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

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Foreword

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

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Executive summary

Context

Romania has one of the lowest GDPs per capita in Europe. In 2014, GDP per capita in PPS was 54% of the EU28 average. Further discrepancies can be found between the eight regions, with Bucharest registering more than double of the GDP per capita compared with the second-best region (West Region) and close to four times compared with the region with the lowest level (North East).

The economic crisis which hit severely the country in 2009 and 2010 brought to a standstill the rising trend of R&I investments from previous years. Decision-makers from both the public and private sectors chose to cut or delay R&I investments. The scarcity of financial resources led to deprioritising funding to carry on R&I activities. Not only R&I investments were concerned, but also human resources. Young researchers were affected by the diminishing revenues from R&I activities and had to choose better-paid jobs in other sectors. Hiring was nearly stopped in the entire public sector for several years, including research institutes and autonomous universities.

Romania has registered annual economic growth rates of around 3% of GDP starting in 2013, but the cuts in public R&D expenditures have not been scaled back. The levels of government funding are still comparable to those from 2009. This can be partly explained by a political choice to decrease spending on R&I, but also by a commitment to satisfy the EU criteria before Romania's accession and then by a choice to decrease the R&I spending. The latter may be due to a presumption that there will be sufficient Structural Funds (SF) for R&I that will fill the gap, yet Romania allocated one of the lowest shares in the EU of total ESIF funding to R&I activities.

The adoption of the National RDI Strategy 2014-2020 in October 2014 has not brought stability in the system so far, since the commitment for public resources has been already broken. The National RDI Plan, which should warrant the implementation of this strategy, has just been adopted, after an extended delay.

Compared to 2007, when Romania joined the EU, the R&I system performance has improved to a certain extent in several departments, but it still lags behind the EU average and similar countries. While on certain aspects such as publications in the main flow Romania scores well, considering its undersized system, the absolute numbers remain weak. In other respects, such as patenting activity, the gap has widened even more. The Innovation Union Scoreboard 2015 defines Romania as modest innovator, ranking last among the EU Member States.

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

- The adoption of the National Plan (NP3) for the implementation of the National Strategy on RDI 2014-2020 in July 2015.
- The adoption of the Law 120/2015 on stimulating individual investors – business angels in May 2015, primarily aimed at improving access to funding for SMEs.
- A draft law on public procurement introduces the concept of "innovation partnership" for public institutions seeking innovative solutions that are not available on the market.
- A draft law to approve the Government Emergency Ordinance 13/2015 on the establishment and organisation of the National Agency for Public Procurement (NAPP) is in the adoption phase.
- A legislative proposal to establish a National Council for Competitiveness as a mechanism for the monitoring and correlation of policy was launched. The Council will evaluate draft policy, propose policy improvements, monitor the efficiency of programs aimed at increasing competitiveness, approve the public budget and the social security budget, assess annually the competitiveness of relevant

sectors of the economy and design and update the National Strategy for Competitiveness.

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

(1) to increase public R&I expenditure and the allocation of Structural Funds for R&D;
(2) to improve the R&I governance;
(3) to improve the framework for R&I private investment and build synergies between science and industry.

R&I Challenges

Challenge 1: **Increase public R&I expenditure and the allocation of Structural Funds for R&D**

Description

The Romanian R&I system is heavily underfinanced. In 2014 gross domestic expenditure on R&D (GERD) was the lowest among all the EU Member States (0.38% of GDP compared to an EU average of 2.03% of GDP). A target of 1% public R&D expenditure was first set in 2006 and used as basis for the programming period 2007-2013, but the average annual allocation was three times smaller. Romania has reaffirmed this target for 2020, which also forms the basis for the National RDI Strategy 2014-2020 and its instruments. However, several months after the adoption of this strategy, the 2015 budgetary allocation is 2.17 times lower than this objective for the year.

The allocation of structural funds for R&D is also surprisingly low, in light of the 1% target. For the period 2007-2013 structural funds provided 20% of public R&D expenditures, while for the period 2014-2020, the allocation has not increased significantly (€1 billion, representing 15% of the R&D required to reach the target in 2020). The low allocation of structural funds for R&D displays the low political interest in this field, even if the absorption rate for R&D was 100%, particularly high compared to less than 40% in some other fields.

Policy response

Between 2000, when Romania started the negotiations for the accession to the EU, and until the economic crisis struck, the Romanian Government gave a high priority to R&I as a driver of competitiveness and sustainability. Since 2001, policy objectives were derived mostly from the Lisbon Strategy and the European Research Area targets. This new direction was reflected, particularly starting in 2006, in policy documents as a justification for channelling resources to R&I. However, the noticeable hikes in expenditures lasted only a few years, until the beginning of the economic crisis. The National Development Plans and the National Reforms Programmes and two of its Operational Programmes (OPs) provide strong arguments for increasing R&D resources; the R&I-oriented Plans and OPs also contain objectives and special instruments to achieve them.

Assessment

The government has made progress in identifying the causes of structural weaknesses of the R&I system, but the implementation of the solutions is delayed and/or absent. Given the drastic reduction in funding for most research programmes, recent infrastructures are underused, while the research career prospects of the new PhD graduates look grim. The long-term underfinancing has been translated into a substantial brain-drain. Romania has one of the largest scientific diaspora among the EU countries, with an estimated 15,000 researchers working abroad (World Bank 2011). While the new doctoral schools funded by Structural Funds provided students with generous financial support, they experience difficulties in finding jobs in Romania and become contenders to enlarge the diaspora.

Romania has the second lowest rate of Structural Funds (SF) absorption in the EU (62.2%), although it has managed great improvements since 2012, when the rate was below 10%. The implementation of the SF Sector Operation Programmes is significantly affected by the quality of governance which is determined by the administrative capacity, still weak in comparison to other European countries, by poor institutional coordination and fragmentation, frequent legislative and institutional changes, and by insufficient policy capacity. The European Semester Country Report for Romania shows that the weak administrative capacity is causing delays in reforms and in the absorption of Structural Funds (SF).

Between March and October 2010, the World Bank undertook six sectorial reviews on behalf of the Romanian Government. They disclose public administration is characterised by a focus on compliance with norms rather than performance, while budget resources are spread thinly across policy areas without prioritisation. The reviews indicate that Romania has a poor institutional capacity at the central structure of the government to coordinate policies and resource commitments across sectors that would better align and achieve medium-term budgets and strategies.

Challenge 2: **Improve the R&I governance**

Description

Romania has a very fragmented research, development and innovation policy governance. The main actor is the Ministry of Education and Scientific Research (MESR). The ministry discharges its mission in the domains of research and innovation through its National Authority for Scientific Research and Innovation (NASRI), which coordinates the implementation and evaluation of the National RDI Strategy. However, MESR has limited power beyond implementing the National RDI Plan and allocating Structural Funds. Innovation policies have very limited inter-ministerial coordination, as the National Council for Science and Technology Policy (NCSTP), the responsible body at governmental level, has been inactive since its creation.

According to the National RDI Strategy 2014-2020, the consulting bodies for RDI are the Advisory Board for Research, Development and Innovation (ABRDI) and The National Council for Scientific Research (NCSR). These boards are supported by NASRI and, respectively, by the Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI) and they contribute directly to the management of the programmes of the National RDI Plan, through developing professional procedures for project financing. These councils have limited power in determining the flow of resources.

Regional research innovation policies are mostly national, reflecting the general structure of the public administration in Romania. This is also the case for smart specialisation, which is clearly addressed in the National RDI Strategy 2014-2020. However, all the 8 Agencies for Regional Development are also required to prepare their RIS3 strategies by the end of 2015. Given that there is de facto no regional autonomy in Romania, the main concrete actions resulting from these strategies will most likely focus on the allocation of RDI funds under the Regional Operational Programme (17% of RDI structural funds for the period 2014-2020).

Policy response

Following a long foresight exercise, the National RDI Strategy 2014-2020 was adopted in October 2014. The strategy includes an important component of smart specialisation and is a reassuring step. The new strategy sets fairly ambitious targets and includes priorities of national interest and instruments and policies to support the development of an innovation ecosystem, but its implementation is still uncertain since the National RDI Plan has just been adopted after an extensive delay. The Strategy provides for the creation of The National Council for Science, Technology and Innovation Policy (NCSTIP), with several ministers on board, to replace the National Council for Science and Technology Policy (NCSTP).

Romania adopted a set of additional strategies which include a broad range of innovation-related objectives and measures (e.g., for competitiveness, for the SME sector), but their resources and implementation plans remain unclear.

Assessment

Despite changes and improvements in policy formulation, the public R&I sector needs a reorganisation. There is a lack of coordination between the relevant policy actors, a fragmented institutional setting, and unpredictability at the level of the advisory councils of the MESR, unreliable funding, and a limited evaluation culture.

