation Office (NKFIH) that, from January 2015, integrates the activities of the previous National Innovation Office and ministry departments responsible for innovation policy*
    - *Establishment of the National Research, Development and Innovation Fund in January 2015 that integrates the Hungarian Scientific Research Fund (OTKA) and the former Research and Technological Innovation Fund (KTIA) programmes*
- *The Prime Minister's Office overtakes the role and responsibilities of the National Development Agency (NFÜ) responsible body for distribution of the Structural Funds*
    - *Dedicated ministries became successors of the managing authorities previously working under NFÜ*

Main Changes in 2013

- *Set up of a new advisory body - the National Science Policy and Innovation Board (NTIT)*
- *National Development Agency works within the prime minister's central office and is supervised by a government commissioner*

Main changes in 2012

- *Reorganisation of the research network of the largest PRO, the Hungarian Academy of Sciences (MTA)*
- *Set up of the National Development Cabinet (NFK) that co-ordinates all major governmental development actions including STI policy decisions and dissolution of the National Research, Innovation and Science Policy Council (NKITT)*

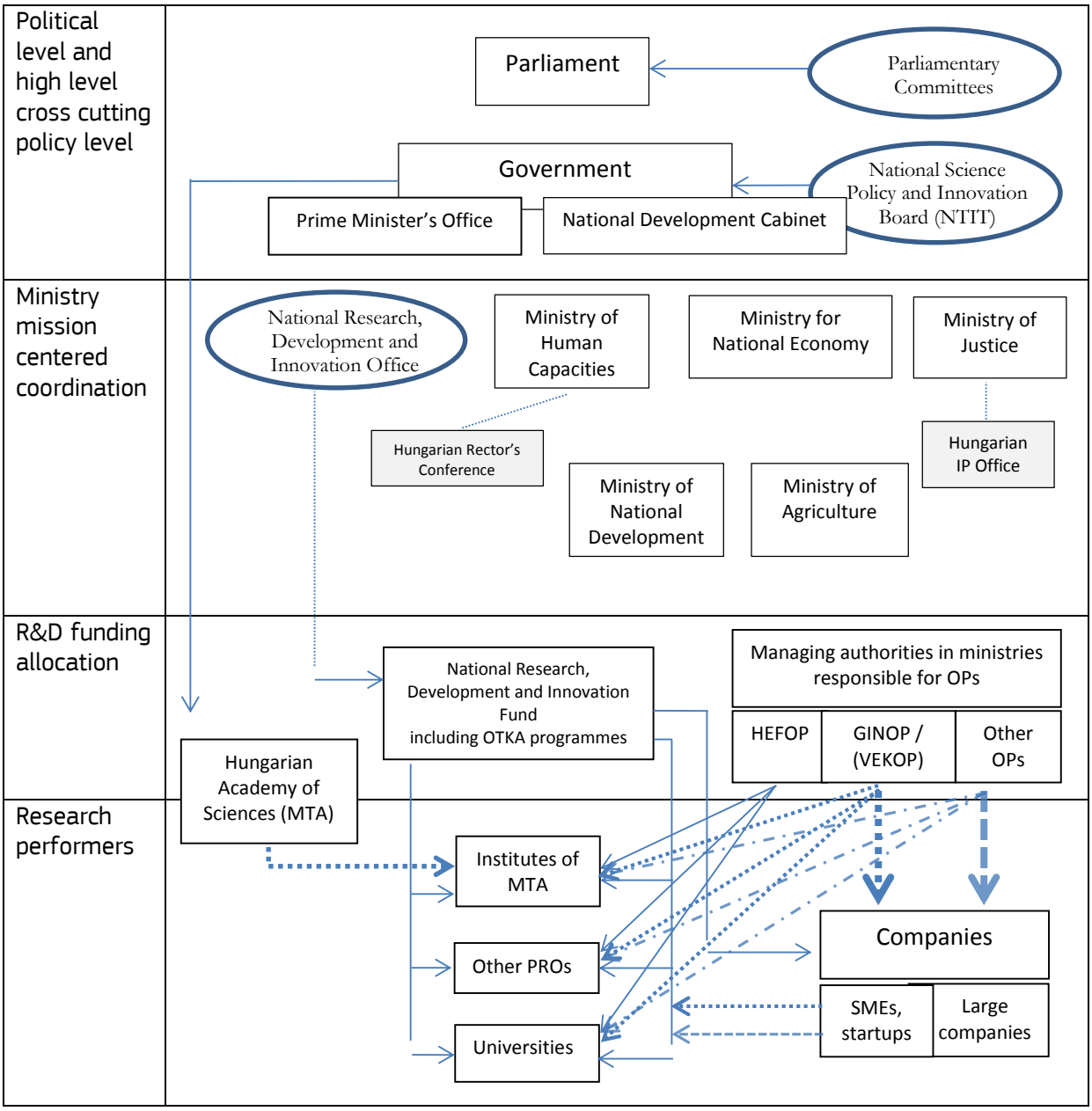
Main changes in 2011

- *No noteworthy changes*

Main Changes in 2010

- *Establishment of the National Innovation Office (NIH) as a new governmental body responsible for research, development and technological innovation*
- *Set up of the advisory body National Research, Innovation and Science Policy Council (NKITT) to co-ordinate governmental STI policy decisions*

Figure 1. Policy governance subsystem of the Hungarian research and innovation system



Source: author's own compilation

2. Recent Developments in Research and Innovation Policy and systems

2.1 National economic and political context

Hungary exited from recession in early 2013, and the expansion continued further in the first half of 2014. This allowed the government to avoid cutting research budget and to focus on the implementation of RTDI targets set by the National Research-Development and Innovation Strategy 2013-2020. According to the most recent data published by the Hungarian Central Statistical Office[5], the gross domestic product of Hungary – following an increase of 3.7% in the first quarter of 2014 – rose by 3.9% in the second quarter of 2014 compared to the corresponding period of the previous year. The volume of GDP was 3.8% higher in the first half of 2014 as a whole than a year earlier. The decreasing tendency of national economic investments – accounting for more than eight-tenths of gross fixed capital formation – stopped in the course of 2013 and turned into growth. Investment output was up by 22% in the first six months of 2014 compared to the corresponding period of the previous year. In particular, investments in machinery and equipment rose by 29% and construction investments went up by 15%. (KSH, 2014a)

Access to international bond markets has improved significantly, but the still high foreign currency indebtedness remains a key vulnerability. The Economic Survey of Hungary, 2014, produced by OECD[6], underlies that monetary easing has helped the return to growth. Successive cuts in the policy rate to historical lows have been largely transmitted to rates on new loans. The Funding for Growth Scheme and its extension has provided banks with free refinancing for SME lending. According to the forecast of the OECD, lending remains hampered by poor bank profitability and high non-performing loans. Foreign-currency mortgage relief schemes have begun to address high foreign-currency indebtedness.

Also, the International Monetary Fund (IMF) has raised its economic growth forecast for Hungary in its annual World Economic Outlook report published in October 2014[7]. It is acknowledged by the IMF that the Hungarian economy is likely to grow by 2.8% in 2014, while only 2% growth was estimated earlier in April 2014. Based on the IMF report, the Ministry for National Economy highlighted that the Hungarian economic model is functioning well. According to the international monetary organisation, the long-term economic growth of the Hungarian economy is ensured without financial constraints, the unemployment rate has been on a falling trend, while financial stability is increasing. Hungary has succeeded in achieving an economic upturn while keeping the budget deficit below 3% for the fourth consecutive year. Furthermore, Hungary was able to pay back both the IMF and the EU loan.

A first parliamentary election was held in Hungary on 6 April 2014 to follow the country's new constitution and electoral rules which were highly debated by the opposition and the international community. For the first time since Hungary's transition to democracy, the election had a single round and voters elected 199 MPs instead of 386 lawmakers

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[5] See KSH (2014a): Statistical Reflections. 72/2014, 3rd October 2014, Hungarian Central Statistical Office, Budapest.

[6] See OECD (2014a): OECD Economic Surveys: Hungary 2014, OECD Publishing.

[7] See IMF (2014): World Economic Outlook 2014. Legacies, Clouds, Uncertainties, October 2014, International Monetary Fund.

previously. In the general election, the previous centre-right government maintained its power and the Fidesz-KDNP coalition party was able to keep two-thirds majority in the Parliament. The **focus of the Hungarian economic policy** remained to support the economic growth and increasing of employment.

2.2 National R&I strategies and policies

R&I structure

The Hungarian research and innovation system could not be stabilised in the past few years as major innovation policy-making bodies and the RTDI funding structure were reorganised almost every year since 2010. The most recent major change happened at the end of 2014. After the new government came to power in June 2014, a government commissioner – the former president of the Hungarian Academy of Sciences – was appointed with the mandate to reinforce the resource allocation for RDI and to reorganise the National Innovation Office (NIH) into a new government agency called National Research, Development and Innovation Office (NKFIH)[8]. This restructuring is based on the law on "Scientific Research, Development and Innovation" that was approved by the Parliament on 25 November 2014 and came fully into force by 1 January 2015. According to this law, the new government office (i.e. NKFIH) is responsible not only for RTDI policy design but also for RTDI funding programmes through the newly created National Research, Development and Innovation Fund. This fund integrates OTKA and KTIA funding programmes (see Section 1.3 for details).

According to the justification of the new law on scientific research, development and innovation the new office (i.e. NKFIH) ensures the government level coordination of research and innovation policies, and provides stable institutional background of predictable financing as well as efficient and transparent implementation of RDI funding. Other reasons behind the establishment of the NKFIH office and the NKFI fund were to support the funding of the entire innovation chain starting from basic research through applied and experimental research. In addition, the new office operates the database of RDI projects that are financed by public resources.

With regard to the Hungarian research and innovation structure, it could be concluded that it involves all relevant stakeholders, especially through the Hungarian Innovation Association (MISZ) and its member organisations. With more than 700 members ranging from research institutes, innovative SMEs, large firms and NGOs, MISZ has been very active in producing declarations on new government initiatives that have impact on research and innovation.

National R&I strategy

The National Research-Development and Innovation Strategy (2013-2020), entitled "Investment into the Future" was approved by government decree 1414/2013. (VII.4.) after public consultation that started in November 2012. The strategy aims to raise the RDI investments, and as a result, to mobilise the Hungarian economy and to strengthen its competitiveness. The strategy set the target to raise the amount of R&D expenditures to

[8] See at http://nkfih.gov.hu/

1.8% of GDP and the BERD/GDP ratio to 1.2%, as well as to increase the number of researchers from 37,000 in 2012 to 56,000 by 2020.

Various benchmarking methods, including a SWOT analysis, have been used in the situation analysis part of the RDI strategy. The strategy clearly addresses the priorities of the EU and the Horizon 2020 programme as well as the importance of the "smart specialisation" and market developments.

The RDI strategy intends to support the creation of an environment in which public institutions, companies and innovative enterprises could develop and grow. The strategy focuses on three main areas of intervention: the knowledge creation, knowledge transfer and knowledge utilisation. The RDI strategy employs direct and indirect measures, such as tax reliefs, adjustments of capital market conditions, public procurement systems (also PCP) and innovation services to promote specialisation built naturally on the characteristics of local actors as well as market-driven and society-driven innovation processes. The strategy foresees a purposeful system building according to three priority axes: i) internationally competitive knowledge bases, ii) support of efficient knowledge and technology transfer collaborations and iii) companies that exploit intensively the results of modern S&T. The expected results of the above specific targets are: the stimulation of RTDI demand, establishment of an efficient support and funding system as well as the completion of the start-up ecosystem.

According to government decree 1414/2013, the RDI strategy should be used as a guiding document for planning the budget allocations for research, development and innovation for the next programming period 2014-2020. The vision, objectives and instruments of the RDI strategy are also taken into account in the elaboration of sectoral strategies and smart specialisation strategies (RIS3/S3). The National Reform Programme 2013 and the National Reform Programme 2014 make reference to the RDI strategy as well. (NRP, 2013 and NRP, 2014)

While the RDI strategy reflects the EU priorities and acknowledges the leverage effects of the EU instruments, it does not mention explicitly opportunities for joint programming and cross-border cooperation that could be exploited. However, the strategy aims to support the development of research centres to become part of the "global elite". This process requires the flow and exchange of domestic and foreign researchers, therefore the foreseen measures supporting the knowledge base have a strong international dimension, e.g. joining large international research networks (in particular ESFRI infrastructures) and supporting the mobility of researchers, including the reintegration of researchers. The RDI strategy foresaw that the measures will be designed in collaboration with an advisory body, while the implementation of the strategy will be review by an inter-ministerial coordination body and the key performance indicators will be monitored by the RDI observatory within the National Innovation Office (from 1 January 2015 National Research, Development and Innovation Office). Actually, no public information is available on the assessment of the RDI strategy since its approval. Nevertheless, the new Law on "Scientific Research, Development, and Innovation" defines that NKFIH is responsible for the elaboration of methodologies, background analyses, reports required for the planning of RDI programmes, concepts and strategies, as well as for the evaluation and monitoring of the funding programmes.

R&I policy initiatives

As mentioned above in this Section, the Hungarian Parliament passed a new Law LXXVI (of 25 November 2014) on "Scientific Research, Development, and Innovation". According to this new law, the National Innovation Office will be integrated into a new government office called National Research, Development and Innovation Office. From 1 January 2015 this new office is responsible for RDI strategy making and the distribution of national public research and innovation funding.

The support of research and the fostering of innovation can be considered as key areas of policy intervention. The Hungarian government intends to invest a significant part of the Structural Funds (about HUF740b) in R&I. As stated in the RDI strategy, the government would like to provide stable and foreseeable funding for fundamental research and to support the public research network, in particular the higher education and the research centres of the Hungarian Academy of Sciences.

Main research programmes

From January 2015, there are three main funding sources for research in Hungary:

- the National Research, Development and Innovation Fund (NKFIA)[9] that integrates
  - the Research and Technological Innovation Fund (KTIA),
  - the Hungarian Scientific Research Fund (OTKA),
- various Operational Programmes of the Structural Funds co-funded by the central budget.

The main source (after 2010 the only one) of KTIA is the innovation levy that is collected from medium-size and large companies based on their income before taxation. Companies pay every year about EUR160m (~HUF50b) out of which multiannual projects and new calls are financed. Between 2010 and 2011 no new tender was launched because of the obligations from previous years. Funding available from KTIA was reduced by ~€35m (HUF10b) in 2013 because of measures required for improvement of the balance of the central government's budget[10]. The strategic objectives of KTIA are to support technology transfer and the open, pre-competitive and social innovations as set in the RDI strategy. The territorial focus of KTIA is Central Hungary, the region of the capital Budapest, which has no access to Structural Funds. In 2014 only one call, "R&D competitiveness and excellence contracts" (VKSZ), was announced by KTIA with a total support of HUF7.2b (about €24m) to be allocated to 3-12 consortia.

With regard to relevant research programmes, KTIA published the following two research programmes in 2013:

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[9] See at http://nkfia.kormany.hu/index (Date of access: 23 February 2015)

[10] The 2013 central budget as set by the Law CCIV of 2012 planned HUF53b (about €183m) income from innovation levy and foresaw HUF37.6b (about €130m) for support of the Hungarian innovation, HUF5.9b (about €20m) for international RDI collaboration and HUF10b (about €34.5m) for the central budget. The 2014 central budget as set by the Law CCXXX of 201 planned HUF55b (about €190m) income from innovation levy and foresaw HUF35.4b (about €122m) for support of the Hungarian innovation, HUF3.5b (about €12m) for international RDI collaboration and HUF10b (about €34.5m) for the central budget.

- The National Brain Programme (NAP)[11] was launched in February 2013 to dedicate HUF12b (about €40m) to the support of research groups and the establishment of new research infrastructures in the next four years. An important objective of the National Brain Programme is to enable Hungarian researchers to join international research programmes and initiate international projects with participation of foreign researchers. The NAP programme is financed from the Research and Technological Innovation Fund (KTIA) and co-financed by the consortium members of the Hungarian Academy of Sciences. The NAP has two levels: the "A" programme supports the strengthening of the research infrastructure with HUF6.4b, while the "B" programme dedicates HUF5.6b for the research activities of 15-30 newly established research groups.
- The measure called "R&D competitiveness and excellence contracts" (VKSZ)[12] – and its parallel measure "support to RTDI umbrella projects" (ERNYO) focusing on the Central Hungary region – aims at supporting those strategic research and development activities that contribute to the competitiveness of Hungary with the creation of new R&D jobs, initiating strategic collaboration with PROs, development of prototypes of new, marketable products, technologies and services that contain significant intellectual added value as well as the development of sectoral networks indicated in the Science and Innovation Programme of the New Széchenyi Plan. This measure aims especially at further development of the results achieved by previous development pole and national technology platform programmes. The measure consists of two sub-programmes: a) integrated R&D projects and b) societal challenges. The funding available for this measure from KTIA was ~€33.6m in 2012. According to the initial plans, the winning consortia (3-6) could get additional ~€78.6m between 2013 and 2019. The budget (HUF7.2b (€24m)) of the most recent call (VKSZ_14), published on 21 October 2014, will be allocated to three priority areas: i) R&D in health industry, ii) R&D in energetics and iii) control technologies. The expected number of consortia is 3-12, at least one consortium in each sub-programme.

Until the end of 2014, the Hungarian Scientific Research Fund (OTKA)[13] used to be an independent scheme aiming at the improvement of the public research base and facilitation of international transfer of knowledge by providing independent support to scientific research and research infrastructures, financial assistance for young researchers and promotion of the achievement of scientific results that meet international standards. This focus of OTKA will remain under the new National Research, Development and Innovation Fund (NKFIA), through which the funding will be allocated instead of the central budget previously. OTKA will continue to provide financial support through competitive calls to scientific research projects, research infrastructures, and the publication of results that are expected to lead to the recognition of new scientific laws, the generation of new scientific knowledge, and the elaboration of new methods and techniques. OTKA provides

[11] See at http://nkfia.kormany.hu/?_preview=209ce22a-656d-c5e8-b269-00002bcfacd3 (Date of access: 23 February 2015)
[12] See at http://nkfia.kormany.hu/vksz-14 (Date of access: 23 February 2015)
[13] The Hungarian Parliament passed Law LXXVI on "Scientific Research, Development, and Innovation" on November 25, 2014, terminating the OTKA Office with legal successor and overruling the previous OTKA law as of December 31, 2014.

financial support via open competitive bidding. The annual budget of OTKA used to be around €20m between 2008 and 2011. It increased to €26.5m (HUF7.7b) both in 2013 and remained the same in 2014. The approved state budget for fiscal year 2015 contains the same amount for OTKA.

According to the Cohesion Policy Database of the European Commission[14], Hungary received a total of €2,125.6m from the Structural Funds to R&D and innovation, which means 8.5% of the total funding in the past financial cycle 2007-2013. Mainly the following Operational Programmes supported research and innovation through a large number of competitive measures[15]:

- Societal Renewal Operational Programme (TÁMOP): in particular measures TÁMOP 4.2 supported the increase of the research and innovation capacities of higher education organisations (299 projects were supported with HUF158.5b, about €60m) as well as new research programmes, including the implementation of some basic research projects;
- Societal Infrastructure Operational Programme (TIOP): in particular measures TIOP 1.3 supported the establishment of new research infrastructure at higher education organisations (76 projects were supported with HUF99.6b, about €34m)
- Economic Development Operational Programme (GOP): 4,140 beneficiary companies received HUF253.7b (about €875m) support for their innovation and research activities from GOP 1.3 measures between 2007 and 2012. The measure GOP 1.3.2 supported particularly the expansion of research capacities of companies (38 beneficiaries received HUF20b, about €69m support).

According to the Partnership Agreement signed by the European Commission and Hungary, the following programmes and particularly their competitive measures will support research and innovation in the new programming period 2014-2020:

[14] See at https://cohesiondata.ec.europa.eu/country?country=Hungary

[15] The data on various Operational Programmes come from the EMIR database of the former National Development Agency, now called Széchenyi 2020 portal. Unfortunately, there is no statistics available on programmes only dedicated to research. Data were retrieved on 18 October 2014.

Programme	Objective	Total budget (2014-2020)[16]
Economic Development and Innovation OP (GINOP) Priority 2	Reinforcement of research, technological development and innovation	€1,687.9m
Economic Development and Innovation OP (GINOP) Priority 7	Financial instruments to top up R&I support by 10%	€2,553.2m
Competitive Central Hungary OP (VEKOP) Priority 1	Improvement of the competitiveness of companies and development of the knowledge economy	€202.2m
Competitive Central Hungary OP (VEKOP) Priority 2	Financial instruments and development of services	€44.1m
Human Resources Development OP (EFOP) Priority 3	Increase research, innovation and smart specialisation in the field of human resources, improvement of the quality of education, etc.	€898.3m
Rural Development Programme (VP) Priority 1	Knowledge transfer and innovation measures	€25.3m

Source: NIH (2014a)

According to the planning documents, Hungary will allocate 60% of the total EU funding available in the period 2014-2020 for economic development purposes and about €2b for the development of the knowledge economy (i.e. support of company R&D and research programmes). More specifically, €2,148.9m or 10.0% of the total funding will be devoted to research and innovation projects, which is a similar amount and ratio of the total to the previous financial period 2007-2013. The above mentioned new research and innovation programmes clearly focus on specific priorities and address the priorities of the Horizon 2020 programme, namely reinforcement of "scientific excellence" and the leading role of industry. In line with the priorities defined by the European Union, Hungary focuses on strengthening the development of R&D infrastructure and capacity, especially in favour of the support of the competence centres of European interest. The main objective is to get involved in the international cooperation of excellence to the greatest possible extent through creating research-development capacities of high standard. (NRP, 2014) Also, one of the foci of the RDI strategy is to respond to global societal challenges. Nevertheless, the societal challenges are explicitly addressed only in the priorities of the new Human Resources Development OP.

Apart from the National Research-Development and Innovation Strategy 2013-2020, which has a generic character, there are two thematic R&I strategies in place:

- the National Environmental Technology Innovation Strategy that aims to create programmes and tenders based on the budget of the Operational Programmes of 2014-2020

[16] It should be noted that not all the budget of the enlisted Operational Programmes will be devoted to research and innovation, e.g. financial instruments.

- in connection to the National Energy Strategy 2030, an Energy Industry Development and R+D+I Action Plan was drafted in 2013 in the field of energy research-development and innovation in order to support the companies that build intelligent systems facilitating the regulation of electricity networks, which contributes to domestic employment and the encouragement of producing exportable products and services (nuclear supply, nuclear training, designing, implementing and operating intelligent systems).

According to Eurostat GBAORD figures, R&D financed from General University Funds (GUF) accounted for 27.6% and 23.2% of the total GBAORD in 2009, and 2012, respectively. Among the socio-economic objectives, the general advancement of knowledge had the highest weight in the Hungarian GBAORD throughout the period 2009-2012 and reached its peak (45.7%) in 2011. The high share of this objective is most likely due to the fact that the majority of the Hungarian STI policy schemes are meant to advance broad objectives (e.g. enhancing competitiveness), as opposed to narrowly defined themes. Other relevant areas of the total GBAORD are transport, telecommunications and other infrastructures (slightly above 10%), health (9.5% in 2009 and 8.0% in 2012) as well as industrial production and technology (13.7% in 2009 and 5.3% in 2012). Agriculture lost some weight over the last four years (8.6% in 2009 and 3.8% in 2012).

2.3 National Reform Programmes 2013 and 2014

With reference to research and innovation-related goals as presented in the National Reform Programmes 2013 and 2014 (NRP), the following major achievements could be reported:

1. Hungary made significant progress in the last two years towards the quantitative R&D target set by the NRP that aims to increase the level of research and development expenditures to 1.8% of the gross domestic product (GDP) by 2020. According to Eurostat, the R&D expenditures increased further in 2013 and reached 1.41% of the GDP. This means a 15.5% nominal increase in 2013 compared to 2012, after an 8% increase in the previous year. The structure of the increase is advantageous as companies increased their research and development expenditures by 22.2%. Funding from abroad grew the most dynamically, close to one-quarter (24.3%). Also, the total number of research personnel grew by 5%.
2. The National Research-Development and Innovation Strategy 2013-2020 entitled "Investment into the future" was produced in 2012 in order to ensure the achievement of the research and development targets. After public consultation in November-December 2012, the RDI strategy was approved by government decree 1414/2013. (VII.4.) on 4 July 2013. The RDI strategy plans to solve the problems identified in the assessment with the following means: encouraging smart specialisation, creating a sustainable support system that ensures equal opportunities, providing stable financing conditions, raising public awareness and strengthening the acknowledgment of knowledge and technology, and creating a stable, innovation-friendly economic and regulatory environment. (NRP 2014)

3. The National Smart Specialisation Strategy (S3) was approved by the government on 14 November 2014[17]. All the seven Hungarian regions elaborated their S3 strategies after a series of workshops involving regional stakeholders by the end of May 2013. Then a draft White Book entitled "S3 White Book. Smart Specialisation Directions of Hungary" was published for public consultation by the Ministry for National Economy in November 2013. Country-wide events took place in autumn 2013 to make the methodology and the so-called entrepreneurial discovery process (EDP) widely-known so as to assist the preparation of the S3 process. In the first part of 2014, a scientific supervisory board was established to elaborate the methodology and to monitor it constantly. After the new government was formed in June 2014, a government commissioner was appointed by the prime minister who became responsible for setting up the National Research, Development and Innovation Office. He was responsible also for the finalisation of the S3 strategy, which is a pre-condition to get access to the Operational Programmes dedicated to research and innovation in the EU financial planning period 2014-2020. By October 2014 county level workshops took place in all the 19 counties to define the specialisations of these territorial units. As a result a draft S3 strategy was published for public consultation on 3 October 2014. The government approved the national S3 strategy by government decree 1640/2014. (XI. 14.) on 14 November 2014[18]. Besides, the document "Research infrastructures in Hungary" was prepared that set out the Hungarian participation in the large European research infrastructure projects that are, where appropriate, included in the Roadmap of the European Strategy Forum on Research Infrastructures and the development of the national research infrastructures[19].

4. The Science Policy Strategy (2014-2020) was mentioned both in NRP 2013 and 2014 as being under elaboration. A working group was set up for the preparation of the Science Policy Strategy, in which the Hungarian Academy of Sciences was actively involved. As a result, the draft strategy was published for public administration consultation in September 2013. (Government, 2013) After the integration of stakeholders' comments, the strategy was ready to be submitted at the secretary of state meeting after the formation of the new Government in June 2014. By December 2014, no new public information was available on the status of the strategy. The draft strategy had the following three main objectives: to develop research capacities; to improve the effectiveness of scientific research and increase the international visibility of Hungarian science as well as to support the collaboration between education, research and innovation. Other objective of the strategy and the scientific policy interventions is that the Hungarian academic sector – institutes of higher education, institutes of the Hungarian Academy of Sciences, research facilities supported by the state budget and non-profit institutions – should be able to get involved in the programmes of Horizon 2020, and to receive the appropriate European Science Fund "enabling" grants for that. (NRP 2014)

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[17] See Section 2.6 for further details of the status of the National Smart Specialisation (RIS3) strategy and (NIH, 2014a).

[18] The approved S3 strategy is available at: http://www.s3magyarorszag.hu/documents/224092/253257/national_smart_specialisation_strategy_en.pdf (NIH, 2014a) (Date of access: 23 February 2015)

[19] The strategy on research infrastructures is available at: http://www.s3magyarorszag.hu/documents/224092/253257/research_infrastructures_en.pdf (NIH, 2014b) (Date of access: 23 February 2015)

5. With regard to the development of the innovation ecosystem, the Budapest HUB working group, involving a large scale of stakeholders from the start-up sector, became operational in 2013, and drafted the "Runway Budapest 2.0.2.0 - A Start-up Credo" document. The NRP 2014 foresees that the Budapest HUB working group will continue its work in the field of education and training, taxation and regulation, and in assessing access to funds. The examination of the results and their possible implementation are in progress. The elaboration of direct support measures was carried out within the framework of the Economic Development and Innovation Operational Programme (GINOP) that is under approval by the EC.
6. Measure #59 in NRP 2014, aiming at the establishment of a comprehensive incentive system of R&D and innovation activities, will be implemented within the framework of the GINOP "Knowledge economy development" priority axis. According to the draft OP, support measures will be launched in order to strengthen research, development and technological innovation.