The evaluations of the research institutions carried in the past years may have brought improvements to institutional mid-term strategies, but a comprehensive approach aiming at a possible concentration of institutional resources is still lacking. Broader coordination of innovation policies is still missing and important governance reforms are delayed. There has been no progress in building a regional system of innovation governance or regionalisation.

The Assessment of the 2014 NRP and convergence programme for Romania shows that there is a lack of formal coordination between the Innovation Strategy, Competitiveness Strategy, Industrial Policy Strategy and SMEs Strategy.

Challenge 3: **Improve the framework for private investment in R&I and build synergies between science and industry**

Description

The level of R&D investment in the business sector (BERD) is very low; in 2014 it was 0.16% of GDP, decreasing from 0.19% in 2012. Romania's limited innovation performance is reflected in its economic structure which has a prevalence of low- and medium-technology sectors. The demand for knowledge is low and there is an underdeveloped innovation culture.

Romania is specialised in labour-intensive industries (preparation and spinning of textile fibres, sawmilling, wearing apparel and accessories), in capital-driven industries (cement), and marketing-driven ones (footwear). In terms of innovation, Romania is specialised both in low-innovation sectors (wearing apparel, leather) and in medium-high innovation sectors (textiles, basic metals). Romania's competitiveness is affected by a weak R&I capacity. Manufacturing plays a stronger role in Romania than in most other EU countries (24.8 % of total value added, compared to 15.5 % EU average), but the country is a modest innovator.

One of the most important barriers to develop a strong private R&D sector and promote innovation is the dual economy. Romania has several multinational companies (MNCs) which have high productivity, but lack in-house research activities. Thanks to them, the country has an increasing share of high-tech exports compared with its neighbours and a high share of medium high-tech export, but there is only a very low number of SMEs innovating in-house (see the table with the R&I input and output indicators).

The level of privately-funded public R&D expenditure in Romania is low. In 2012 it was 8.6% of the total GERD and 0.04% of GDP, which indicates a low level of science-business collaboration and a weak commercialisation of research results. In 2013 Romania received a country-specific recommendation to ensure closer links between research, innovation and industry, by prioritising R&D activities that have the potential to attract private investment.

The weak commercialisation of public research may have several sources. On the demand side, in Romania there is still a limited capacity for knowledge transfer caused mainly by the low interest and involvement of companies in research and development activities, including the cooperation with research institutions. This is complemented by the poor understanding of the need for quality control and certification, which leads to a low degree of conformity with advanced quality standards, a reduced interest in issues

such as industrial and intellectual property and also an unclear perception about the advantages that the applied research provides to industry. On the supply side, there is a traditional low level of industry-academia relations, a lack of entrepreneurial culture and skills among researchers, and a lack of bodies aimed at facilitating knowledge transfer.

Policy response

The National Strategy for Competitiveness 2015-2020, approved in September 2015, identifies several significant economic sectors with competitive potential, i.e., tourism and ecotourism, textiles and leather, wood and furniture, creative industries, automotive components, ICT, food processing and beverage, health and pharmaceuticals, energy and environmental management, bio-economy, biopharmaceutical and biotechnology.

The National RDI Strategy 2014-2020 which includes an important component of smart specialisation identifies a set of four priorities: Bioeconomy; ICT, Space and Security; Energy, Environment and Climate Change; Eco-nano Technologies and Advanced Materials. The regional smart specialisation strategies in all of the 8 regions should be elaborated by the end of 2015/beginning of 2016, but as the actual regionalisation process is still pending in Romania, the spectrum of instruments these strategies can use remains limited.

One of the most important policies introduced in the last 5 years concerns the 50% tax deduction for R&D expenditures. A 20% tax deduction was adopted in 2010 and it was raised in 2013 to 50%, but it is only in 2015 that the eligible costs and other implementation details were clarified, a fact that may encourage its use by companies.

The National RDI Strategy 2014-2020 sets targets in terms of activating the business sector and economic impact, following the Innovation Union Scoreboard indicators. The Governmental Strategy for the SME sector and business environment was adopted in 2014. Its action lines include: support and promotion of entrepreneurship, SMEs access to adequate funding, innovative SMEs, access to markets and internationalisation of SMEs, and reactivity of public administration to the needs of SMEs.

University spin-offs are represented only by few cases in Romania. Technology transfer and entrepreneurship in universities are relatively recent activities and only the major universities have developed their own technology transfer offices. There is a need for a friendlier environment (legal, institutional) for innovation in the private sector and a more attractive package of incentives for clustering and networking.

The Regional Operational Programme (ROP) and the Priority Axis 4 'Strengthening regional and local business environment' provides funding for regional and local business support structures, especially in less developed and declining areas, rehabilitation of industrial sites, regional and local entrepreneurial initiatives to attract investors, job creation and sustainable economic growth, technology transfer to micro enterprises.

Assessment

The business sector shows signs of an increasing interest in innovation, as revealed by the emergence of hubs, especially in ICT. The tax deduction for R&D expenditures was finally made functional and has the potential to become a very powerful trigger for R&D activities in the business sector. The Business Angels Law, also adopted in 2015, provides for a 3-year tax exemption for the dividends earned by the transferee.

In response to complaints by companies that intellectual property law in Romania was too flexible and insufficiently supportive of investor interests, the IPR legal framework was changed under Law no. 83/2014 on service inventions. The law clarifies the rights of intellectual property revenue sharing between employees and their employers producing such inventions.

Support to knowledge-based start-ups, including funding for product development, is provided via dedicated measures financed under Structural Funds. The main support for business R&D activities and investment is given by RDI project co-financing under the

National RDI Plan and Structural Funds, but access to loans for R&D activities in SMEs is very limited. For the period 2014-2020, both the RDI Strategy and SMEs Strategy provide for the creation of an investment fund with opening capital and seed capital for entrepreneurs with innovative ideas and an investment fund with venture and growth capital for innovative start-ups.

Romania has shown limited progress in addressing the recommendation to ensure a better link between research, innovation and industry, in particular by prioritising research and development activities that have the potential to attract private investment. Some public-private cooperation initiatives, associated with the development of clusters, succeeded in gathering policy makers, public research institutions, big companies and SMEs. Well-targeted support measures would be helpful to support their further development.

Despite the current scarcity of resources, Romania's performance on knowledge transfer might be improved provided that the necessary funds are allotted according to identified priorities. The main risks are related to the implementation process. The overlapping of measures, programmes and implementing agencies, as well as the lack of coordination, monitoring and of clear responsibilities for each actor involved in the implementation process, the lack of transparency in structural funds management, as well as bureaucratic delays in respecting the EU deadlines and procedures, may compromise the attainment of strategic goals.

1. Overview of the R&I system

1.1 Introduction

Despite its relatively resilient public research base, Romania has a fragmented innovation ecosystem, where the interaction between the private and public actors is still very limited. As such, the country finds itself in a paradoxical situation. While, as a whole, its research and innovation system shows poor results on a variety indicators, it has also achieved global distinction in both fundamental research (e.g., subfields in Mathematics or the natural sciences) and technological innovation (e.g., internet security). This suggests that there is potential for catching-up. However, the country faces challenge of brain drain and the danger of remaining unable to build the critical mass of elite researchers needed to boost its R&I ecosystem.

To these unresolved issues adds up a political dimension. Over the past 4 years Romania had 8 ministers of education and research. Several lasted in office a few months (or even weeks); a few left among ethics scandals. The high turnover of ministry heads has led to a cycle of high expectations followed by frustration and disappointment and has generated mistrust in policy makers.

Despite this, the country has recently posted a relatively solid economic performance. The rate of economic growth was 3.5% in 2013 and 2.8% in 2014 (Eurostat) and is estimated in the 2015 draft autumn forecast of the National Forecasting Commission at 3.4% for 2015.[2] The country's general deficit in 2014 was among the lowest in Europe at -1.4% of GDP, decreasing from -2.2% in 2013. Likewise, the consolidated gross debt as a percentage of GDP is among the best in Europe at 39.8 (Eurostat data). The latter figures may, however, also reflect a considerable drop in public investments (4.2% less for capital expenses in 2014 compared to the previous years),[3] with potentially adverse long-term economic effects.

Romania still has one of the lowest GDPs per capita in Europe: in 2014, GDP per capita in PPS was 54% of EU28 average (Eurostat). Furthermore, internal discrepancies among the 8 development regions are large. The Bucharest-Ilfov region, whose GDP per capita in PPS is 131% of the EU28 average (2013), is over 2.2 times richer than the second-richest region (West) and close to four times richer compared with the poorest region (North East).[4]

In 2014, the unemployment rate was 6.8%, down from 7.1% in the previous year (Eurostat). It has been fluctuating around this figure since 2010. The employment rate in 2014 was 65.7%, slightly up from the previous years, but below the 70% target and the EU28 average (69.2%) (Eurostat). Of the over 8.5mn active-age men and women in Romania, just under 4.5mn hold a remunerated job. The very high levels of self-employment (2.1mn individuals, or 25% of all jobs) is attributable not to entrepreneurship, but to a subsistence economy. Around 20% of the working population is employed in the public sector.[5]

The structure of the country's economy is considerably different from the EU average: while employment in manufacturing is slightly above the latter (at 19%, compared to 16%), agriculture accounts for 26% of all employment (compared to a 4% EU average) (Eurostat data, 2013).

The research, development and innovation (RDI) system is small relative to the country's population. The number of researchers (FTE) per population is more than 3.5 times below the EU average.

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[2] National Forecasting Commission, *Prognoza preliminara de toamna 2015*, available at http://goo.gl/4hqJYr.

[3] Andra Oprescu, Romania, printre cele mai mici deficite bugetare din UE [Romania, among the lowest budget deficits in the EU], *Ziarul financiar*, 24 April 2015, available at http://goo.gl/tnyNsk.

[4] Eurostat Newsrelease, *GDP per capita in the EU in 2013*, 21 May 2015, available at http://goo.gl/UQUD34.

[5] National Forecasting Commission, *Prognoza preliminara de toamna 2015*.

In terms of financing, the RDI system continues to be "in a silent crisis" (World Bank, 2010): GERD was 0.38% in 2014, down from 0.39% in 2013 and 0.48% in 2012. Some of the drop was caused by the diminished contribution of business, with no signs of recovery (0.16% in 2014, up from 0.12% in 2013, but still far less than the 0.17% in 2012 and the 0.22% before the crisis years). Another factor which had an impact on the GERD are the additional cuts in public outlays for R&D, down from 0.26% in 2011 (and close to 0.4% before the crisis) to 0.21% in 2013 and 2014.

In absolute terms, GERD per capita is 19 times lower than the EU average. This puts into relative perspective the R&D system's ability to act as a driver of economic development. Turnover from innovation as a percentage of total turnover was 5.4% in 2012, compared to a European average of 11.9%.

The official target of 1% public R&D expenditures, then complemented by 2% private R&D expenditures, was first set in 2006. It was used as a basis for the programming period 2007-2013. The average annual allocation under the National Plan was, however, three times lower than planned. In 2014, Romania reaffirmed the strategic objective of 1% public expenditures, this time with an additional 1% from private sources, for 2020. These figures were used as a yardstick in the National RDI Strategy 2014-2020 and its main implementation instruments. However, only several months after the adoption of the NS 2020 in October 2014, the budgetary allocation for 2015 was set at a figure more than 2.1 times smaller than the objective. In response, civil society representatives raised the issue of ministerial responsibility.[6]

The draft national budget for 2016 allocates, as of December 2015, RON 2.21bn (approx. €0.5bn) for RDI. This represents an increase of over 32% in absolute terms vis-à-vis the previous year. As a share of GDP, however, the uptick is less impressive, below 0.3% *budgeted* (0.296%), compared to 0.27% budgeted for the previous year.[7] Note that actual allocations were considerably lower than the budgeted amounts in 2014 (as well as in previous years).

[6] "Ad Astra: Bugetul pentru cercetare este prea mic si incalca legea", available at http://goo.gl/NYAIOW.
[7] See http://openbudget.ro.

Table 1 Main R&I indicators 2012-2014

Indicator	**2012**	**2013**	**2014**	**2015**	**EU average**
GDP per capita	6,700	7,200	7,500	N/A	27,400 (2014)
GDP growth rate	0.6	3.5	2.8	3.4*	1.4 (2014)
Budget deficit as % of public budget	-3.2	-2.2	-1.4	N/A	-3.0 (2014)
Government debt as % of GDP	37.4	38.0	39.9	N/A	86.8 (2014)
Unemployment rate as percentage of the labour force	6.8	7.1	6.8	6.8*	10.2 (2014)
GERD in €m	644.2	557.8	575.1		283,009.4 (Total for EU28)
GERD as % of the GDP	0.48	0.39	0.38	N/A	2.03 (2014)
GERD (EUR per capita)	32.1	27.9	28.8	N/A	558.4 (2014)
Employment in high and medium-high-technology manufacturing sectors as share of total employment	4.5	4.8	5.3	N/A	5.7 (2014)
Employment in knowledge-intensive service sectors as share of total employment	20.4	20.1	20.0	N/A	39.8 (2014)
Turnover from innovation as % of total turnover	5.4	N/A	N/A	N/A	11.9 (2012)
Value added of manufacturing as share of total value added	27.7	26.3	N/A	N/A	20.2 (1012)
Value added of high tech manufacturing as share of total value added	1.4	1.3	N/A	N/A	2.5 (2012)

Data source: Eurostat; * Estimate by Romania's National Forecasting Commission, preliminary autumn forecast 2015.

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

1.2.1 Main features of the R&I system

The RDI system is centralised: While the country is formally divided into 8 'development regions', their administrative powers are very limited. A process of regionalisation was announced on several occasions, but both the public opinion and experts are divided with respect to the best approach or the depth of regionalisation. Each region has an Regional Development Agency (RDA)[8] which elaborates a Regional Development Plan (RDP) and ensures the technical management of funding thereunder.

The RDAs act under the direct coordination of a Council for Regional Development – a regional deliberative body without legal personhood consisting of the presidents of county councils and representatives of municipal, town, and commune councils. The Agencies identify and promote regional partnerships, attract foreign investments, raise funds for development projects and so on.

Under the Framework Agreement, the RDAs act as regional Intermediary Bodies for the Operational Programme Regional Development (OP RD). The RDPs are supported financially mainly through the structural funds (SF) allocated via the OP RD. For the period 2014-2020, the RDI funds under this programme will amount to around 20% of the total SF for RDI. Given the design of the first priority axis of Operational Programme Regional Development, which directly targets technological development, these amounts will be predominantly directed towards innovation and technology transfer activities, as well as R&D infrastructures. (For details on regional RIS3, see section 2.4.)

The public R&D system is divided between a roughly equal number of 'applied research' and 'fundamental research' organisations: The main 'research and development' organisations are the national R&D institutes (NRDIs), formerly the sectoral institutes of the communist-era (i.e., pre-1990) central administration. Almost all (42, specifically) are now subordinated to the Ministry of Education and Scientific Research (MESR), under a government decision dating from 2013 (see section 2.5 on main policy changes).

Not counting the around 100 universities, the other important section of the public R&D system consists of the institutes and research centres of the Romanian Academy (RA). These approximately 60 organisations are typically (self-) identified as 'fundamental research' institutions.

The public R&D system is dominated by institutional funding: Both NRDIs and the RA institutes receive institutional funding that is, in practice, not based on performance. The former types of organisations are funded under the programme Nucleu. The latter obtain their financing through the Romanian Academy's own separate chapter in the national budget. In both cases, the financing mechanism is not very transparent (Zulean et al. 2015). Mostly, allocations are correlated strongly with the number of research staff employed by the institutes. This suggests a financing system which remains constrained by historical patterns.

Private research organisations make up a small minority: In a chronically underfinanced system, where public funding streams continue to be independent, the survivors are usually the organisations which receive some form of institutional financing. The privatisation of (some of the) public research institutes inherited from the communist era was proposed occasionally and, in a few cases, even accomplished. However, the institutes were typically bought for their assets, primarily real estate, sometimes far below market prices.

[8] The role of each Regional Development Agency is to contribute to sustainable and equitable development by removing disparities and imbalances among areas within the region. Established by Law 151/1998, the Regional Development Agencies currently operate under Law 315/2004 on regional development in Romania.

The SME sector consists, to a large extent, of 'subsistence organisations'. For example, in 2013, over 91% of all Romanian SMEs were entirely self-financed. The several large multinational corporations operating in the country host relatively limited R&D activities here. This being said, in ICT particularly, the development centres of large corporations are expanding in the big cities as well as some of the smaller urban centres.

State-of-the-art private sector innovation has been emerging in a few areas. This is the case, mainly, of the strong domestic ICT sector and is attributable to the country's engineering excellence and international competitiveness in this last respect.

Business interest in R&D remains very low: BERD is only around a third of GERD (0.13% and, respectively, 0.38% of GDP) – and both figures are very low, compared to the EU average, in absolute and relative numbers. A mere third of companies' R&D expenditures are directed to activities carried out by universities, research institutes or other public research organisations.

An updated research infrastructure and an expanding pool of young researchers remain underused: Romania has recently rebuilt its research infrastructure through structural funds. The same funding source was essential in boosting rapidly the number of PhDs. However, anecdotally speaking (since no data is collected in these respects), both resources remain seriously underused given meagre project funding. Furthermore, the hiring and promotion practices in universities and research institutes reportedly continue to privilege insiders over competitive outsiders. Both these factors limit the ability of the around 10,000 newly minted PhDs and postdocs supported through SF to enter the public research and development system.

Massive brain drain hampers prospects of critical mass in key fields: The rather bleak prospects of a career in research or in higher education have led to an outflow of talented researchers and academicians. This has been the case especially among the best and the youngest; and fields, such as STEM and life sciences. Brain drain has been undermining the capacity of the R&D system to replenish its workforce and to reach critical mass.