2.4 Policy developments related to Council Country Specific Recommendations

No country specific recommendations relevant to the research and innovation policy in Hungary have been adopted by the council of the European Union.

2.5 Funding trends

2.5.1 Funding flows

The national R&D investment target is stated in the National Reform Programmes for 2013 and 2014, as well as in the National Research-Development and Innovation Strategy (2013-2020) that was approved in June 2013. According to these documents, the Hungarian government aims to raise the amount of R&D expenditures to 1.8% of GDP by 2020 and 3.0% of GDP by 2030. The strategy also declares that the BERD/GDP ratio should reach 1.2% by 2020.

The Hungarian GERD was fluctuating between 0.9-1.17% of the GDP between 2000 and 2010. The economic crisis had severe impact on the Hungarian economy. According to the forecasts of Eurostat, the Hungarian GDP in nominal terms will reach its 2008 value only in 2014. Even in this situation the government maintained its R&D target and did not cut salaries, neither laid off civil servants in public research institutions. The government would increase the number of researchers by 50% up to 56,000 (from 37,000 in 2012) in order to achieve the GERD/GDP target by 2020 set by the RDI strategy. The challenge is, on the one hand, to secure the supply of qualified researchers and attract young researchers into PROs and HEIs as the age pyramid of many research units is heavy on the top. On the other hand, the government should provide incentives – in addition to the tax incentive for employment of PhD researchers at companies that was introduced in January 2013 – and create an environment in which the business sector would create more jobs for researchers.

As reported above in Section 2.3, Hungary made significant progress in the last two years towards the quantitative R&D target set by the National Reform Programme that aims to

increase the level of research and development expenditures to 1.8% of the GDP by 2020. It should be highlighted that GERD grew in all years between 2009 and 2013. According to the most recent data published by Eurostat, R&D expenditures increased further in 2013 and reached 1.41% of the GDP[20], which achievement was brought by BERD. Also, the total number of research personnel grew by 5%. If this trend continues, the R&D target set by the RDI strategy could be reached by 2020.

Table 1. Basic indicators for R&D investments

	2009	**2010**	**2011**	**2012**	**2013**	**EU-28 (2013)**
GDP growth rate	-6.8	1.1	1.6	-1.7	1.1	0.1
GERD (% of GDP)	1.14	1.15	1.2	1.27	1.41	2.02
GERD (euro per capita)	106.4	112.4	120.6	126.6	142.8	539.2
GBAORD - Total R&D appropriations (€ million)	426.6	349.3	296.2	337.4	600.9	90,505.6
R&D funded by Business Enterprise Sector (% of GDP)	0.53	0.55	0.57	0.6	0.66	1.1*
R&D funded by Private non-profit (% of GDP)	0.01	0.01	0.01	0.01	0.01	0.03*
R&D funded from abroad (% of GDP)	0.12	0.14	0.16	0.2	0.23	0.2*
R&D performed by HEIs (% of GERD)	21.7	19.9	20.2	18.4	14.4	23.6
R&D performed by Government Sector (% of GERD)	20.1	18.5	15.7	14.4	14.9	12.2
R&D performed by Business Enterprise Sector (% of GERD)	57.2	59.8	62.4	65.6	69.4	63.3
Share of institutional public funding for R&D	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Employment in high- and medium-high-technology manufacturing sectors as share of total employment	7.9	8.1	8.5	8.3	8.5	5.6
Employment in knowledge-intensive service sectors as share of total employment	34.2	35.0	34.5	35.0	36.0	39.2
Turnover from Innovation as % of total turnover	N.A.	13.7	N.A.	N.A.	N.A.	13.4**

Notes:
* Data from 2012,
** Data from 2010
Source: Eurostat database

[20] This figure is 1.44% according to the publication of the Hungarian Central Statistical Office. (see KSH, 2014b)

Apart from the increase of the GERD, also the R&D personnel grew by 3.1% in 2013 compared to the previous year, while the calculated number (FTE) grew by 5.0%. Since 2009, the R&D personnel (FTE) increased by one-quarter (24.7%). The share of research and development investments out of the total national investments also increased from 0.75% to 1.63% in the period 2009-2013. The growth was especially high in 2012, while the increase was 22.5% in 2013 thanks to massive investment in public R&D infrastructure. The majority of the research and development expenditures were devoted to experimental development (48.9%), 31.1% to applied research, while 19.9% of GERD was spent on basic research. The expenditures spent on experimental research grew the most (58.4%) between 2009 and 2013 while the basic research expenditures increased only by 10% in nominal terms in the same time period. (KSH, 2014b)

The GERD per capita increased by 34.2% in the period 2009-2013, still it reached only one-quarter of that of the EU-28 average (26.4%). Nevertheless, it is a positive development that companies located in Hungary invest steadily increasing amounts on research and development. The R&D funded by the business enterprise sector grew from 0.53% of the GDP in 2009 to 0.66% in 2013 which is 60% of the EU-28 average.

The business expenditures on research and development constitute the biggest share of the total R&D funding and stayed almost at the same level between 2009 and 2013 (46.4% and 46.8% respectively). Public funding decreased significantly from 41.9% in 2009 to 35.9% in 2013, as its growth could not keep up with the considerable aggregate growth rate of GERD. This decrease is even more remarkable if we consider a longer period as the government sector funded half (49.6%) of the total R&D expenditures in 2005. However, it should be noted that overall public funding increased from 0.45% to 0.51% of the GDP in the same period. Research and development funding from abroad has a quite high and increasing share of GERD (10.9% in 2009 and 16.6% in 2013).

The patterns of R&D performance by sectors became similar to the EU-28 average in the period 2009 and 2013. The business enterprise sector increased its share from 57.2% to 69.4% in this period (63.3% in EU-28). The higher education organisations underperformed the EU-28 average (23.6%), because their share decreased slightly in the past five years from 21.7% to 14.4%. The research performance of the government sector was shrinking from 20.1% to 14.9% which is close to the EU-28 average (12.2%). It should be highlighted that R&D performance of both companies and public research organisations is rather concentrated. More than half of the total business expenditures on R&D were spent by 8% of the total business R&D units. In the case of public research organisations, the 16 research institutes of MTA are responsible for 71.2% of all government sector research expenditures.

The Structural Funds play a prominent role in the total national R&D funding, nevertheless no annual statistical data is available on the R&D funded by the Structural Funds. According to the Cohesion Policy Database of the European Commission[21], Hungary received a total of €2,125.6m from the Structural Funds to R&D and innovation between 2007 and 2013. The annual amount could be estimated around €300m that makes about one-quarter of the GERD in 2013. Certainly, this is a strong simplification, because this share also includes innovation expenditures, but nevertheless it highlights the significance of the Structural Funds in GERD.

[21] See at https://cohesiondata.ec.europa.eu/country?country=Hungary

Growth in venture capital investments has been the highest of all Member States in 2012 (0.069% of the GDP) when most of the Jeremie funds were launched, but then this figure fell back to 0.018% of the GDP in 2013.

The employment in high- and medium-high-technology manufacturing increased slightly between 2009 and 2013. The Hungarian figure of 8.5% in 2013 is one of the highest in the EU-28 and overperforms the community average by more than 50% thanks to the several multinational companies employing highly qualified personnel in their manufacturing plants in Hungary. Also the employment in knowledge-intensive service sectors grew between 2009 and 2013, and the figure of 36% in 2013 is close to the EU-28 average (39.2%).

Although, the latest figures beyond 2010 are not available in the Eurostat database, the same development could be identified concerning the turnover from innovation. For the last available year, 2010, Hungarian organisations received 13.7% of the total turnover from innovation which was slightly higher than the EU27 value for that year.

According to the eCORDA database (status 1 July 2014), altogether 1,582 Hungarian projects received a total of €280.26m funding from the 7th Framework Programme between 2007 and 2013. This total amount is 22% of the GERD in 2013 and two-thirds of the combined GOVERD and HERD in 2013. Dividing by seven the total amount of the R&D funded by the FP, still about 10% of the total public R&D was financed by the FP, although it is just about 3% of the GERD.

If we compare the above estimates with the annual budget of the two main national funding instruments, (i.e. KTIA had about €120m and OTKA €26.6m budget in 2013) we can conclude that the EU funding plays a key role as a national public funding instrument for research and innovation.

2.5.2 Project vs. institutional allocation of public funding

From 1 January 2014, all managing authorities that used to be controlled by the National Development Agency (NFÜ) in the period 2007-2013 work under the Prime Minister's Office and four ministries that are responsible for the implementation of various Operational Programmes co-financed by the European Union in 2014-2020. In addition, all the other intermediary bodies responsible for managing Structural Funds have been integrated into dedicated ministries by 15 April 2014. Responsible ministries for allocation of Operational Programmes co-financed by the European Union in 2014-2020 are the following:

- Ministry for National Economy: Economic Development and Innovation OP (GINOP), Competitive Central-Hungary OP (VEKOP), Territorial and Settlement Development OP (TOP)
- Ministry of Human Capacities: Human Resource Development OP (EFOP)
- Ministry of National Development: Intelligent Transport Development OP (IKOP), Environmental and Energy Efficiency OP (KEHOP)
- Ministry of Agriculture: Rural Development and Fisheries OP
- Prime Minister's Office: Coordination OP

Out of the above OPs, only the GINOP, VEKOP and EFOP will allocate project based funding for research and innovation. The allocation of funding follows the EU regulation, i.e. in a competitive manner based on calls for proposals.

Apart from the above changes in the allocation mechanism of the OPs in the new financing period 2014-2020, there has been no legislative reform that influences the legal framework for the allocation of R&D project and institutional funds.

Concerning state higher education organisations, several concepts were elaborated and discussed in the past five years by the Hungarian Rector's Conference and other stakeholders to reform the higher education system and its financing. After the first reading by the government in mid-October 2014, the state secretariat of the Ministry of Human Capacities responsible for higher education published the draft higher education concept entitled "*Changing gears in higher education. Directions of performance based development of higher education*". This new concept foresees major changes in the way the HEIs are financed but does not specify how the new funding system, based on more concentrated resource allocation, will support the achievement of international quality standards in HEIs. The foreseen performance indicators of HEIs are: i) cost of teaching by specialisations, ii) cumulated number of credits, iii) increase of the competence level of students, iv) number of diplomas, v) drop-out rates and vi) scientific measures (i.e. number of publications in foreign languages, technology transfer projects, patent applications, PhDs awarded, scientific prizes). In particular, the strategy expects that HEIs will be able to rise the funding through research grants from industry (the current level is 2-4% of the HEI's budget). In addition, the government will support the entrepreneurial and "third mission" activities of universities through technology transfer and spin-off activity that is regulated by intellectual property rights. (Government, 2014b)

The austerity measures had a major impact on the institutional funding of the higher education organisations that decreased by one-third between 2009 and 2013. The total sector got an institutional funding of €424m (HUF123b) in 2013 which corresponds to the budget of a bigger Western-European university. In 2014 the institutional funding of HEIs remained at the same level as they received a total of €469m (HUF136b). In 2015 the central budget will provide only HUF7b (a mere €23m) more compared to 2014 (a total of HUF143b). It should be noted that the decrease of institutional budgets was quite uneven among the HEIs, as the shrinking of their budget depended on the evolution of the number of students and the specialisation of the respective HEIs. The priority was given to natural science and engineering specialisations, while the social science faculties suffered the most. At the same time, the HEIs got access to substantial funding from different Operational Programmes of the Structural Funds 2007-2014. This funding was distributed through competitive measures (i.e. TIOP and TÁMOP) through which HEIs were able to establish new research centres, renew their research infrastructure and launch new research programmes, including the implementation of some basic research projects. No analysis or assessment is available on this topic, however the size of the project-based funding could be estimated similar to the institutional funding of HEIs. This view is supported by the state-secretary for higher education who estimates that HEIs could have access to funding from OPs in the order of about HUF200b (€666m) per year in the years to come. The draft higher education concept published in October 2014 describes the average pattern of the budget of HEIs in the following way: about 50% institutional funding, 24% competitive public funding (e.g. operational programmes), 22% own incomes (i.e. tuition fees, services), 2-4% direct R&D funding from third parties, and less than 1% donations.

The institutional public funding for research and development decreased significantly in the past few years. The Hungarian government's central budget spends every year less on R&D. Therefore, institutional funding is vital for the operation of research units at higher education organisations and PROs. There used to be two principal channels for providing such funding: block funding for R&D activities conducted at HEIs, and support to the largest PRO, the Hungarian Academy of Sciences[22]. However, higher education organisations have not received block funding from the Ministry of Human Capacities since 2011 when the Convergence Programme cut almost by half the funding of HEIs.

According to its annual report, the Hungarian Academy of Sciences (MTA) received HUF43.5b (€149m) from the Hungarian central budget in 2012 out of which HUF34.3b (€118m) was institutional support. In addition, the MTA institutes earned HUF34.4b (€117m) from various national and foreign grants, in particular from the Research and Technology Innovation Fund (KTIA). (MTA, 2013)

In sum, it could be concluded that both the Hungarian higher education organisations and the largest PRO network, the MTA, are funded by about half-half from institutional funding and project-based funding. Even if no statistical data are publicly available on the project funding, in particular on the R&D allocation of the Structural Funds, it could be estimated that the share of institutional funding decreased in the budget of HEIs drastically in the past few years. This trend is likely to be continued because the government would allocate more funding from the Structural Funds to research and innovation, while HEIs can access them only through project applications.

Institutional funding

Institutional assessment is not playing a key role in institutional funding allocations. Government decree 50/2008 (III.14.) regulates the calculation of the institutional funding of HEIs. The basic principles are the following:

- education support that is calculated based on the number of full time students inscribed, the type of education, level of education (i.e. BA, MA, PhD); the norms per student are differentiated by specialisations (e.g. medicine, engineering, humanities).
- research support that is calculated based on the number of teachers and researchers (FTE); number of state financed PhD students (FTE); number of qualified staff out of teachers (FTE); number of teachers that get qualified (i.e. PhD and higher scientific qualifications) in the current and previous two years; and the number of awarded scientific qualifications in the current fiscal year.
- maintenance support that is based on the size of the infrastructure.

The largest PRO, the Hungarian Academy of Sciences (MTA), receives its funding from the central budget that is allocated to its research centres through criteria of scientific excellence. According to the annual report of MTA, two-thirds (65.7%) of the budget directly support scientific activities. Close to one third of this amount is allocated through internal tenders, e.g. for renewal of scientific infrastructure. Apart from this, no public

[22] Unfortunately, no statistical data are available neither on institutional funding nor on block funding provided for state-owned higher education organisations.

information about the evaluation mechanisms of allocating institutional funding could be identified.

Project funding

Until the end of 2014, the largest funds used to be the Research and Technological Innovation Fund (KTIA), and various Operational Programmes of the Structural Funds, while the bottom-up funding was provided by a smaller fund, called Hungarian Scientific Research Fund (OTKA). As presented in Section 2.2, the National Research, Development and Innovation Fund integrates both KTIA and OTKA funding programmes from January 2015. The largest STI policy support schemes are co-financed by the EU Structural Funds, and given the cuts in domestic public funding, the balance has shifted significantly towards EU funds. Actual funding figures are not publicly available, and using that metric might lead to a somewhat different picture, but probably still with a larger share of EU funds.

The Research and Technological Innovation Fund allocates funding through several calls that clearly specify the activities to be carried out, the expected results indicators, as well as the conditions to be fulfilled by the applicants. Similar mechanism is in place for the calls for the Operational Programmes. The proposals are evaluated by the experts requested by the bodies responsible for the management of the Operational Programmes.

The domestic research fund OTKA has provided bottom-up funding for fundamental research projects of researchers or small research teams that are based at a Hungarian research organisation. The annual budget of OTKA for 2014 was €26.5m, the same as in 2013. The average size of a funded research project has been a few million HUF. A successful applicant researcher could get a maximum amount of HUF3m (about €10,000) per year and the maximum duration of a project has been three years. The funding is allocated on a competitive basis and appraised through a peer review system. The proposals are evaluated on the basis of the following criteria: originality of the fundamental research, scientific relevance, novelty, expected results, scientific and societal benefits, scientific background, institutional conditions and guarantees, justification and reality of funding requested, planned working hours, scientific results, publications so far, results of previous OTKA experiences. The peer-review has been carried out by Hungarian scientists on a voluntary basis requested by the OTKA secretariat. OTKA has continuously tried to involve a greater number of foreign experts in remote peer review, which has been facilitated by the fact that all proposals (with the exception of 'Hungaricum' proposals) have been submitted in English since 2009. According to the OTKA self-evaluation report the percentage of foreign reviewers has continuously grown since 2009, i.e., from 9.51% in 2009 to 28.9% in 2014.

International peer review of research proposals is not yet typical, although the MTA applies more and more frequently this type of evaluation in its funding programmes, e.g. the Momentum Programme. This programme aims at the renewal of the research teams of the MTA and participating universities via attracting outstanding young researchers back to Hungary. The impact and success of this application model is highly acclaimed and recognised even by the international scientific community whose members participate in the selection board.

Another recent good example is the "Start-up_13" scheme that was launched in June 2013 in order to support the development of the Hungarian start-up ecosystem and more specifically the development of technology start-up companies. The National Innovation

Office (NIH) organised an international peer-review that involved two foreign experts. As a result of the evaluation, in October 2013 four companies were announced to receive the title of "accredited technology incubator" that enables them to participate in the "Start-up_13" programme.

In order to carry out international peer review, applications should be written in English, which would be a major change of the current practice that requires only a short summary of the project in English, if any.

Other funding allocations

No other funding allocations could have been identified.

Assessment

The balance between the project funding and institutional funding could be seen as appropriate in Hungary. While public financing of the largest PRO, the MTA remained stable, the institutional R&D funding is significantly decreased in the higher education sector. This decrease could not be balanced by Operational Programmes of the Structural Funds. Competitive project based funding is already relatively high especially in smaller HEIs while in large, traditional state universities the institutional block funding still prevails. In most cases there are several research groups at HEIs that can attract and manage very efficiently project based funding while others – that are usually outside of the priority areas of the RDI strategy – should rely on institutional research funding, if any. The other issue that hinders the increase of project based funding is the governance structure of universities that does not favour the operation of research groups/teams that are mainly financed through R&I projects. Furthermore, the administration and research support is not always prepared for managing large scale research and innovation projects due to the lack of capacities and experience. Also, the generally low basic salaries of researchers make academic and research jobs not attractive for young graduates.

The recent policy documents, such as the RDI strategy and the new higher education concept entitled "*Changing gears in higher education*" published in mid-October 2014, recognise the above mentioned barriers and present an appropriate situation analysis. Their strategic objectives and priorities could improve the performance of the research and innovation system, but the way they will be implemented is a challenge. (Government, 2014b)

2.5.3 R&I funding

There are a large number of measures in place that cover the entire research and innovation process. Bottom-up funding for fundamental research is provided by OTKA, larger scale (applied) research and innovation projects are funded by the Research and Technological Innovation Fund (KTIA) and various operational programmes of the Structural Funds. Hungary has one of the most beneficiaries of financial engineering instruments such as loans, guarantees and venture capital in the Economic Development Operational Programme (GOP) of the New Széchenyi Development Plan. Altogether 28 Jeremie funds were established between 2010 and 2013 that significantly improved the access to financing in the early stage of innovation. Nevertheless, there is still a scarcity of funding

available in the "valley of death" stage. The situation could be improved by support of proof-of-concept phase of innovation.

As stated in the National Research-Development and Innovation Strategy 2013-2020, Hungary will increase its research and development expenditures to 1.8% of the GDP by 2020 and 3% by 2030. A complementary target of the strategy is that BERD will reach 1.3% by 2020. The public measures clearly reflect this objective as several measures aim at leveraging greater private sector investments, e.g. support to market-oriented R&D activities, development and strengthening of research and development centres. The most recent indication of the success of this effort is that the companies increased their research and development expenditures by 22.2% according to the Central Statistical Office (KSH, 2014b).

Innovative financing solutions such as private-public-partnerships are not really explored even if there was a pilot pre-commercial procurement (PcP) programme carried out by the National Innovation Office in 2012 and this tool is mentioned in the most recent RDI strategy 2013-2020. This strategy foresees measures that are dedicated explicitly to innovative SMEs and positively discriminate innovative SMEs in certain restricted areas of pre-commercial procurement (PcP). More specifically, the RDI strategy would increase the public demand for innovation through PcP actions. New tools for intensifying the dynamics of innovation in the public sector through PcP are foreseen in the fields of health care, environment protection, energy, education and transport. Also, the National Smart Specialisation Strategy sees the opportunity to launch an experimental programme in order to examine how much the Hungarian application of foreign best practices requires the amendment of regulations in force and the introduction of new legislation. (NIH 2014a)

The indirect measures for R&D play a minor role compared to direct funding. The measure 200% of R&D expenditures deductible has been in place since 1996. The objective of the scheme is to promote R&D activities of companies, and thus they can deduct 200% of their R&D expenditures from their taxable income. A 300% RTD tax allowance is applicable from 2004 if a company lab is located at the site of a university or a public research institute.

An indirect measure was introduced in January 2013 that made the employment of researchers with a PhD title (up to salaries of ~ €1,800 (HUF300,000)/month) cheaper as they are exempt from paying social security and other contributions (altogether 27% less). This incentive cost the government about €3.5m according to estimates of the Ministry for National Economy and was applied for about 1,300 researchers employed in companies.

Apart from the latter measure, no significant change could be observed in the balance between subsidies and tax incentives. The National S3 strategy also states that the resources of the Structural Funds provided in the framework of the EU Cohesion Policy account for the most significant sources of public support for the RDI sector in both the last and the next seven-year EU financial periods.

2.6 Smart Specialisation (RIS3)

Status of the RIS3. All the seven Hungarian regions elaborated their Smart Specialisation Strategies (S3) according to the guidelines provided by the European Commission by the end of May 2013. A peer review workshop took place in Budapest on 24-25 June 2013 that was organised jointly by the Smart Specialisation Platform of the European

Commission and the National Innovation Office. In summer 2013, the S3 strategy was further developed using a process-based approach. In September 2013 the longer term development scenarios for Hungary were taken into account for the planning of the S3. An important milestone of the S3 planning was the elaboration of the draft White Book entitled "S3 White Book. Smart Specialisation Directions of Hungary" that was published for public consultation by the Ministry for National Economy in November 2013. Country-wide events took place in autumn 2013 to make the methodology and the so-called entrepreneurial discovery process (EDP) widely-known so as to assist the preparation of the S3 process. In the first part of 2014, a scientific supervisory board was established to elaborate the methodology and to monitor it constantly. After the new government was formed in June 2014, a government commissioner was appointed by the prime minister who became responsible for setting up the National Research, Development and Innovation Office, as well as the finalisation of the S3 strategy which is a pre-condition to get access to the Operational Programmes dedicated to research and innovation in the EU financial planning period 2014-2020. By October 2014 county level workshops took place in all the 19 counties in order to define the specialisations of these territorial units. As a result a draft S3 strategy was published for public consultation on 3 October 2014 and the National Smart Specialisation Strategy was approved by the government decree 1640/2014. (XI. 14.) on 14 November 2014.

Main features of the S3. A multi-level governance structure was established for the elaboration of the S3. A dedicated *government commissioner* and his working group in the Prime Minister's Office is responsible for the elaboration of the strategy. All coordination is carried out within the *National Management Body* that consists of experts and representatives of stakeholder groups. The *Central S3 Working Group* is responsible for the operational activities, quality assurance and preparatory work for decision making. An *Inter-ministerial Working Group* was set up in order to ensure the follow-up of the elaboration of the S3, to provide feedback and coordinate the planning of the S3 and relevant Operational Programmes. Finally, *county level Working Groups* supported by the government bureaus are responsible for the involvement of local and regional stakeholders.

Based on the RIS3 Guide provided by the EC, the draft S3 strategy classifies the Hungarian counties into three groups and defines their vision and strategic objectives according to their level of development. Significant part of the draft S3 strategy deals with the development of research infrastructures that could have the highest impact on the development of the Hungarian economy. In addition a national survey was launched to collect development ideas from those who could not attend the above mentioned workshops.

Three national smart specialisations were formulated in the course of the strategy building in accordance with the types of regions outlined in the S3 strategy. These are: i) systems science, ii) smart production and iii) sustainable society. Determined by means of the two round EDP process, 6+2 (six sectoral and two horizontal) national research priorities and a limited number of local specialisation sectors/technologies were created in order to achieve the vision and objectives to be implemented along the smart specialisation. As a result, the following national priorities were defined with local, county level specialisations included:

- healthy society and well-being;
- advanced technologies in the vehicle and other machinery industry;
- clean and renewable energies;

- sustainable environment;
- healthy and local food;
- agricultural innovation.

Besides the national S3 priorities, a few horizontal priorities have been set up: i) ICT and related services; ii) inclusive and sustainable society and liveable environment. In the country level specialisations technologies closely linked to the national priorities such as bionics, photonics, laser technology, creative industry or logistics are represented.

Consideration of financial requirements. The National Smart Specialisation Strategy clearly discusses its consistency with key planning documents, namely the National Reform Programme, the National Research-Development and Innovation Strategy 2013-2020, the Operational Programmes and the Horizon 2020 programme. According to the financing principles of the S3, it will mainly employ direct instruments, but soft instruments for innovation financing will be tested in order to strengthen the collaboration between industry and academia. No new indirect instruments and tax credits are specified. With regard to the resources, the majority of funding would come from the European Regional Development Fund (ERDF), in addition to the two major national R&I funding instruments, i.e. KTIA and OTKA. (NIH, 2014a)

Foreseen monitoring and evaluation mechanisms. The draft S3 clearly specifies the reasons for an effective monitoring and evaluation mechanisms. Three kinds of evaluation methods are foreseen: interim evaluation, on-going evaluation and ex-post evaluation. The provisions of the S3 foresee that the implemented evaluation will be both normative and summative according to pre-defined indicators.

2.7 Evaluations, consultations, foresight exercises

STI policy monitoring and evaluation culture is weak in Hungary. This situation has changed with the establishment of the Science and Technology Observatory (called Kaleidoscope information service) within the National Innovation Office in 2012. This could be seen as a mayor improvement towards evidence-based planning and policy design. After several years of planning, this new service of NIH provides stakeholders of the innovation system with reliable data and reports. The Science and Technology Observatory is an analytical-evaluation database system and knowledge base which contains in a homogenous structure all the relevant information from the field of RTDI – in particular about the RTDI tenders – to facilitate networking and the evidence-based decision-making.

Currently, there is no service available that provides accurate and comparable information about the quality and efficiency of funding through R&I programmes.

In the last few years, two comprehensive assessment studies were carried out. In 2010, an assessment of the operation of the Research and Technology Innovation Fund (KTIA) between 2004 and 2009 was produced by a consortium of Ernst&Young and GKI Economic Research Co. (EY, 2010) Most recently, the evaluation of OTKA was carried out based on an agreement with the European Science Foundation (ESF)[23]. The evaluation had the overall

[23] The evaluation report is available at http://www.esf.org/fileadmin/Public_documents/Publications/otka_evaluation_01.pdf (Date of access: 23 February 2015)

goal of identifying strengths and recommendations for further improvement related to OTKA governance and management structures. OTKA's international evaluation has been preceded by a long process of development. In order to effectively carry out a constant task of more than 25 years (supporting internationally competitive basic research projects in an open call system), OTKA introduced English as the language of proposals and strict rules on conflicts of interest in the peer review process. The number of foreign referees has gradually increased; international review panels, consisting of foreign experts, have been established. The OTKA Board decided to order the evaluation in 2012. Published in November 2014, the conclusions from the Evaluation Committee review and the survey were overwhelmingly positive in terms of OTKA's governance, administrative procedures, and potential for an expanded role in the Hungarian research system. According to the recommendations made by the ESF, OTKA should:

- be more centrally involved in developing basic research strategy at national level;
- be more independent and should define its own strategy in keeping with national research priorities;
- negotiate a continuous but substantial (in the order of at least 10% per year) increase in its budget;
- raise its public profile and ensure that relevant policy makers are aware of its grant management expertise;
- continue to offer a limited number of well-defined schemes;
- retain its focus on funding basic research;
- use additional funding to increase the size of grants;
- raise its role in supporting inward and outward mobility;
- continue the process of increasing the involvement of international reviewers;
- monitor both academic and socio-economic impact of funded research by performing an assessment of wider and longer-term impacts of its activities through periodic surveys of grant beneficiaries.