1.2.2 Governance

Inter-ministerial coordination with respect to R&I is mostly absent. Innovation policies have no de facto inter-ministerial coordination, as the responsible governmental body, the National Council for Science and Technology Policy (NCSTP) coordinated by the prime minister, has remained inactive since its creation around a decade ago.

In its chapter on systemic governance, the National Strategy for RDI 2020 provides for the establishment of a National Council for Science, Technology and Innovation Policy (NCSTIP) to replace the non-functional NCSTP. Its members include several heads of key ministries (which exactly, the Strategy does not say explicitly, but context suggests all sectors linked to R&D, innovation and regional development). The mission of the NCSTIP is to ensure the coordination and correlation of RDI policy with sectoral and regional policy.

As of early 2016, exactly one year after the adoption of the NS 2020, the NCSTIP is still inactive. A newly founded RDI policy-support unit of the MESR was also assigned with elaborating the annual reports for this body. It is unclear whether this signals the imminent operationalisation of the NCSTIP or is a merely formal assignment.

Several ministers of education and research have succeeded over the recent years, leading to frequent changes in policy. A new technocratic government was installed in late 2015, but its mandate is short (1 year, until the general elections in late 2016). Adrian Curaj, the new minister for of Education and Scientific Research was in his former capacity – head of the agency implementing the outgoing National Plan for RDI (NP2) – directly responsible for the elaboration of the NS 2020 and the corresponding NP3. This may possibly allow for an accelerated implementation of the overdue NP3 and a more

careful operationalisation of the National Strategy. As of late April 2016, the first round of NP3 calls is expected within the next few weeks.

Advisory councils to the Ministry of Education and Scientific Research are only partially in place. According to the NS 2014-2020, the new consultative bodies for RDI are:

- The Advisory Board for Research, Development and Innovation (ABRDI), which represents the main consultative body of the MESR. Its work concerns mainly applied research, technological development, innovation, technological transfer, and international scientific cooperation.
- The National Council for Scientific Research (NCSR) has jurisdiction over basic and frontier research and the development of human resources in research. The members of the Council were appointed on the 9th of January 2015 after an extended hiatus caused by a mass resignation.

Public funding for RDI is allocated based on annual budgets, mainly through the National Authority for Scientific Research and Innovation which is coordinated by the Ministry of Education and Scientific Research. The agencies implementing the national RDI programmes include:

- The Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI), subordinated to the MESR, is the implementing agency for the National Plan for RDI 2007-2013 (NP2, still operational, budget €131m in 2013) and the recently adopted NP3. The former consists of a set of project-based funding schemes with a structure and procedures similar to FP7 (the programmes Ideas, Human Resources, Partnerships, Innovation, Capacities). The latter has a somewhat similar structure (defined in a further section). The NP2 and NP3 programmes are open to all research-and-development performing actors.
- The NASRI implements the programme Nucleu, an institutional funding instrument for the National R&D Institutes (NRDIs). The budget was €70.5m in 2013.
- The Intermediary Body for RDI, which is part of NASRI, and is thus coordinated by MESR, implemented the RDI-dedicated axis of the Operational Programme Increasing Economic Competitiveness 2007-2013, with an average annual budget of approx. €120m; and the OP Development of Human Resources. For the programming period 2014-2020, the MESR will similarly coordinate the Implementing Body for the Operational Programme Competitiveness, the RDI-dedicated priority axis, and the OP Human Capital.

The Romanian Academy (RA) has its own chapter in the national budget, which it disburses among its 60 research institutes and research centres. The consolidated budget (all sources) for 2014 was €100.7m. The public R&D funding allocated to the RA under the draft 2016 national budget is around €64m.

The universities (both public and private institutions) do not receive public institutional funding for research. Both public and private universities obtain their funds for research through the competitive project programmes which are open to all R&D actors. However, public universities receive some public institutional funding, but only for education activities; private universities do not receive such funds. On the subject of higher education funding, the branch Ministry is advised by the National Council for Higher Education Funding. In terms of organisational structure, programmes, and specialisations structure the public and private universities are similar since they are evaluated by the Romanian Agency for Quality Assurance in Higher Education which is the public body in charge with institutional and programme accreditation in higher education.

The outgoing NS RDI (2007-2013, but operational until 2015) was the subject of an independent mid-term review carried out in 2011. The findings of the review report published in 2012 are outlined in section 2.2.1.

The new NS 2020 also provides for an embedded 'strategic orientation' mechanism which would enable constant data collection, monitoring, and periodic evaluation of its implementation. The mechanism relies on:

- systematic data collection through a variety of instruments (the Registry of Researchers in Romania, the Registry of Research Infrastructures, intellectual capital reports etc.);
- a horizon scanning system for emerging trends (technological trends in particular);
- an observatory of the RDI ecosystem.

These strategic mechanisms are designed under a project whose beneficiary is the MESR and which is scheduled to start in 2016.

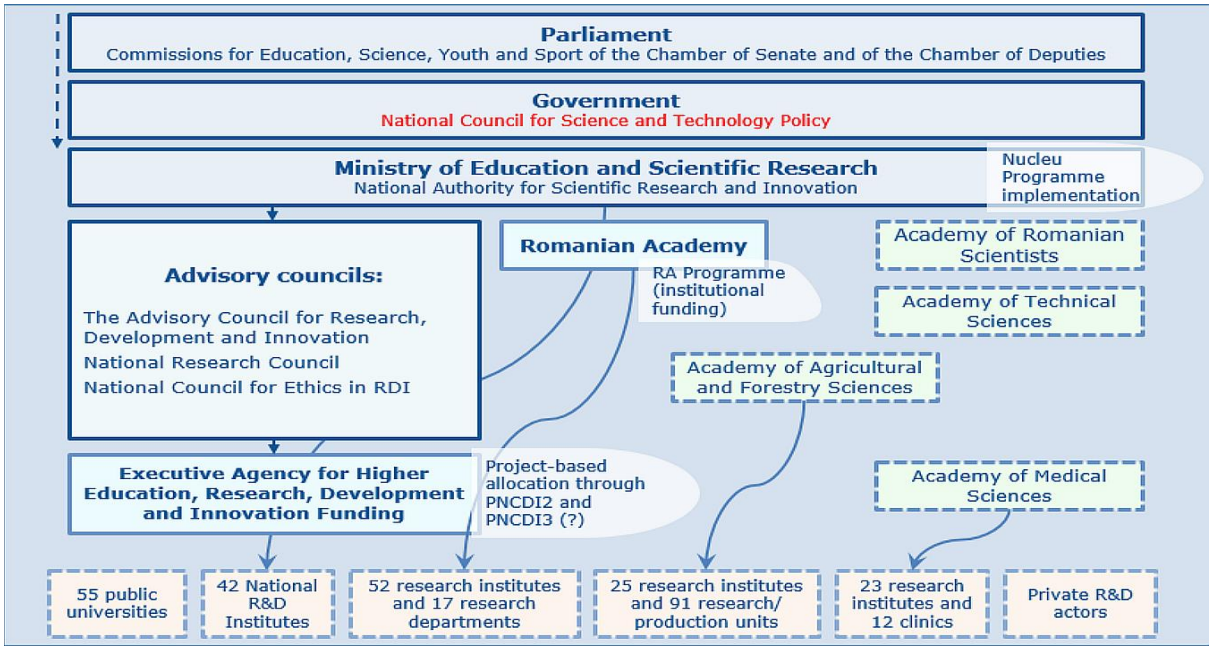
UEFISCDI, the organisation which manages the NP2's competitive R&D programmes, was nominated for the Open Government Partnership Awards 2014, awarded by the Office of the Prime Minister in partnership with the Coalition for Open Data.

Romania does not have a macroeconomic model to assess the impact of R&I on economic growth.

1.2.3 Research performers

The public RDI system consists primarily of national institutes for R&D, institutes of the Romanian Academy, and universities. The organisations most closely identified with 'research and development' are the national R&D institutes (NRDIs), formerly (i.e., under communist rule) the sectoral institutes of branch ministries. Of the around 50 such organisations that are currently active, a little over 40 are coordinated by the Ministry of Education and Scientific Research (MESR).

Figure 1 A diagram of the structure of the Research and Innovation system in Romania



Source: A. Curaj, Stairway to Excellence Country Report: Romania (2015)

The 'fundamental research' function is typically attributed to – claimed by – the institutes of the Romanian Academy (RA). There are currently around 60 institutes and research centres within the Romanian Academy. The latter is complemented by several branch academies – primarily the Academy of Agricultural Sciences and Forestry, and the Academy of Health Sciences, each of them operating 25 institutes.

Universities, both public and private, have rapidly increased in number since the early 1990s. The current figure is a little below 100 accredited higher education institutions

(HEIs), roughly evenly split in terms of public / private ownership. Public universities lead in both student enrolments and research production, and are the only ones to enjoy institutional public funding.