As for the nationally funded support schemes, one of the basic principles of the Law on Research and Technological Innovation (Act CXXXIV of 2004) was that publicly financed STI policy measures shall regularly be evaluated by independent experts. Based on the Law, Government Decree no. 198/2005 specifies the precise range of measures to be evaluated ex-post. As a general rule, one-off schemes above HUF1b (€3.4m) are to be evaluated within three years following the closure of the scheme, whereas continuous programmes (with a cumulated funding over HUF1b) within two years of the closure of the given programme cycle. For continuous programmes, irrespective of the volume, ex-post evaluation is compulsory within four years of the launch of its first call. Several on-going evaluations are under way that address financial support mechanisms and indicators related to the cohesion policy. Apart from these evaluations, no comprehensive evaluation of the STI policy has been carried out since 2010.

Participatory policy preparation tools (e.g. foresight) for designing RTDI concepts and sectoral strategies are rarely used. Nevertheless, the S3 White Book foresaw the application of modern innovation policy decision making tools, such as evaluation, foresight, technology assessment and Delphi-surveys. Apart from the six RDI Sectoral

White Books[24] (i.e. agriculture, health industry, energy, ICT, environment protection, mobility, vehicle industry and logistics) related to the Smart Specialisation Strategy, no comprehensive study of strategic intelligence was published in recent years.

In addition to the consultation of the National Research-Development and Innovation Strategy as well as the Smart Specialisation Strategy, the government launched consultations on the following strategic documents during 2013-2014:

- National Development 2020. National and Territorial Development Concept; (Government, 2014a)
- Draft Science Policy Strategy 2014-2020; (Government, 2013)
- County level development concepts;
- New operational programmes for the planning period 2014-2020, more specifically the Economic Development and Innovation Operational Programme (GINOP) as well as the Human Resources Development Operational Programme (EFOP).

The EcoRET model was used by the National Development Agency for the impact assessment of the National Development Plan 2004-2006. This model was further developed with the support of the 7th Framework Programme. The most recent model called Geographic Macro and Regional (GMR) Hungary is frequently used by the National Development Agency for impact assessment of the cohesion policy. The model was built for regional and macroeconomic impact analysis of regional innovation policies with a specific focus on the impact of R&D and human capital development support.

[24] See the sectoral white books at http://www.s3magyarorszag.hu/kfi_agazati_feher_konyv (Date of access: 23 February 2015)

3. National progress towards realisation of ERA

3.1 ERA priority 2: Optimal transnational co-operation and competition

Although the design of national STI strategies takes into account what is being done in other EU countries, no initiative or experience could have been identified that specifically addresses supporting of joint activities such as sharing information, joint research agendas, joint calls and joint programming.

Apart from the necessary ex-post evaluation of calls of the Operational Programmes co-funded by the Structural Funds, national research and innovation funding schemes are not subjects of evaluation. A most recent exception was the international evaluation of OTKA that was carried out by foreign experts based on an agreement with the European Science Foundation. The conclusions of the evaluation were published in November 2014. In the same month, the Hungarian Parliament passed the Law on Scientific Research, Development, and Innovation that terminated the OTKA Office with legal successor and overruling the previous OTKA law as of 31 December 2014. Given this legal regulation, the OTKA programmes, the administration of the running projects, and the new calls for proposals will be handled by the newly established National Research, Development and Innovation Office.

The Law on Scientific Research, Development, and Innovation – approved on 25 November 2014 – specifically mentions the importance of evaluation. The guiding principles of this new law foresee regular monitoring and independent evaluation of RDI support measures. In addition, the newly established National Research, Development and Innovation Office aims to create an innovation body and special colleges with involvement of distinguished experts to design specific calls, evaluate proposals and assess final reports.

With regard to specific actions, the International Visegrad Fund[25] could be mentioned. The aim of this fund is to promote the development of closer cooperation among the Visegrad Group (V4) countries, i.e. the Czech Republic, Hungary, Poland and Slovakia and to strengthen the ties among people in the region. The Fund provides funding for common cultural, scientific, research and educational projects, youth exchanges, promotion of tourism and cross-border cooperation. The annual budget of the Fund is €8m. Most of the grant recipients are non-governmental organisations, municipalities and local governments, universities, schools and other public institutions. The Fund also awards individual scholarships and artist residencies. Nevertheless, the size of average grants supported by the Fund is rather low (i.e. few thousand euros per project/grant).

[25] See at http://visegradfund.org/ (Date of access: 23 February 2015)

3.2 ERA priority 3: An open labour market for researchers. Facilitating mobility, supporting training and ensuring attractive careers

3.2.1 Introduction

The Hungarian higher education and public research sector could be seen as a centrally regulated system, although individual institutions enjoy high level of autonomy within the regulatory framework. Generally, research positions at public research institutes are open to non-nationals.

According to the Hungarian Central Statistical Office, there were 3,159 research units operated in Hungary in 2013. (KSH, 2014b) The total number of research personnel was 58,237 persons, out of which 25,038 persons worked as full time (FTE) researchers. The number of FTE researchers increased by almost one-quarter (24.8%) compared to 2009. Based on Eurostat data, the total R&D personnel and researchers as % of total labour force and total employment reached 0.87% of the total labour force in 2013 which is 22.5% higher than it was in 2009 (0.71%), although still lagging behind the EU-28 average (1.12% in 2013). The crisis had not much impact on the catch up of the Hungarian research personnel figure as the number of researchers, particularly in the business sector, grew every year in the past five years.

The number of foreign researchers slightly increased compared to 2009, there were 667 foreign researchers (many ethnic Hungarians from the neighbouring countries) working in Hungarian institutions in 2013, out of which 456 came from other EU Member States. This means 1.8% of the total FTE researchers. In addition, 329 foreign citizens hold a research grant, out of which 184 from other EU Member States. The number of Hungarian researchers who spent more than six months abroad was oscillating between 373 and 454 in the period from 2009 to 2013, the lowest value was in 2013. These figures indicate that out-going mobility is smaller than the incoming mobility of researchers, although it can happen that the official statistics does not register all those Hungarian researchers who work abroad. (KSH, 2014b)

3.2.2 Open, transparent and merit-based recruitment of researchers

Higher education organisations as well as the research centres and institutes of the largest PRO, the Hungarian Academy of Sciences (MTA) have no special employment requirements towards foreign researchers other than the requirements of merit-based scientific qualification. Research positions at higher education organisations and public research institutes are open to non-nationals. As long as most of the courses at HEIs are delivered in Hungarian and the share of foreign students is generally low, in most of the cases command of the Hungarian language is among the prerequisites of positions. This condition basically prevents foreign nationals from applying for these positions (except the ethnic Hungarians coming from neighbouring countries). The situation is far more advantageous in the institutes of the Hungarian Academy of Sciences (MTA) where all researchers speak at least one foreign language, therefore foreign national researchers can be easily integrated.

Act CCIV of 2011 on the national higher education set the employment rules of different teachers and researchers positions at HEIs. The main employability criteria are defined by law, i.e. the qualification and sufficient number of years of education and research experience. According to the stipulations of this act, all positions before publication should be signed by the rector and published on the government recruitment portal. All applications are reviewed by the department, then the faculty council and finally they are approved by the Senate.

In case of permanent researcher positions at the largest PRO, the Hungarian Academy of Sciences, positions are announced based on Act XXXIII of 1992 on the status of civil servants. According to this law, permanent contracts could only be awarded to Hungarian citizens or with persons who permanently settled in Hungary. The act also specifies that in certain cases the candidate could be exempt from the criteria of Hungarian citizenship and the knowledge of the Hungarian language which could ease the employability of foreign researchers. Remuneration of academic and research positions is set by Act XXXIII of 1992 that regulates salary classes of all types of teachers and researchers jobs in both HEIs and the institutes of MTA.

According to the new higher education concept "*Changing gears in higher education*", published in December 2014 after first reading by the government, the situation is likely to be changed after the introduction of the performance based and competitive remuneration of employees of HEIs[26]. Performance based financing will be introduced in Hungarian HEIs from 2016 that will be based on various performance indicators (see details in section 2.5.2). The strategy also foresees the introduction of fixed-term post-doctorate positions that are currently lacking from the higher education system. These positions aim to help allow early career researchers to find job opportunities at HEIs and prevent "brain-drain" from Hungary, and ensure the supply of researchers at the same time. The higher education concept also seeks to develop career paths of researchers, in particular in medical, health sciences and pedagogic education. In addition, the concept created the basis of the dual education system that was already launched in February 2015. (Government, 2014b)

Publicly funded researcher jobs are published online on both the institutions' websites and private job sites. Since January 2008, it is legally obligatory to recruit openly researchers who will have an employment status of a civil servant. The institutions are obliged to publish all public research jobs on the central government recruitment portal at run by the Office of Public Administration and Justice[27]. This portal provides all relevant information on the selection process and criteria for the applicants. Also the minimum time period between the vacancy publication and the deadline for submission of the application is defined. The common recruitment practice of Hungarian higher education organisations and the MTA is the following:

- the vacancy is published on the web-site of the organisation and the portal of public sector administration;

[26] The higher education concept foresees among its objectives, without further specification, the elaboration of performance based promotion system, measurement of the performance of academic and research staff and the conditions for competitive remuneration.
[27] See at https://kozigallas.gov.hu

- the announcement includes the job profile, skills and competencies required and eligibility criteria;
- information on the selection process and criteria is generally available for the candidates;
- the time period between the vacancy publication and the deadline for application is usually between 15 and 30 days;
- applicants have the right to receive feedback on the results of the recruitment;
- applicants have the right to appeal against decisions;
- in general, there are no provisions in place for setting up selection panels neither on the rules for the composition of selection panels;
- the composition of selection panel is usually not published;
- selection panels are usually composed of internal staff members of the respective organisation.

No public information or evaluation report is available on the law that regulates hiring of researchers.

The recognition of the level of the qualification and the professional qualification testified by it belongs to the Hungarian Equivalence and Information Centre (Hungarian ENIC) within the Educational Authority, while the nostrification of scientific degrees is done by the Hungarian higher education institutions. The recognition of scientific degrees issued by a foreign higher education institution falls within the authority of those Hungarian higher education institutions which are entitled to offer PhD training and award scientific degrees in the field of study testified by the foreign degree. During this procedure the higher education institution examines whether the degree issued abroad is equivalent to a PhD or Doctor of Liberal Arts (DLA) degree obtainable in Hungary. The nostrification is done by the university chosen by the applicant. Also, it is possible to request the recognition of the level testified by the foreign scientific degree from the Hungarian Equivalence and Information Centre (HEIC) that fulfils the task of the European Network of Information Centres (ENIC) office in Hungary.

The Hungarian scientific labour market is dominated by permanent contracts. However, temporary contacts are typical for early stage researchers. The HEIs and the institutes of the MTA try to attract young researchers because ageing is a serious issue in the public research sector, especially in engineering and natural science fields. Unfortunately, the low salaries and the long take-off of scientific career drive back the younger generations. They often leave the sector because of higher remuneration and faster career opportunities in the private sector, or they simply go abroad. This issue is well recognised and the RDI strategy 2013-2020 aims to improve the situation by allocating more funding to the sector and increasing the number of researchers by 50% up to 56,000 (from 37,000 in 2012).

3.2.3 Access to and portability of grants

The national legislation does not address the issue of access to and portability of national grants.

The Hungarian Scientific Research Fund (OTKA)[28] provides financial support for basic research, international cooperation, development of the research infrastructure and fellowships for young scientists. Even if OTKA supports international cooperation in research projects, only Hungarian researchers could get funding from OTKA while foreign researchers should apply for grants by one of their domestic research funds. Also, it is a prerequisite that Hungarian researchers should be affiliated to a Hungarian research unit. This type of applications could only be approved if both OTKA and the foreign research fund support the research project.

The guidelines and sample contracts of OTKA clearly set that grants (i.e. salaries) are not portable if the successful applicant moves to another country. In case the temporary research stay abroad exceeds 6 months, the beneficiary researcher should suspend his/her OTKA grant, however his/her team could continue the research activities as defined in the contract.

The other main RDI fund, the Research and Technological Innovation Fund (KTIA)[29] has also strict rules for applicants. As long as the main source of the KTIA is the "innovation levy" paid by companies operating in Hungary, the beneficiaries of the fund could only be domestic firms registered in Hungary or research units located in Hungary.

3.2.4 EURAXESS

There is an Euraxess network established in Hungary. Local Euraxess network points are mainly located at universities in almost all seven regions. Contacts of local network points are duly acknowledged on the Hungarian Euraxess portal.

The Euraxess Hungary Team assists foreign researchers and their families coming to work or study in Hungary. The assistance services include: identification of job opportunities and information about living and working in Hungary, provision of help with authorities, formalities and daily life. The Euraxess Hungary also offers information on research in Hungary, fellowships and grants, and contacts as well as personalised help.

3.2.5 Doctoral training

Doctoral training is carried out at 27 higher education institutions at 165 thematically organised "doctoral schools" in Hungary[30]. Hungarian universities are autonomous to develop and promote their own doctoral programmes. In academic year 2014-2015, the

[28] OTKA became part of the National Research, Development and Innovation Fund as of 1 January 2015.
[29] KTIA became part of the National Research, Development and Innovation Fund as of 1 January 2015.
[30] Information about the doctoral schools could be accessed through the portal of the Hungarian Doctoral Council at: http://www.doktori.hu/ (Date of access: 23 February 2015)

state finances 1,270 PhD scholarships, out of which 850 scholarships in "hard sciences" and 420 in "soft sciences".

In case a higher education institution plans to introduce a new PhD curriculum, it requires the approval of the Hungarian Accreditation Committee as stipulated by Act CCIV of 2011 on national higher education. The Hungarian Accreditation Committee (HAC) is a national body of experts facilitating the control, assurance and evaluation of the scientific quality of education, scientific research and artistic activity at higher education institutions. The HAC conducts ex-ante and ex-post evaluation of both doctoral programmes and institutions. The Hungarian Accreditation Committee assures a dedicated quality system for doctoral training, distinct from the quality system for Master studies. Without the accreditation of HAC no doctoral training could take place at universities. The accreditation process involves among others: the evaluation criteria for doctoral schools, the description of the procedure for establishing new doctoral schools.

The doctoral and habilitation process is organised according to government decree 387/2012. (XII. 19.). The organisation of doctoral studies, the assessment of PhD students and the tutoring and conferring of a doctoral degree are overseen by the doctoral council of the individual HEI. The duration of doctoral education is 36 months (i.e. six semesters) and the workload of the students is at least 180 credits. Obtaining a doctoral degree is a separate procedure and it takes generally 2 more years on average in addition to the doctoral studies that is based mainly on lectures.

As a legal requirement for delivering the doctoral training, the HEI must provide master training in the given branch of science or art in order to be granted the right to operate a doctoral school. The doctoral school should undergo an accreditation procedure carried out by the Hungarian Accreditation Committee. The schools should fulfil the criteria set by HAC that are transparent, merit-based and specific to scientific fields.

Within universities, the doctoral training is organised in a given discipline, or cooperating disciplines (i.e. interdisciplinary doctoral school). In a single discipline a doctoral school should have four core members, while in the case of interdisciplinary doctoral schools - minimum seven core members. Launching a doctoral school requires a coherent training and research programme, a definition of research topics for the students, and approval (accreditation) by HAC and the Senate of the higher education organisation.

Most recently, in October 2013, HAC published recommendations on the quality assurance of the doctoral process[31]. The document specifies among others how doctoral themes should be announced, how to monitor and evaluate the progress of doctoral students, as well as the requirements to obtain a PhD degree.

In addition, HAC regularly carries out an evaluation of the doctoral schools. The most recent evaluation of the doctoral schools was carried out in the second half of 2014[32]. According to the previous evaluation report published in December 2013, the term Innovative Doctoral Training is not mentioned explicitly, although the principles of IDT are taken into account in most doctoral training programmes.

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[31] See at http://www.doktori.hu/cikk_file/minosegbiztositas_2013.doc - only available in Hungarian language. (Date of access: 23 February 2015)

[32] The evaluation report will be published in February 2015 as indicated on http://www.doktori.hu/.

3.2.6 HR strategy for researchers incorporating the Charter and Code

According to the Euraxess website, 16 Hungarian universities and research organisations declared the implementation of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers by the end of 2014. So far none of the Hungarian universities obtained the logo of HR Excellence in Research.

The most recent laws and government measures do not tackle explicitly the implementation of the HR strategy for researchers (HRS4R). Nevertheless, the Hungarian Rectors Conference called the attention of the rectors by mail in January 2013 to join the Code of Conduct for the Recruitment of Researchers that aims to improve recruitment, to make selection procedures fairer and more transparent, and proposes different means of judging merit. In addition, the draft Science Policy Strategy 2014-2020 – published in September 2013 – urged measures in order to introduce the principles of the Charter&Code. (Government, 2013)

In conclusion, the Hungarian academic labour market, especially in some institutes of the Hungarian Academy of Sciences, is attractive for both domestic and foreign researchers. In order to inspire the Hungarian research environment, MTA launched the "Visiting scholars" programme in 2012. In this programme prominent foreign scientists are invited to join the activities of the research institutes of MTA. The number of visiting scholars is below 10, although the impact of the programme could be significant on the longer term. Another good practice case of MTA is the Momentum programme for excellence that aims to attract and keep the best Hungarian researchers at home, as well as to renew the institutional culture of Hungarian science. However, the quality of the research infrastructure improved significantly thanks to investments from the Operational Programmes, the main barrier for pursuing a career in research is the low salaries of researchers even within the national context. The basic salaries stay at the level of 2008 without any rise since then, which is not attractive for researchers in the business sector. Besides the salaries, the long take-off of scientific career and the high scientific requirements could be seen as other barriers for younger generations.

3.2.7 Education and training systems

The insurance of sufficient supply of (post)graduates in science, technology, engineering and mathematics (STEM) is clearly a priority of the STI policy in Hungary. In this respect the government stimulates the orientation of the younger generations towards STEM studies and limits the support for other specialisations at state HEIs. In addition, two-thirds of the doctoral scholarships support doctoral studies in the "hard sciences". The government has also introduced the "dual education" that is based on practical training and apprenticeship at companies, but the share of this type of training is rather low for the time being.

More and more emphasis is given to learning of transversal competences such as critical thinking, problem solving, creativity, teamwork, and intercultural and communication skills. However, the education and training curricula are rather rigid and not easy to be changed, therefore it will take a while until this type of training will be embedded in standard curricula. Entrepreneurship education and training appears mainly as an elective course. The government expressed its support for further development of the Hungarian start-up ecosystem in the document entitled "Budapest Runway 2.0.2.0. – A Start-up Credo" published in November 2013. The document sets an ambitious vision that the Hungarian capital will become the start-up centre of the Central Eastern European region within a

decade. Furthermore, the document has several concrete proposals for strengthening a competitive start-up and innovation ecosystem that is based on the following four components and the interactions between them: i) education and training, ii) access to funds, iii) taxation and regulation, and iv) enabling environment.

The new higher education strategy published in October 2014 envisages the objective to achieve world-class education and research through focusing on a limited number of research areas and establishment of RDI networks among HEIs, companies and foreign HEIs and research centres. The strategy also aims at having at least one Hungarian university to fulfil the criteria to qualify as a member of the League of European Research Universities (LERU) by 2025.

Also it should be added that chancellors, responsible for economic and service activities of HEIs were appointed in November and December 2015 at all state owned universities. It is expected that the institutions will be more professionally managed in economic terms and the rectors could focus on the management of academic and research activities of institutions.

3.3 ERA priority 5: Optimal circulation and access to scientific knowledge

3.3.1 E-infrastructures and researchers electronic identity

The National Information Infrastructure Development (NIIF)[33] Programme serves as a framework for the development and operation of the research network in Hungary. The Programme covers the entire Hungarian academic, research and public collection community by providing them with

- an integrated computer networking infrastructure,
- a wide range of communication, information, and co-operation services,
- cutting-edge environment for networking applications, and
- advanced framework for content generation and provision.

The Programme is dated back to the late 1980s and it is based on funding provided by the central state budget. The development and operation of the network as well as the services are executed by the NIIF Institute (NIIFI). The Programme is closely co-operating with Hungarnet, the association of the user community.

Launched in June 2010, the Videotorium[34] is a video/audio sharing portal created for the higher-education and research institutions in Hungary. The Videotorium provides professional presentation of video content recorded at higher-education organisations, research institutions and public collections. Videotorium, together with the Hungarian research and education computer network infrastructure, has been maintained by the National Information Infrastructure Development (NIIF) Institute. The portal is the

[33] See at http://www.niif.hu/en (Date of access: 23 February 2015)
[34] See at http://videotorium.hu/en (Date of access: 23 February 2015)

successor of the former "Video on Demand" repository aiming at providing professional accommodation for the growing collection of recordings and content upload and sharing by institutions.

Hungarian researchers of the MTA and HEIs are requested to use and update regularly their publications in the scientific bibliography database[35] (i.e. List of Hungarian Scientific Works, MTMT in Hungarian) of the Hungarian Academy of Sciences' Library. This database has the main purpose "to keep an inventory of Hungarian academic achievements and to make these valuable contributions known to the world in a high quality format". The database became a central part of the Hungarian research-development information system.

Eduroam offers Internet connectivity to the roaming users of all member institutions operated and coordinated by NIIFI in Hungary. Most Hungarian universities and public research centres joined Eduroam[36].

3.3.2. Open Access to publications and data

The Hungarian Academy of Sciences (MTA), the largest PRO network, introduced several actions with regard to open circulation and access to and transfer of scientific knowledge. The president of the Hungarian Academy of Sciences (MTA) issued an Open Access Mandate decree in 2012. According to this decree, the researchers and employees of MTA – including researchers of the subsidised research units and the Momentum research groups – should make their scientific publications Open Access. Open Access could be achieved by i) self-archiving in institutional or discipline-based repositories, ii) publishing in Open Access journals or in hybrid journals offering paid Open Access.

The Hungarian Scientific Research Fund (OTKA) that provides financial support for basic research signed the Berlin Declaration in 2008 and committed to Open Access. According to the general rules of OTKA, it is the task of the project leader researcher to make public – at least for reading – the results of their research without payment or upload the resulting publications in an open access repositorium (e.g. REAL of MTA).

Operated by the Library of the Hungarian Academy of Sciences, REAL is an electronic library service containing full-text documents. REAL runs EPrints software and supports the OAI-PMH protocol (Open Archives Initiative Protocol for Metadata Harvesting). The collection contains research output (journal articles and conference publications) of projects supported by grants from OTKA, mandated for open access by the same organisation and uploaded by the authors themselves, as well as research reports deposited centrally by OTKA. Research reports are in Hungarian, with English titles and abstracts. REAL welcomes and encourages the depositing of articles in other languages, if available. REAL-d database contains theses of the doctors of the MTA. The collection contains dissertations submitted in partial fulfilment of the requirements for the degrees of Candidate of Sciences (C.Sc.) and Doctor of Sciences (D.Sc.) of the Hungarian Academy of Sciences.

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[35] See at https://www.mtmt.hu/ (Date of access: 23 February 2015)
[36] See participating organisations at http://www.niif.hu/szolgaltatasok/middleware/eduroam_intezmenyek (Date of access: 23 February 2015)

Apart from running REAL, the Library of the Hungarian Academy of Sciences offers to its registered users (SMEs could potentially also be included) access to more than 10,000 e-journals in full text. Access to e-journals is regulated by license agreements that the Library signed with the individual e-service providers.

With regard to share of Open Access publications, the Hungarian figure is close to 46%, a four-year non-weighted sampling in the period 2008-2011, according to the estimates of the study made by Science-Metrics[37]. Out of this figure, about 7% could be perceived as "Gold access" while 39% as "Green and Hybrid access".

Nevertheless, the main obstacle for the implementation of open access is the lack of national Open Access strategy, the general lack of awareness about relevant copyright and digital issues and the resistance by researchers to allocate time and effort to the depositing process. Advocacy programmes (attached to a network of institutional repositories) by higher education libraries could provide an effective way of increasing national research visibility and impact.

[37] See at http://www.science-metrix.com/pdf/SM_EC_OA_Availability_2004-2011.pdf (Date of access: 23 February 2015)

4. Innovation Union

4.1 Framework conditions

The Government is committed to increase the R&D expenditures, especially in the business sector and aims to make Hungary an R&D centre in Central and Eastern Europe. The government set the objective in 2010 to make Hungary a production centre of Europe. This objective was expanded further in 2014 and now the government aims to attract as much as possible innovation and information and communication technology (ICT) capacities to Hungary. The quantitative objective is that industrial production and export should have the highest share in GDP in Europe. In order to achieve these objectives the government made 52 strategic contracts (by December 2014) with large domestic and multinational companies.

Also, the most recent Law on "Scientific Research, Development, and Innovation" (approved on 25 November 2014) would support the competitiveness of companies based on research, development and innovation and the creation of high added-value jobs.

In addition, the new higher education concept published in October 2014 supports the above government objectives and foresees measures to foster collaborative research, development and innovation activities between HEIs and companies, as well as to tailor the curricula toward the needs of the business sector.

In conclusion, several RDI related strategies were elaborated and consulted with stakeholders in the past two years, nevertheless they didn't include a straightforward implementation plan. Due to the reorganisation of the National Innovation Office and the RDI funding system, calls were frozen particularly in the second part of 2014.

4.2 Science-based entrepreneurship

Several support schemes were implemented in the past few years that specifically aimed at the facilitation of knowledge transfer and supported the creation of university spin-offs. After Hungary joined the EU in 2004, regional knowledge centres were created at major universities that resulted in some dozens of university spin-offs. In addition to the knowledge centres, Technology Transfer Offices (TTOs) were established at HEIs[38]. These university organisations face the challenge to sustain their operation after termination of funding as long as university budgets decreased on average by one-third compared to 2011.

Although there are a number of innovation and technology centres operating across the country, these centres have no critical mass activity especially in cases when they are not attached to the local HEI. Unfortunately, no business incubators are working at universities. The situation might be improved with a two-stage scheme, called "Start-up_13" that was launched in June 2013 in order to support the development of the Hungarian start-up ecosystem and more specifically the development of technology start-up companies. The programme is supported by HUF2.1b (about €7.2m) from the Research and Technological Innovation Fund. The first stage of the programme aims at the accreditation of technology incubators, accelerators that will work together with technology start-ups on their business

[38] See for more details Section 4.4.

plan and prepare them for fundraising to finance their growth. The second stage of the scheme focuses on the technology start-ups. Based on competitive selection procedure, promising start-ups will be located in accredited technology incubators that will support the implementation of their business plans and help them in fundraising, so as to enable them to enter and grow on international markets. So far four technology incubators have been accredited in October 2013. The signature of the support contracts of the accredited incubators were postponed several times throughout 2014, while the main promotor organisation, the National Innovation Office was reorganised. Finally, the president of the new National Research, Development and Innovation Office signed the contracts with three incubators in January 2015 that could start selecting and investing in start-ups.

The most recent measure was published in December 2014 that aims to support the establishment of 8-10 "knowledge parks" in collaboration with local self-governments and universities. According to the objectives of the measure, the following types of activities will be supported:

- support of strategic collaboration between HEIs and their partners;
- long-term development of knowledge transfer and RDI services;
- development of RDI priority activities in the context of the RDI strategy and the National S3 strategy, as well as monitoring and evaluation methodologies;
- development of institutional collaboration.

Furthermore, in the new programming period 2014-2020, the Economic Development and Innovation OP (GINOP), and in particular its Priority #1, foresees to support the improvement of the competitiveness of SMEs by the establishment and further development of business incubators with an indicative budget of €30m. In addition, GINOP also foresees the further development of industrial parks and science parks.

With regard to support provided to the creation and early stage development of innovative enterprises, a number of start-up events and competitions were organised by the National Innovation Office throughout 2014. The most visited events were the Startup Spring[39] and the Innotrends Hungary[40] conference and fair.