The academic system remains relatively homogenous. The universities are comparatively new players in RDI and have been struggling to adapt to this new section of their mission after 1990. They have shown respectable results in scientific publication, but their ties to industry remain weak. Depending on universities' mission and type – the country has several large technical universities –, R&D activities in academia are rather irregular. They also remain dependent on project-based funding; and on faculty's publishing efforts. Only 'teaching duties' are clearly defined for individual faculty in virtually all Romanian academia, so a 'research duties' is more informally set at 25% of the former. For this reason, in official statistics the number of researchers in universities is estimated simply as the equivalent of 25% of all academic staff.

The academic system is relatively homogenous in terms of organisational structures and learning experience. Universities currently offer only "Bologna-type bachelors, masters, and doctoral programs, while distance or 'open' education programs are few in number and questionable in quality" (Andreescu et al., 2012). The uniformity of the services provided and the absence of a strong reputational mechanism (Miroiu & Andreescu, 2010) – the legally mandated periodic rankings and classifications have practically been suspended after just one round – is reflected in the low and undifferentiated tuition fees (in the range of 600-750 Euro per year in both the private and state universities for a typical programme in the social sciences or the humanities).

The paucity of top-level R&D outputs generated by universities is likely explained by the low public R&D allocations, as well as the absence of institutional R&D financing for universities.

Romania has no company in the top 1000 EU R&D performers. By comparison, in 2014 Hungary had one, Greece and the Czech Republic each had 2, while Poland had 4 (The 2014 EU Industrial R&D Investment Scoreboard). Several multinationals run R&D centres in Romania. They include Renault Technology Romania with 3,200 engineers, Honeywell Romania (Automation and Control Solutions, and Transportation Systems) with 20 R&D engineers/scientists, Infineon Technologies (semiconductors) with 300 employees and Continental Automotive with three R&D centres (Kaminski 2011, 12; Dachs et al., 2014, 129). Other multinational companies with R&D centres in the country include IBM, Adobe Systems, Freescale Inc., Alcatel-Lucent, Ubisoft, and Microchip Technology.

According to the European Alpbach Forum, Romania is among the top European countries in terms of brain drain: with 26,296 highly educated specialists working in other Western countries since 2003, the country positions itself third on the continent, after Poland and Germany. The main destinations are the UK, Italy, Germany, and Belgium.[9]

[9] Katrin Nussmayr, "Where the European brains go", available at http://goo.gl/BEsnva. The source of the data is the European Union's *Regulated Professions Database*.

2. Recent Developments in Research and Innovation Policy and systems

2.1 National R&I strategy

The National Strategy for Research, Development and Innovation 2014-2020 (NS 2020) was adopted on 21 October 2014. Its elaboration was outsourced by the Ministry of National Education to a consortium headed by 11 main partners supported by an additional 141 associated partners. The project (www.cdi2020.ro) was carried out in 2013. It deployed an evidence-based, smart specialisation-aware foresight exercise, resulting in a 'technical version' of the NS 2020 as well as of its two main implementation instruments. The latter are the National Plan for RDI 2014-2020 (National Plan 3, or NP3) and the RDI-dedicated axis of Operational Programme (OP) Competitiveness for the same period. The adopted version of the strategy is similar to that resulting from the foresight, except for two main areas: the list of smart specialisation priorities, extended by political decision; and the governance structure, which was amended.

The Vision for 2020 at the core of the NS envisages an innovation ecosystem where research and development support the advancement in global value chains. In this environment, excellence and an entrepreneurial spirit mobilise a critical mass of actors; companies become key actors of innovation; the R&D sector develops around strategic fields and is internationally integrated. Romania is closely positioned in key European or global initiatives, both through co-participation or by assuming a leading role (in cases such as ELI-NP or Danubius-RI).

As the NS 2020 itself sets out, it is to be implemented through the following programmes (in addition to other policies, part of a broader mix, such as the 50% tax deduction for R&D activities):

- The National Plan for RDI 2014-2020
- The Operational Programme Competitiveness, Priority Axis 1– Research, technological development, and innovation in support of economic development and business development
- The Operational Programme Human Capital, mainly through Priority Axis 6 – Education and competencies
- The Operational Programme Regional Development, Priority Axis 1 – Promoting technological transfer
- The Operational Programme Rural Development, component on 'Investment in agriculture and rural development'
- The sectoral plans of various branch ministries
- The Research Plan of the Romanian Academy and its institutes
- Other sectoral policies (coordinated by NCSTIP but not specified in the Strategy).

NP3 is the main implementation instrument of the Strategy and the responsibility for its management and execution belongs to MESR, which, according to the NS 2020, "may outsource management to financing agencies or other service providers".

The draft versions of the NP3 and the RDI component of the Operational Programme Competitiveness were elaborated in the same process as the Strategy, in 2013. The OP was adopted relatively swiftly. The NP3 followed almost one year (in July 2015) after the adoption of the Strategy, subsequent to consultations as well as heated controversies as to which organisation(s) will ensure the administration of its programmes.

The NS 2020 and the procedures underlying it underwent an S3 peer-review process on 3-4 July 2014, in Dublin. The peer review was meant to assess the procedural aspects of the national RIS3 elaboration as well as the substance of the strategic documents in 5 countries, with comments and suggestions from their representatives as well as outside experts on smart specialisation.[10]

Four smart specialisations (S2), defined at a national level, were aggregated through the foresight-based elaboration process in the NS 2020. They are relatively close, or at least directly relevant to the continent's societal challenges:

- Bioeconomy, based mainly on the considerable agricultural potential of the country;
- ICT, which is currently the most dynamic RDI sector in Romania;
- Energy and environment, in connection with the challenges of energy efficiency, water resources, and substitution of critical materials; and
- Eco-technologies, which focuses on new-generation vehicles and equipment, the generation of bioresources, depolluting and waste reuse.

It should be noted, at this point, that the Strategy in fact operated at a different level of granularity, eventually selecting 30 promising 'research and innovation programmes' out of a much larger number, after several waves of panel work and consultations. The four fields represent, in fact, clustering of these R&I programmes under a broader umbrella. The NS 2020 itself explicitly worked with R&I programmes rather than broad fields.

The set of specialisations was subsequently expanded by political decision in the adopted form of the NS 2020, to include:

- Space and security;
- Energy production; and
- New materials (their entire spectrum).

Under the new National Strategy for RDI, smart specialisation is supported through a mix of instruments intended to apply to a broad range of activities considered relevant to the improvement of Romania's competitiveness. Together with the smart-specialisation approach, the policy mix represents an effort to deal with research and innovation in an integrated manner. Thus, for example, the Strategy's main programmes will cover such things as company-initiated innovative projects, ideally in partnership with public research organisations or other research-providers; competence centres and the technology transfer infrastructure more broadly; innovation incubators; research infrastructures, and so on. A more detailed look at the structure of the NP3, one of the strategy's two main instruments, is provided in section 3.4.3 below.

Given the varieties of PROs in Romania, the strategy provides for the creation of a legal framework setting out clear, simple procedures and supporting initiatives aimed at merging public research organisations. At the same time, the NS 2020 supports actions for more strongly correlated investments in research infrastructure, including an updated Roadmap for Infrastructures and the concentration of doctoral and post-doctoral projects financed through SF around the smart specialisation fields. So far, however, the Operational Programme component dealing with doctoral and post-doctoral studies has been weakly correlated with S2s.

Another important component of the smart specialisation process is the 'strategic orientation mechanism', whose objectives are to monitor and analyse the creation of competences in the S2 fields, and to periodically propose corrections and reorientations. The mechanism includes, among others, a Registry of Researchers in Romania, a National Registry of Research Infrastructures, and a horizon scanning system pursuing technological trends. These components are under development in two SF projects coordinated by UEFISCDI, and the actual integration into decision-making processes is planned to start in 2016.

[10] More information on the event of which the Romanian team was a part is available here: http://goo.gl/ZYk97i.

As of this writing, it is too early to assess how the NS 2020 will be implemented and to what extent its ambitious targets will be met. The public funding allocated for R&D in 2015 – that is, soon after the formal adoption of the NS – was more than twice below the level to which the policy-makers had just committed themselves. The national implementation plan NP3 was delayed for almost a year and its adoption was surrounded by controversy over the agency administering the main competitive funding streams. More recently, however, the allocated R&D budget for 2016 increased by almost a third over the previous year. Furthermore, the new head of the MESR under the technocratic government instated at the end of 2015 was directly responsible for coordinating the elaboration of the National Strategy.

Investment in infrastructures is expected to continue through the Operational Programme Competitiveness, the priority axis for RDI. However, an important challenge is now to optimise usage of existing and planned infrastructures and to broaden access. The National Registry for Research Infrastructures was announced in the NS 2020 and is part of a SF-funded project to be commenced by the MESR in 2016. An English-language platform offering booking services for public and private research infrastructure owners and users was launched in the summer of 2015 and is now fully operational (www.erris.gov.ro). In April 2016 the registry listed a little over 300 infrastructures with close to 4000 pieces of equipment and over 1600 distinct services.