4.3 Knowledge markets

Fees relating applications and prices of intellectual protection services[41] could be considered efficient, affordable and effective even if Hungarian patent applications are relatively low compared to other European countries. The Hungarian Intellectual Property Office (HIPO), the government office responsible for the protection of intellectual property, promotes awareness of intellectual property protection by providing several training options, and ensures the operation of the industrial property education system. In addition, HIPO develops, supports and operates the graduate and the post-graduate system of intellectual property education. In addition, it cooperates in the organisation of special trainings tailored to individual needs from basic to proficiency levels. HIPO also maintains

[39] See at http://startupspring.eu/ (Date of access: 23 February 2015)
[40] See at http://www.nih.gov.hu/innotrends (Date of access: 23 February 2015)
[41] See patent application fees at http://www.sztnh.gov.hu/English/urlapok_dijak/dijak/index.html (Date of access: 23 February 2015)

and supports the operation of PATLIB centres in collaboration with Chambers of Commerce in almost all counties and university Technology Transfer Offices (TTOs). These local PATLIB centres offer IP consultancy services and IP trainings for researchers and local SMEs.

HIPO has extended its function from February 2012 to cover qualification of R&D activity. This service includes, on the one hand, preliminary qualifications that could be initiated optionally and on a voluntary basis by companies. On the other hand, HIPO qualifies the R&D activity of firms in response to requests received from the National Tax and Customs Administration (NAV).

The Hungarian Intellectual Property Agency (Hipavilon)[42] is a government-owned non-profit company that supports the creation of knowledge based products and services and assists their commercialisation on Hungarian and foreign markets. The founder's rights are exercised by the Hungarian Intellectual Property Office as the government office responsible for the execution of intellectual property policy in Hungary. In collaboration with national partner organisations dedicated to innovation, Hipavilon is committed to providing services that cover every step of the innovation process and are tailored to the market needs to support Hungarian economic development efforts. Hipavilon has a network of both national and international contacts, highly qualified staff and access to specialised international databases that guarantee the quality of their services.

Policies and instruments for the development of knowledge markets for patenting and licensing could not be identified. However, a related initiative of the National Innovation Office is worth mentioning since it aims at the establishment of an "innovation marketplace". An interactive portal was launched in October 2014, where innovative project owners can upload and share their projects seeking for investments[43].

4.4 Knowledge transfer and open innovation

The exploitation of public research results, including knowledge transfer and spin-off creation is not yet a well explored area, even if TTOs are established at all major HEIs. These intermediary organisations are not yet ready to efficiently mediate between academia and business and to transfer the research results to companies. Initiated by the National Innovation Office in 2013, discussions started with key stakeholders in order to formulate a national policy to promote knowledge transfer. By the end of 2013, a recommendation was prepared in order to facilitate technology transfer at Hungarian universities, but this recommendation has not been published. Since the new government stepped into office in June 2014, no new initiative has been launched. Nevertheless, the National Smart Specialisation Strategy, published in November 2014, mentions two specific pilot measures that address the interaction and strategic partnering between industry and academia. These pilot measures would be implemented along with the national priorities formulated in the smart specialisation strategy (see NIH, 2014a, pp. 78-79):

[42] See at http://hipavilon.hu/en (Date of access: 23 February 2015)
[43] See at http://www.nih.gov.hu/innovacios-szolgaltatasok/innovacios-piacter (Date of access: 23 February 2015)

- "Open laboratories" means opening up public research laboratories and corporate labs for the public, in particular for other companies and SMEs. These open laboratories would be in charge of networking between public research centres, technology centres, large companies and SMEs and would support the innovation activities of those actors of the R&I system that have no research capacities and equipment. The benefit expected from the measure is that currently non-innovating companies could engage in some innovation activity with the help of open laboratories. Also, the open laboratories could play a "living lab" role.
- "Higher Education and Industry Collaboration Centres" (FIEK). In the framework of FIEK, a broad cooperation between industry and the higher education sector will be established. The aim of the FIEK is to develop sectoral training and R&D&I activities in a co-ordinated way, which is aligned with economic interests. Based on the "quadruple helix" model, several higher education institutions, research institutes, sectoral large enterprises and SMEs are expected to participate in cooperation activities. The participants in FIEK aim to jointly develop the curricula and education methods on subjects that meet the technological needs of the industry, to harmonise their accreditation activities, to develop the common structure and content of the practice-oriented (so-called dual) education.

Apart from the above mentioned university Technology Transfer Offices, it should be noted that there are a relatively large number of intermediary organisations (e.g. regional innovation agencies, foundations for enterprise promotion) in the Hungarian national innovation system, nevertheless they have no critical mass neither in their size nor in their responsibilities.

In the last five years, few measures were launched to support research and innovation cooperation and knowledge transfer (KT) between public and private sector, in particular those related to KT performance and outcome:

- "Start-up_13" – development of the Hungarian start-up ecosystem. The main objective of the scheme is to support the development of young, technology companies that are exploiting the results of some kind of research and development activities and are potentially able to grow into a dynamic firm active on international markets. The measure is supported by HUF 2.100m (~€7.2m) from the Research and Technological Innovation Fund.
- Support to market-oriented R&D activities. The objective of this scheme is to support R&D projects that build on research results and are expected to develop prototypes of marketable products, services or processes representing high added value. The measure aims to stimulate the demand of R&D activities from businesses and to strengthen technology transfer by stimulating co-operation between the actors of the innovation system, especially between publicly financed R&D organisations and businesses.
- Development and strengthening of research and development centres. The scheme aimed to strengthen the business enterprises established as R&D centres, which were originally set up as so-called Co-operative Research Centres (KKK) and Regional Knowledge Centres at Universities (RET). These KKKs and RETs were originally created with public funding with the aim of strengthening co-operation between publicly financed research organisations and firms and carried out collaborative research, whose research results can be developed into marketable

products. It was expected that these enterprises would be able to provide high-quality RTDI services to the business sector.

4.5 Innovation framework for SMEs

In insolvency procedures companies can keep their assets untouched, i.e. they stay in possession of the company and their liabilities will be reduced at the end of a successful insolvency procedure. After the changes in the insolvency regulation in 2009, insolvency procedures became more popular because debtors could immediately get a payment moratorium and they have 90 days to come to an agreement with creditors. Previously, debtors could only get a payment moratorium with the qualified majority of creditors that they usually did not get. Certainly, the crisis resulted in a growing number of insolvency procedures that used to be between 20-30 in the years before 2008 and reached the peak in 2010 with 140 procedures. After that the number of insolvency procedures decreased to 105 in 2012, and 128 in 2013. At the same time, the number of compulsory liquidations reached 10,000 in 2008, then lowered to 7,389 in 2012, and grew again up to 10,039 in 2013. Based on these data provided by KSH, we could conclude that insolvency procedures provide solutions only for a fraction of companies facing (temporary) liquidation problems.

More than 70 clusters and 20 accredited innovation clusters are registered in the website of the National Innovation Office[44]. This type of collaboration between companies, research centres and other types of organisations became popular in the early 2000 years and several policy measures supported their activities. In the new financing period 2014-2020 GINOP is foreseen to support the further development and operation of clusters with combined measures, i.e., vouchers and improvement of the quality of services provided by the cluster member organisations. In addition, several measures of GINOP will focus on supporting the collaboration of companies and knowledge transfer.

From 2015 innovation support will be available from the new National Research, Development and Innovation Fund and the Operational Programmes (mainly GINOP and VEKOP) co-funded by the Structural Funds. The design of the OPs took into account the needs of SMEs and the application procedure will become simpler than it used to be in the previous programming period.

4.6 Venture capital markets

Act CXX of 2001 regulated the launch and operation of venture capital (VC) funds, nevertheless the impact of this law was seen to be moderate while state venture capital funds were operating. The take-off of private VC was in fact in 2007, when several new funds began their operation. The real breakthrough happened with the launch of the New Hungary Venture Capital Programme. However, it took several years until eight venture capital funds (Jeremie I) were set up within the frame of the New Széchenyi Venture Capital Programmes in the first half of 2010. The Jeremie II programme, launched in 2012, foresees €140.3m (HUF40.7b) venture capital to be invested by the end of 2015 in three different investment categories: seed funding, growth I and growth II, which reflects the focus of the funds with regard to stage of the company life cycle. By the end of 2014,

[44] See at http://www.nih.gov.hu/hazai-innovacios-szervezetek/klaszterek (Date of access: 23 February 2015)

altogether 28 Jeremie Funds were created out of which four funds focus on the early stage investments. According to the report published by the Hungarian National Bank in January 2015, 70% of venture capital invested in Hungary was connected to one of the Jeremie Funds in the period of January 2010 and end of June 2014. In this period, there were 50 exits but only a minority of them has connection to the Jeremie funds, while 62% of them were "trade sales". (MNB, 2015)

Business angels and angel networks are new phenomena in Hungary. The first events of the Business Angel Club were organised by INNOSTART National Innovation Centre between 2007 and 2010. After INNOSTART stopped its activities, the series of events, a kind of business get-together happenings, were re-launched by the Startup Underground in October 2012. The objective of the club is to establish such an environment, where business angels could meet and learn about potential investment opportunities or start-ups could seek for early stage investment.

So far there is specific taxation regime available for business angel investments.

4.7 Innovative public procurement

The National Innovation Office (NIH) launched a pilot programme to elaborate a pre-commercial procurement (PcP) strategy in 2012. According to the model developed by NIH pre-commercial procurements could be used in the fields of e-government, ICT, healthcare, defence, new and renewable energies and public transport.

The RDI strategy 2013-2020, approved in June 2013, foresees measures that are dedicated explicitly to innovative SMEs and positively discriminate innovative SMEs in certain restricted areas of pre-commercial procurement (PcP). More specifically, the RDI strategy would increase the public demand for innovation through PcP actions. New tools for intensifying the dynamics of innovation in the public sector through PcP are foreseen in the fields of health care, environment protection, energy, education and transport.

The most recent National Smart Specialisation Strategy, approved in November 2014, foresees a PcP pilot action in order to examine whether the domestic application of PcP will require amendments to the existing regulations or the introduction of new legislation. The pilot action aims to investigate what financial incentives are needed for the domestic expansion of the PcP programme. Another objective of the pilot will be to map international (primarily EU) PcP (or PPI) programmes along which the domestic public institutions and public service providers can come to know the best foreign practices. The pilot is scheduled for the years 2016-2017 and no budget is allocated to it in the S3 document. (NIH, 2014a)

5. Performance of the National Research and Innovation System

5.1 Performance of the National Research and Innovation system

The Innovation Union Scoreboard 2014 report concludes that Hungary belongs to moderate innovators, a group of countries characterised by an overall innovation performance below that of the EU-28, together with Italy, the Czech Republic, Spain, Portugal, Greece, Slovakia, Malta, Croatia, Lithuania and Poland. These countries are rather diverse, e.g., in terms of their size, structural composition of the economy, level of socio-economic development, and historical legacy. The innovation performance of Hungary improved between 2006 and 2013. Despite some fluctuations, the performance relative to the EU average increased to 63% in 2013 from around 60% in 2006. Hungary performs below the EU average for most indicators assessed by the IU Scoreboard, especially for new doctorate students. The relative strengths are observed in license and patent revenues from abroad, international scientific co-publications. While high growth is observed for R&D expenditures in the business sector, R&D expenditures in the public sector declined. (see Table 2)

Table 2. Assessment of the Performance of the National Research and Innovation System

1. ENABLERS	Year	HU	EU
Human resources			
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	2011	0.80	1.70
Percentage population aged 30-34 having completed tertiary education	2012	29.90	35.80
Open, excellent and attractive research systems			
International scientific co-publications per million population	2012	411.90	343.15
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	2009	5.20	10.95
Finance and support			
R&D expenditure in the public sector as % of GDP	2012	0.43	0.75
Venture capital (early stage, expansion and replacement) as % of GDP	2012	0.05	0.08
2. FIRM ACTIVITIES			
R&D expenditure in the business sector as % of GDP	2012	0.85	1.31
Linkages and entrepreneurship			
Public-private co-publications per million population	2011	31.25	52.84
Intellectual assets			
PCT patent applications per billion GDP (in PPS€)	2010	1.47	3.92
PCT patent applications in societal challenges per billion GDP (in PPS€) (climate change mitigation; health)	2010	0.44	0.85
3. OUTPUTS			
Economic effects			
Contribution of medium and high-tech product exports to trade balance	2012	5.56	1.27
Knowledge-intensive services exports as % total service exports	2011	26.26	45.26
License and patent revenues from abroad as % of GDP	2012	0.88	0.59

Source: European Commission, IUS Database (2014).

Concerning inputs to research and development, the Hungarian GERD grew continuously in the past years and reached its highest value in 2013 (1.41% according to Eurostat). With these efforts, Hungary still devotes significantly less resources to R&D than the EU-28 average: the GERD/GDP ratio was 69.8% of the EU-28 average in 2013. Businesses have maintained their position as the largest employer of FTE researchers and reached 58.3% of the total researcher employment in 2013, and had the biggest share in performing GERD (69.4%), too. Since 2009, the share of FTE researchers in total employment increased by 20.7% from 0.53% in 2009 to 0.64% in 2013, while the share of all FTE R&D employees did so from 0.79% in 2009 to 0.97% in 2013. Apart from the increase of the employment of researchers in the workforce, the share of R&D investments in total investments doubled from 0.75% in 2009 to 1.63% in 2013.

As for scientific output, the number of publications by Hungarian researchers slightly decreased in 2013 compared to the previous year. While the number of articles published

in Hungarian language decreased, the number of publications in a foreign language grew by 2.8%. (KSH, 2014b)

On average in 2012, Hungary produced 9.2 publications per 10,000 inhabitants, well below the EU-28 average (13.8). They are also internationally orientated with 46.9% of publications internationally co-published. In 2012, Hungary had about 432 international scientific co-publications per million population. In the period 2002-2012, a bit more than 7.6% of the Hungarian scientific publications were in the top 10% most cited publications worldwide in comparison with 11% of top scientific publications produced in the EU-28 (Science Metrix, 2014)[45]. The share of public-private co-publications in Hungary is 1.3% in the period 2008-2013 against 2.8% for the EU-28[46].

According to the annual report of the Hungarian Intellectual Property Office (SZTNH), the number of national patent applications was 701 in 2013 which is a 5.7% decrease compared to 2012. The steady increase of the number of direct applications by foreign applicants continued in 2013, although this level is still below 10% of all applications. The domestic application decreased by 7% mainly because favourable tender applications could not be used as much as in 2012. (HIPO, 2014) In Hungary 1368 patent applications were made at the EPO in the period 2000-2010. More than 2000 applications followed the Patent Cooperation Treaty (PCT) route, while the National Patent Office (SZTNH) received close to 8000 applications in this period[47].

In order to identify key issues regarding the performance of the RDI system and policy the *Innovation Union self-assessment tool* was used. The main strengths of the Hungarian RDI system could be summarised in the following:

- promotion of research and innovation is considered as a key policy instrument to enhance competitiveness and job creation;
- significant attention and effort is made to improve the performance of the RDI system;
- design and implementation of research and innovation policies is steered at the highest political level and based on a multi-annual strategy as reflected in the RDI strategy 2013-2020 and the National Smart Specialisation Strategy;
- adequate and predictable public investment is secured through the RDI strategy and the Operational Programmes of the Structural Funds to stimulate private investment and reach the R&D target set by the strategy;
- research funding is increasingly allocated on a competitive basis and the balance between institutional and project-based funding of research has a clear rationale;

[45] These publication data are based on Elsevier's Scopus database. ScienceMetrix, Analysis and Regular Update of Bibliometric Indicators, study conducted for DG RTD. They represent an update of the data displayed in the table below. See also http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=other-studies.

[46] Scival 2014, Scopus based publication indicators derived from Elsevier's SciVal platform, www.scival.com last accessed December 2014.

[47] Source of this data is the study performed for DG Research and Innovation „Measurement and analysis of knowledge and R&D exploitation flows, assessed by patent and licensing data." INCENTIM KU Leuven, Universita Commerciale Luigi Bocconi, KITeS and Technopolis Consulting Group, 2014.

- the largest PRO, the Hungarian Academy of Sciences introduced several measures to increase the efficiency and effectiveness of scientific research as well as programmes to make researchers career more attractive for both foreign researchers and ex-pats working in research centres abroad;
- partnerships between higher education institutes, research centres and businesses, at regional, national and international level, are actively promoted;
- use of tax incentives are explored, although their significance is rather low compared to the total R&D funding;
- excellence is becoming a key criterion in funding of the public R&D and the financing of the higher education organisations as proposed by the new higher education strategy;
- policies to promote innovation, entrepreneurship and enhance the quality of the business environment are interconnected;
- increasing attention is paid to building a start-up ecosystem (i.e. the capital Budapest to become the start-up hub of Central and Eastern Europe by 2020).

5.2 Structural challenges of the national R&I system

Using the Innovation Union self-assessment tool the following **main weaknesses** of the Hungarian RDI system could be identified:

- unstable, frequently changing STI governance structure even within government cycles and generally low interest of stakeholders to be actively involved in the design of STI policy and related measures;
- weak supply of researchers especially in the public sector where age structure of researchers in many scientific disciplines, in particular in natural science and engineering, is unfavourable;
- weak RDI governance - although relevant institutions exist, their capacities and capabilities are rather low due to a great extent to their insufficient funding and lack of empowerment, especially at regional level;
- despite the large number of measures in operation for many years, the business-academy partnership and interoperability are still weak;
- innovative financing solutions such as private-public partnerships are not really explored although in 2012 there was a pilot pre-commercial procurement (PcP) programme carried out by the National Innovation Office, which is mentioned in the recently approved RDI strategy 2013-2020;
- public funding of research focusing mainly on tackling and improving the competitiveness of the economy and not really oriented towards addressing major societal challenges, such as ageing and climate change as reflected in GBAORD figures;
- weak programme evaluation culture apart from the necessary ex-ante/ex-post evaluation of the Structural Fund programmes and low use of modern STI policy making tools such as foresight and technology assessment;

- education and training curricula mainly focus on factual learning while critical thinking, team and project work is not frequently used neither in secondary nor in higher education. Entrepreneurship education and training is not available in the curricula apart from these specialisations at dedicated faculties;
- low share of women in senior researchers and management positions in research and higher education organisations;
- weak entrepreneurial culture and framework conditions (e.g. changing regulation) do not favour entrepreneurship, specific support is not widely available to young innovative companies to help them commercialise their ideas rapidly and to promote internationalisation partly because university technology transfer offices set up in the past decade could not become stronger.

Opportunities are the following:

- high-quality higher education with established knowledge centres;
- increasing focus on natural science and technical education, expansion of practice-oriented training (dual training) and reinforced innovation management education and entrepreneurship training;
- increasing economic role of networking, cooperation and innovation clusters as well as spreading of incubator services;
- closer cooperation between academia and the business sector;
- strengthening excellence in public research and education as well as development of centres of excellence that take part in world-class research projects;
- integrated research and innovation funding system that supports smart specialisation and avoids double financing.

Based on the ERAWATCH country reports produced in previous years (i.e. Havas 2010, Havas 2012, and Dőry-Havas 2013), the situation analysis of the National Research-Development and Innovation Strategy 2013-2020 and the National Smart Specialisation Strategy, the IUS and other data presented above, the following five major structural challenges[48] of the Hungarian NIS are highlighted:

1. ***Low level of innovation activities, especially that of the SMEs***: only about one-fifth of enterprises introduce product or process innovations in Hungary, with no major change in the last decade. This ratio is even lower for SMEs and the share of SMEs innovating in-house is only 11.4%, only one-third (!) of the EU-28 average. According to IUS 2014, only 16.8% of Hungarian SMEs introduced product or process innovations, that is, 44% of the EU-28 average. This is not surprising because R&D activities are highly concentrated in large companies and a mere 8% of all Hungarian research units are responsible for half of the business expenditures on R&D.
2. ***Low occurrence of co-operation in innovation activities between academia and business***: the Hungarian economy is composed of highly productive and technologically advanced foreign-owned large firms, on the one hand, and fragile,

[48] The presented challenges are fairly similar to those of the previous years as the situation and framework conditions for RTDI have not changed significantly.

financially and technologically weak domestic SMEs, on the other hand. Small innovative firms co-operate less frequently with their clients or customers than large innovative companies. Compared to the EU-28 average, there are only half as many innovative SMEs that cooperate in Hungary (6.7%) than in other European countries (11.7%). Although this challenge has been recognised since long ago, no major change happened in the last decade although several measures tried to reinforce the collaboration between academia and business.

3. **Insufficient quantity and supply of human resources for R&D and innovation**: the future of R&D and innovation activities is predetermined by the quality and quantity of scientists and engineers, and the level of skills more generally. Yet, both the share of science and engineering (S&E) graduates and the rate of participation in life-long learning are rather low in international comparison. A significant gap might be opening between the supply and demand for qualified S&E personnel in the near future. According to the IUS 2014, the number of doctoral graduates in the 25-34-year age group is 0.8 (per 1,000 people), which is only half of the EU-28 average (1.7) and lower than the figure was in 2009 (0.9). It is a positive trend, however, that the share of the population aged 30-34 having completed tertiary education increased slightly to 29.9% according to the IUS 2014 figures and reached 83% of the EU average (35.8%). Furthermore, brain-drain primarily affects the highly qualified, young workers, especially those with S&E degrees that are overrepresented within the group of Hungarians working abroad. Some reverse brain-drain could be observed thanks to the "Momentum" programme of the Hungarian Academy of Sciences (MTA), although the volume of the brain-gain is rather small scale, but it could be seen as a role model for researchers working abroad.
4. ***Unfavourable framework conditions for innovation***: the macroeconomic situation, the structure of the economy dominated by large, usually multinational companies, the overall low entrepreneurship culture, the low level of risk-taking together with the intensity and type of competition seem to influence firms' behaviour with such a power that STI policy schemes cannot offer strong enough incentives to overrule these unfavourable effects.
5. ***Deficiencies in the STI governance system and the institutional framework***: the shortcomings in the Hungarian STI policy remained as they were identified in the OECD Review[49] in 2008 when four aspects of policy failures were highlighted: (i) lack of political commitment, (ii) instability, (iii) shortfalls in implementation, (iv) slow, insufficiently informed policy learning processes. In the last few years the situation has neither improved nor stabilised much because of the reorganisation of major STI policy-making bodies between 2010-2012, and the restructuring of the RTDI funding system at the end of 2014.

5.3 Meeting structural challenges

There are a number of policy measures in place that address the low level of research, development and innovation activities of companies, in particular SMEs, as well as their collaboration with public research institutions. However, companies – particularly small

[49] See for details OECD (2008), pp. 15-16.

domestic firms – often wait for public support in order to launch new research and innovation projects, therefore they try to avoid taking risk and rarely invest in RDI activities from their own pocket. Another related issue is that a high percentage of companies focus only on local/domestic markets and have no international view in their commercialisation strategy. This certainly prevents them from scaling up rapidly their operation and becoming a "Gazelle". Some attitude change could be identified with the uptake of the Hungarian start-up ecosystem in the past few years. Start-ups appear often in the news as role models, especially those that achieved an international reputation and became a large company (e.g. Prezi, LogMeIn, NNG). The National Innovation Office (NIH) has been playing a major role in the development of the Hungarian start-up ecosystem and its promotion activities (e.g. pitching competitions during the Start-up Spring, the Innotrends conference). NIH also offers a number of business development and mentoring services for start-ups and SMEs. Also the Office is behind the establishment and accreditation of business incubators that were set up within the frame of the "Start-up 13" programme.

The most recent policy documents, including the RDI strategy 2013-2020, the National Smart Specialisation Strategy, the new law on scientific research and innovation, the new higher education concept as well as the operational programmes of the new financing period 2014-2020 (i.e. GINOP, VEKOP, EFOP, TOP) recognise well the situation and propose measures that could offer solutions for a faster and more effective development of the Hungarian NIS. However, it depends a lot on the quality of implementation of those strategies and measures in order to achieve the expected outcomes and impact. Apart from the necessary ex-ante and ex-post evaluation of RDI measures, policy level evaluation and (international) review of the impact and outcomes of the measures would be beneficiary for the fine-tuning of these instruments and could provide input for strategy making.

The exploitation of public research results, including knowledge transfer and spin-off creation is not yet a well explored area, even if TTOs are established at all major HEIs. Besides, the attraction of young and mid-carrier professionals from companies to PROs and universities to introduce professional research management techniques, develop collaborations with companies and foreign R&D institutes could significantly enhance institutional performance and excellence.

There are a relatively large number of intermediary organisations (e.g. regional innovation agencies, technology transfer offices) in the Hungarian NIS, nevertheless they have no critical mass neither in their size nor in their responsibilities. More targeted funding could increase their specialisation and help them in gaining critical mass in order to become significant players of the NIS.

In addition, there is an engraved cultural attitude that hinders innovation activities. Creativity and problem-solving is a traditional strength of Hungarian researchers and companies. Nevertheless, monetisation of scientific results and building a company that lasts long and achieves global success should be learned by Hungarian innovators and entrepreneurs. With this regard the education of transversal skills (e.g. teamwork, presentation skills) and entrepreneurship training provided for both secondary school and university students could make a difference. Also, more bottom-up initiatives, innovation, responsibility and risk taking in the public administration could stabilise the STI policy making bodies that are reorganised quite often. Clear organisational hierarchies, well defined guidelines, and review of performance against objectives could be beneficiary for institution building on the longer term.

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Annex 2 – Abbreviations

BERD	Business Expenditures for Research and Development
BME	Budapest University of Technology and Economics
CERN	European Organisation for Nuclear Research
CIS	Community Innovation Survey
COST	European Cooperation in Science and Technology
CSR	Country Specific Recommendation
EFOP	Human Resource Development Operational Programme
EIS	European Innovation Scoreboard
ELTE	Eötvös Lóránd University of Sciences
ERA	European Research Area
ERA-NET	European Research Area Network
ESF	European Science Foundation
ESFRI	European Strategy Forum on Research Infrastructures
EU	European Union
EU-28	European Union including 28 Member States
FDI	Foreign Direct Investments
FP	European Framework Programme for Research and Technology Development
FP7	7th Framework Programme
FTE	Full-time equivalent
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GINOP	Economic Development and Innovation Operational Programme
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HERD	Higher Education Expenditure on R&D
HES	Higher Education Sector
HUF	Hungarian Forint
IP	Intellectual Property
IKOP	Intelligent Transport Development Operational Programme
IU SAT	Innovation Union self-assessment tool
JTI	Joint Technology Initiative
KEHOP	Environmental and Energy Efficiency Operational Programme
KSH	Hungarian Central Statistical Office
KTIA	Research and Technological Innovation Fund
MISZ	Hungarian Association of Innovation
MTA	Hungarian Academy of Sciences
NEFMI	Ministry of National Resources
NEKIFUT	National Research Infrastructure Survey and Roadmap
NFK	National Development Cabinet
NKFIH	National Research, Development and Innovation Office
NKFIA	National Research, Development and Innovation Fund
NIH	National Innovation Office
NIS	National Innovation System
NKITT	National Research, Innovation and Science Policy Council
NKTH	National Office for Research and Technology
NRP	National Reform Programme
NTIT	National Science Policy and Innovation Board
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Co-operation and Development
OP	Operational Programme
OTKA	National Scientific Research Fund
PcP	Pre-commercial Procurement
PCT	Patent Cooperation Treaty
PPS	Purchasing Power Standard
PRO	Public Research Organisation

R&D	Research and Development
R&D&I	Research and Development and Innovation
RI	Research Infrastructure
RIÜ	Regional Innovation Agency
RTDI	Research Technological Development and Innovation
S&E	Science and Engineering
S&T	Science and Technology
SF	Structural Funds
SIP	Science - Innovation Programme
SME	Small and Medium Sized Enterprise
SZTE	University of Szeged
SZTNH	Hungarian Intellectual Property Office
STI	Science, Technology and Innovation
TTPK	Science and Technology Policy Council
TOP	Territorial and Settlement Development Operational Programme
VC	Venture Capital
VEKOP	Competitive Central-Hungary Operational Programme

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