2.2 R&I policy initiatives

The years 2014 and 2015 were characterised by institutional fragility and uncertainty in the R&D system. The National Council for Scientific Research (NCSR), the main buffer organisation in this field, was non-functional between April 2013, when its members resigned *'en masse'* in protest over cuts to the R&D budget, and early 2015.

Furthermore, the Government Ordinance (74/2010) which reorganised the main RDI funding agency (UEFISCDI) by pooling three agencies dealing with different NP2 programmes was another subject of protracted dispute. Four years after that GO's adoption, a period of increasing procedural transparency during which operational costs were halved, the parliamentary Commission on Education approved a draft law repealing it. This threatened to leave competitive funding for R&D in a state of legislative void and organisational limbo. The law met with wide protests from civil society representatives, with the Romanian Academic Society (RAS), a non-profit organisation, calling attention to "the risk of feudalising research funds during an election year".[11] The law abrogating the GO was later sent back by the president to the Parliament for re-examination, and several high-profile NGOs dispatched a protest to the Prime Minister. The conflict was eventually resolved when the National Plan (NP3) implementing the NS was belatedly adopted in July 2015. Although the NP2 funding agency is not mentioned in the Plan, it seems to have retained most of its formal role.

As far as other (i.e., beyond the NS 2020) strategic documents with an impact on innovation are concerned, Romania has recently adopted, as part of its ex-ante conditionality, a set of additional strategies setting out a broad range of research and innovation objectives. Thus, the *National Strategy for Competitiveness 2014-2020* intends to be an umbrella strategic document, setting out five mostly horizontal priorities (e.g., improving the regulation framework, increasing mutual trust among the private and public sectors, improving the competitiveness of 10 promising economic sectors etc.). The strategy provides for a set of general action lines accompanying these priorities (not described in any detail) and the associated targets.

[11] According to UEFISCDI general director Adrian Curaj, quoted by the daily *Adevarul* (1 April 2014), in the period 2007-2010, out of 298 projects in the Innovation programme, Politehnica University in Bucharest coordinated 186. The second-ranking institution was a private company, with 21 projects, followed by the Politehnica University in Iasi with 19 projects. By comparison, in the period 2011-2014, out of 277 projects, Politehnica only coordinated 23.

The *Government Strategy for SMEs and the Business Environment – Horizon2020* has very ambitious objectives in support of innovation in the SME sector. For example, the Strategy sets out that by 2020 the number of SMEs per 1000 population should increase by more than 50% (to 36, compared with the current 22); that the number of SME employees should rise by almost 25%; that SMEs' contribution to added value should go up by 60%. As to the main action lines, these include the following five:

- Support for and promotion of entrepreneurship;
- Improving SME access to adequate funding;
- Support for innovative SMEs;
- SME internationalization and access to markets;
- Public administration response to SME needs.

The action line *Innovative SMEs* includes a very broad spectrum of measures, many of them overlapping with the NS 2020 (e.g., support for partnerships between SMEs and R&D institutes, or support for technological transfer). It is not clear where there are additional resources for these action lines or whether an inter-institutional coordination mechanism will correlate their implementation.

Other action lines (e.g., business consulting services for SMEs, support for integration into productive chains, support for clusters, awareness campaigns on IP protection and support for certification of new products) are complementary to the SN 2020. However, the strategy has not yet been followed by clear action plans with dedicated resources.

At the end of May 2015, the Parliament adopted the Law on stimulating individual investors – business angels (Law 120/2015), primarily in order to improve access to funding for SMEs facing a reticent banking sector (in 2013, over 91% of all Romanian SMEs were entirely self-financed, according to the document justifying the draft law). See section 5.4 below for additional details.

Evaluations, consultations, foresight exercises

An evaluation of the period 2007-2013 at the level of the various funding programmes for R&D is difficult because, for many such programmes (e.g., those of the Romanian Academy and its institutes, Nucleu), information on outputs is not available (Zulean et al., 2015). As for the NP 2007-2013, the initial targets were correlated with a planned budget 3 times larger than the real allocation. A mid-term review of NS 2007-2013 was carried out in 2011.

Among others, the review report concluded that, while a "full-fledged" research policy system is in place, "the main thrust of required improvements is aiming at reducing complexity, simplifying and stabilising processes, sharpening the profile of actors, strategies and plans and establishing a thorough and robust system of policy intelligence in order to allow evidence-based policy making".[12] The report also pointed on the outgoing strategy's focus on broad thematic topics rather than subfields; the comparatively low share of structural funds in allocations for RDI; the complex sets of project evaluation criteria; some governance problems, such as the excessive number of roles and tasks to be fulfilled by varied National Councils with overlapping mandates; and the major cuts in funding during and after the economic crisis. Conversely, the mid-term review report highlighted substantial improvements in project evaluation and in the distribution of the projects in specific programmes across the institutional landscape.

Information at institutional level is also poor. Out of 41 public universities, 42 national institutes subordinated to MESR, and 60 institutes and research centres of the Romanian Academy, on average just around one quarter provide publicly available annual reports over the 2007-2013 time frame (Zulean et al., 2015, 52-53). These institutional reports vary in extent and substance, but often consist of just a listing of activities and

[12] Technopolis Group, GEA Consulting, FMMC, Mid-Term Evaluation of the National Strategy and of the National RD&I Plan 2007-13, 2012, p. 121.

accomplishments. The same is true for the main sections of the RA (such as, e.g., the Section for Information Science or the Section for Economic, Legal and Social Sciences, and so on). Reports are difficult to find on the RA website and they consist primarily of an inventory of 'achievements' for each institute within the relevant section and of a brief, one-paragraph conclusion.

In this context, it may be relevant to note the NS 2020 provides for the creation of the Council for Statistics and Prognosis in Higher Education, Research, Development and Innovation, which is designed to support an integrated evidence base for RDI policy. The NS 2020 also identifies several mechanisms for collecting and sharing data on institutional and programme performance. So far, there is no information as to the establishment and staffing of this Council.

As detailed in a previous section, the main foresight exercise on RDI since 2006 provided the framework for the elaboration of the NS 2020. It focused on the identification of thematic priorities at the national level, i.e., smart specialisations and national interest priorities. The exercise employed data analytics methods for the evaluation of the current state-of-affairs. Its future-oriented evaluations were supported by 13 expert panels and over 4000 experts and stakeholders taking part in online Delphi consultations. The most important criterion for the final evaluation of smart specialisations was economic relevance.

In the late summer of 2015, the Romanian President made public his initiative to launch a national consultation on education and research. The previous Presidential Administration coordinated a similar initiative almost a decade ago (the result, a short-lived Pact on Education, crumbled soon after). No specific details on the format and date of the consultation were made public before the end of 2015, but the Presidency is expected to launch the process in the early spring of 2016.

2.3 European Semester 2014 and 2015

The National Reform Programme 2014 (NRP 2014)[13] of the Romanian Government represents "the framework defining the reforms and priorities for Romania's economic development over the period July 2014 – June 2015, in compliance with the Strategy Europe 2020 and the European Semester 2014". In evaluating recent progress (2013) in these respects, the NRP fails to mention the NS 2007-2013 targets for public expenditures for RDI (four times below the 1% level) or its projected outputs. Instead, support through project funding is only assessed in terms of the number of projects.

While the NRP does mention the raise in tax deduction for R&D expenditures from 20% to 50% (under Government Ordinance 8/2013 – see section 2.5), it glosses over the fact that the lack of implementation norms rendered the tax deduction non-operational for some two years, until March 2015. The reasons for the delay can only be a matter of speculation, but one known issue of dispute was the eligibility of R&D expenditures made by multinationals abroad (the clause was maintained in the adopted form).

Among the other relevant achievements, the NRP mentions the start of the Extreme Light Infrastructure – Nuclear Physics (ELI-NP) project, as well as the elaboration of the White Paper on including on the ESFRI roadmap a new pan-European research infrastructure financed by SF, the Danube International Centre for Advanced Studies for River-Delta-Sea Systems (Danubius-RI, www.danubius-ri.eu).

The NRP 2014, released months before the adoption of NS 2020, briefly mentions the following action lines in regards to R&D:

- support for private R&D investment (without further details);
- IPR training for researchers and engineers;
- continuing investment in human resources for RDI;

[13] See http://ec.europa.eu/europe2020/pdf/csr2014/nrp2014_romania_ro.pdf.

- concentration of national R&D institutes (NRDI) under the MESR;
- the elaboration of a National Roadmap for Research Infrastructures;
- wide access to scientific literature for a broad spectrum of research organisations.

As to the operationalisation of these measures, some of them have been implemented in part or whole, some are pending. A dedicated project for the IPR training for researchers was launched. Improved coordination of NRDIs by the MESR was achieved through a government decision that gave the Ministry the requisite powers. Access to scientific literature is ensured through project ANELIS PLUS, continuing the older ANELIS projects.

The investment in human resources for RDI will be achieved mainly by means of SF funding for doctoral and post-doctoral schools (PO Human Capital). The elaboration of the National Roadmap for Research Infrastructures is still pending, but the MESR is expected to launch a project tackling the Roadmap in early 2016.

2.4 National and Regional R&I Strategies on Smart Specialisation

The National Strategy for Research, Development and Innovation 2014-2020 was adopted on 21 October 2014. Its elaboration was outsourced by the MESR to a consortium headed by 11 main partners, supported by an additional 141 associated partners. The project (www.cdi2020.ro) was carried out in 2013. It deployed an evidence-based, smart specialisation-aware foresight exercise.

Support for smart specialisation (S2) is ensured through a policy mix covering a broad range of activities, including those of innovative SMEs. In light of the heterogeneity of the public R&D organisational landscape, the Strategy sets out that a simplified legal framework needs to be created to support PRO mergers and other forms of organisational concentration. The NS 2020 also supports better coordination of investments in research infrastructures and the concentration of SF-funded doctoral and postdoc research in the S2 fields.

Another component of the smart specialisation process is the 'strategic orientation mechanism', whose objectives are to monitor and analyse the creation of competences in the smart specialisation fields; and to periodically propose corrections and reorientations.

The two main instruments implementing the NS 2020, the RDI-dedicated axis of the Operational Programme Competitiveness and the National Plan, were adopted recently, the latter in July 2015. For additional details on the national smart specialisation strategy, see section 2.1 above.

The regional smart specialisation strategies of the country's 8 development regions should have been elaborated by the end of 2015. As of early 2016, there are only two explicit regional RIS3 (regions Centre and West). The other six regional development agencies (RDAs) in charge with the development of strategies have, however, all produced a Regional Development Plan for the period 2014-2020 or 2015-2020. All of these 8 documents follow a nearly identical structure; and all of the 6 Plans also comprise a distinct strategic document.

While each of the Strategies embedded in the Plans select a number of priorities, these are typically formulated as broad goals (e.g., improving human capital, sustainable urban development, ensuring transportation infrastructure, increasing the use of renewable energy sources), while the measures contemplated are horizontal in nature. Few among the 6 Plans include among their priorities an economic sector of interest, and those who do so do not narrow it down to specific subsectors or subfields of promise.

Of the two explicitly 'smart' strategies, one essentially borrowed the S2 fields of the National Strategy for RDI (at the largest level of granularity, not at the R&I programme-level introduced in the latter document); and then identified the relevant economic strengths in the region. The second regional RIS3 strategy selected four broad economic

sectors as its smart specializations. Just like the Plans, both documents focus most of the measures they envisage for 2015-2020 on several 'horizontal priority axes'.

A genuine regionalisation process still remains uncertain in Romania. The topic has been intermittently at the forefront of the public agenda, but widespread controversies concerning the appropriate depth and breadth of regionalization have determined the delay of any firm decision as to the path of the process. Under these circumstances, and given the currently limited competencies of RDAs, the spectrum of instruments these strategies may credibly deploy in practice remains limited.

2.5 Main policy changes in the last five years

Main Changes in 2011

Decision on the financial allocation for ELI-NP. The project represents a considerable opportunity for Romania. At the same time, the decision was not supported by an increase in the allocation of structural funds for R&D, thus introducing constraints on project funding and other financing streams.

The Law on National Education of 15 January 2011; and Government Decision no. 789/2011 on the Methodology for the classification of universities and the ranking of study programmes. Among others, the Methodology restricted the right to organise doctoral studies to 'research-intensive' universities, but failed to connect the classification and the rankings to clear financing streams.

Main changes in 2012

Government Ordinance 96 of 22 December 2012 on the reorganisation of the central public administration. According to the GO, the Ministry of Education, Research, Youth and Sport was reorganised by being split into the Ministry of National Education (MNE) and the Ministry of Youth and Sport. The National Authority for Scientific Research (NASR) was dissolved, with all powers taken over by the new MNE (currently, the Ministry of Education and Scientific Research). Furthermore, the GO established the position of Delegate Minister for Higher Education, Scientific Research and Technological development within the MNE.

Main changes in 2013

Government Decision 185 of 16 April 2013. Most of the National R&D Institutes, traditionally coordinated by the line ministries relevant to their field of activity, are brought under the coordination of the Ministry of Education and Research under this GO. The NRDIs' boards of administration now consist of 5 members, 3 nominated by the Ministry of Education and the other 2 by the relevant line ministry.

Main Changes in 2014

Government Emergency Ordinance 49/2014 brings new changes to the 2011 Law on National Education. Under the amended Law, the Ministry of National Education may raise by up to 10% the matriculation limits imposed on academic programs by the Romanian Agency for Quality Assurance in Higher Education (which are directly related to the per capita funding); private universities may be also established by private individuals rather than, as previously, by foundations only; universities may establish part-time doctoral study programs, rather than full-attendance programs exclusively; universities may also establish pre-tertiary educational institutions; private universities may decide on their organisational structures, the powers of their officers and the length of their terms.

The National RDI Strategy 2014-2020 is adopted by Government Decision. The new strategy has ambitious targets, includes smart specialisations and priorities of national interest, and a large spectrum of instruments and policies to support the development of an innovation ecosystem. However, much of the strategy remains, at least for the foreseeable future, a formal pledge: the budgetary commitment was broken soon after adoption; the main implementation instrument, the National Plan, was delayed.

Law no. 83/2014 on service inventions is adopted. The goal of the law is to better clarify the rights of intellectual property revenue sharing between employees and their employers generating such inventions. The new law responds to complaints by multinationals regarding the flexibility of the previous law (passed in 1991), with amended methodologies under a more recent Government decision which dates from 2008. The old regulations were thought to discourage investments in R&D, particularly by leading to IP conflicts between employers and employees. The new law aims to stimulate the production of patents directly relevant for the economy by clearly distinguishing among several types (and contexts) of invention, as well as among different types of public and private institutions with an eye to clarifying IPR regimes and fuelling entrepreneurial, innovative behaviour.

Since December 2014 the Government has a new structure approved by Parliamentary Decision 44/2014. Since the new government structure is meant to reduce the number of ministries, the decision eliminates the office of 'delegate minister', thus including the delegate minister for Higher Education, Scientific Research and Technological Development. The new name of the ministry becomes the Ministry of Education and Scientific Research (MESC); the RDI-specific structure is the National Authority for Scientific Research and Innovation (NASRI).

Main Changes in 2015

The National Plan (NP3) for the implementation of the National Strategy on RDI 2014-2020 is adopted in July 2015. For a description of its structure, see section 3.4.3 below.

Law 120/2015 on stimulating individual investors – business angels is approved in May, primarily in order to improve access to funding for SMEs. The law provides, among others, that income earned as dividends for acquired shares by individual transferees shall be exempt from tax for a period of 3 years. Also, the positive difference between the sale price and the purchase price resulting from the transfer of ownership of the assignee's shares is exempt from tax, provided the transfer occurs after a period of 3 years since acquisition. The Law's promoters estimate 500 business-angel investments during the first year since adoption.

A draft law on public procurement introduces, for the first time, the concept of an "Innovation partnership" for public institutions seeking innovative solutions that are not available on the market. Participation is open to all economic actors.

On the same subject, Law 244/2015 on approving Government Emergency Ordinance 13/2015 on the establishment and organisation of the National Agency for Public Procurement (ANAP) is promulgated the president. The ANAP is to serve as the dedicated structure overseeing the coordination and implementation of the National Strategy on Public Procurement, which was due in July 2015.

The Government adopts the National Strategy on Public Procurement (GD 901/2015) in October 2015, in response to the Partnership Agreement. The main goal of the Strategy is to ensure efficiency and value-for-money, as well as transparency and responsible allocations, among others by reducing legislative clutter in the field. The Strategy also mandates an Electronic System for Public Procurement within the ANAP, which should

ensure adequate monitoring and supervision of relevant actions. The Strategy contemplates the drafting of 4 major items of legislation in the field to transpose relevant EU directives: a law on 'classic' (traditional) acquisitions, a law on utilities, one on PPPs, and one on review procedures concerning the award of public contracts.

A legislative proposal launched in 2015 on establishing the National Council for Competitiveness as a mechanism for the monitoring and coordination of policy is adopted by both houses of Parliament in late 2015; as of this writing, the law is pending promulgation. The Council should be a public legal person whose 9 members – three each nominated by the Romanian Academy, businesspersons associations, and universities and research institutes – should be appointed by the Parliament. The Council will evaluate draft policy, propose improvements to current policies, monitor the efficiency and effectiveness of programs aimed at increasing competitiveness, approve the public budget and the social security budget, assess annually the competitiveness of relevant sectors of the economy, and design and update the National Strategy for Competitiveness.

The Government adopted the Strategy on Tertiary Education 2015-2020 (GD 565 of July 2015), partly in response to the Partnership Agreement. Among others, the Strategy aims to improve governance in tertiary education; improve funding and introduce better performance criteria; develop academic dialogue with business and increase academia's relevance for the economy; and stimulate access to and participation in tertiary education of disfavoured groups such as the Roma, low-income student, students in rural areas, and others.

The government resigns in November 2015 in response to massive street protests after an accident in a Bucharest club. A new government of technocrats is instated. The Prime Minister is the former EU Commissioner Dacian Ciolos. The new Minister of Education and Research is Adrian Curaj, the former head of the agency disbursing competitive R&D funds under NP2 and one of the coordinators of the elaboration of the national RIS3.

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

3.1 Introduction

Public allocations for R&D started to drop abruptly during the recent economic crisis, subsequent to a few years of consistent increases. After having reached a GBAORD as share of GDP of 0.39% in 2008, Romania entered a downward spiral which seems to have recently reached a flat valley: figures for 2012-14 were 0.22%, 0.21% and 0.21%, respectively (the EU28 average was 0.68% in 2012-13). Furthermore, public expenditures for R&D have not picked up despite sustained economic growth.

For the period 2007-2013, structural funds (SF) provided approx. 20% of public R&D expenditures. The sum allocated for 2007-2013 was €805m, while the one for the coming programming period (2014-2020) is €1bn.

R&D financed by businesses reached only 0.12% of GDP in 2013 and 0.16% in 2014 (down from 0.19% in 2012). While this figure may be underestimated, mainly because companies are not stimulated to declare their R&D expenditures, the low level is partly explained by the fact that the economy is dominated by multinationals, of which only a few perform relatively limited R&D in Romania. These multinationals include, among others, Renault, Continental, Infineon, Microchip Technologies, Freescale, or IBM. On the other hand, the still young SME sector carries out predominantly low value-added activities, as suggested by the fact that Romania ranks lowest in Europe in terms of innovative small and medium enterprises (CIS data, 2012).

The BERD target in the new national RDI Strategy is 1% of GDP in 2020. So far, the main measures designed to accomplish this very substantial hike consist of a large increase in public expenditures (planned but, so far, not achieved); and the 50% tax deduction for business R&D expenditures (whose methodology has recently been adopted after a long delay).

In terms of R&D performers, it is not only business companies that have experienced a decreasing trend in expenditures; higher education institutions (HEIs) have followed the same route. The latter have been especially exposed to the cuts in project financing, also because they receive no institutional funding for RDI. In this respect, Romania is on a divergent trend compared to the EU average.

Table 2 Basic indicators for R&D investments

Indicator	**2011**	**2012**	**2013**	**2014**	**2015***	**EU average (2015)****
GERD (as % of GDP)	0.49	0.48	0.39	0.38	N/A	2.03 (2014)
GERD (Euro per capita)	32.5	32.1	27.9	28.8	N/A	558.4 (2014)
GBAORD (€m)	352.815	287.938	297.42	319.772	333.624	92828.145 (Total for EU 28)
R&D funded by BES (% of GDP)	0.18	0.17	0.12	0.13	N/A	1.12 (2013)
R&D funded by PNP (% of GDP)	0	0	0	0	N/A	0.03 (2013)
R&D funded by HES (% of GDP)	0.01	0	0	0.01	N/A	0.02 (2012)

Indicator	2011	2012	2013	2014	2015*	EU average (2015)**
R&D funded from abroad	0.06	0.07	0.06	0.07	N/A	0.2 (2013)
R&D performed by HEIs (% of GERD)	0.11	0.1	0.08	0.06	N/A	0.47 (2014)
R&D performed by government sector (% of GERD)	0.2	0.2	0.19	0.16	N/A	0.25 (2014)
R&D performed by business sector (% of GERD)	0.18	0.19	0.12	0.16	N/A	1.3 (2014)

3.2 Smart fiscal consolidation

As of 2015, Romania has a new Fiscal Code (Law 227) and a new Code of Fiscal Procedure (Law 207). The new fiscal code lowers taxes on dividends from 16% to 5% starting 2015 and on other earnings from investments. It also extends health insurance contributions to all types of income. Among the most significant changes was the reduction in VAT from 24% to 20% starting 1 January 2016, and further to 19% in 2017. VAT on some cultural products (e.g., books) and services was also lowered from 9% to 5%. Earlier during the year the government had decreased the value-added tax on food from 24% to 9%.

In 2015, the country posted one of the lowest general deficits in Europe (-1.5% of GDP), approximately half of the EU28 average (-2.9%). The deficit was also halved compared with 2012 (-2.9%). Similarly, the consolidated gross debt is among the lowest in Europe at 39.8% GDP (Eurostat data). While the deficit was achieved, in part, through improved tax collection by the National Fiscal Administration Agency, the figure has been criticised as reflecting the considerable reduction in public investments, with negative long-term consequences for economic growth.[14] Capital expenditures were down at below 5% in 2014, from 7% five years before.

As noted previously, public expenditures on R&I continued their downward trend in 2014-2015 despite sustained GDP growth over the past years. The research and educational sectors were particularly affected by the blanket policy of personnel retrenchment throughout the public sector and the almost total halt of recruitment between 2011-2014. In the national budget projected for 2016, the approach suggests a significant change in philosophy. Overall expenditures are planned to rise by 6.7%, while the deficit will almost triple, from around 1% GDP in 2015 (estimated) to a projected deficit (ESA) of 2.95% GDP. Among the consistent percentage point increases are those in research and development (32% more compared to the previous year). Other relevant hikes include capital expenses (18.5%) and education (9.6%).[15] More money will go to health and the army, among others.

[14] Andra Oprescu, "Romania, printre cele mai mici deficite bugetare din UE" [Romania, among the lowest deficits in the EU], Ziarul Financiar, 24 April 2015. Available at http://goo.gl/7S0ycz.
[15] "Buget 2016", *Ziarul Financiar*, 5 Dec. 2015, available at http://goo.gl/N98Rnk.

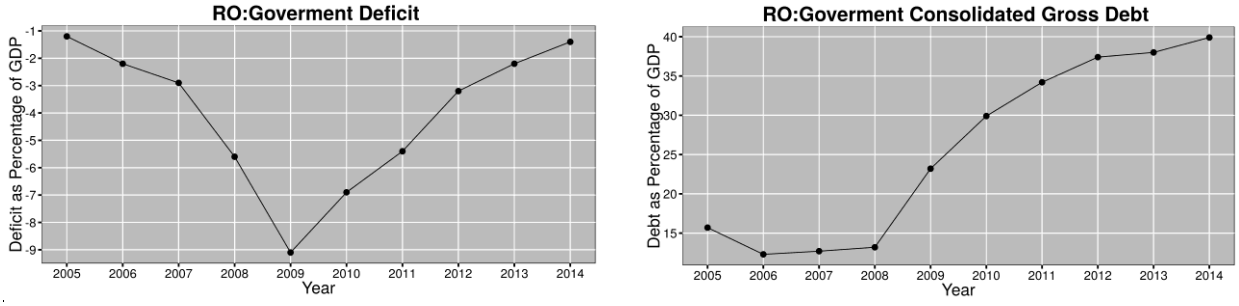
3.2.1 Economic growth, fiscal context[16] and public R&D

Before the crisis, Romania recorded high but unsustainable real GDP growth rates (6.5% on average between 2001 and 2008). Fuelled by strong domestic demand and expansionary pro-cyclical fiscal policy, the country mounted up large external imbalances financed by volatile capital inflows. The crisis swept away 8% of GDP in 2009-2010, but growth returned in 2011 driven by a gradual recovery of domestic demand and strong exports. It is expected to remain robust over 2016-2017 at an annual rate of 4.2% (2016) and 3.7% (2017).

Due to the above mentioned pro-cyclical fiscal policy the country ran high budget deficits in the pre-crisis period (Figure 2). With the support of three EU/IMF programs, Romania managed to reduce the deficit to 1.4% of GDP by 2014 from the 9.1% peak during the crisis and the lower but mounting values in the pre-crisis period. In 2012, the Excessive Deficit Procedure was abrogated. The 2015 deficit is estimated to be at 1.1% of GDP, which is in line with a structural deficit of 1.25% of GDP corresponding to the medium-term target (MTO of 1% plus 0.25% EU funds adjustor[17]).

Signs of fiscal easing have become more evident since 2014 (cut of social security contributions and of the VAT rate on food, doubling of child benefits, etc.). As a result, the headline deficit is expected to increase to 3% in 2016 and to 3.8% in 2017. The structural deficit is also increasing (2016: 3%, 2017: 4%), drifting the country further from its MTO. Public debt increased from 13.2% of GDP in 2008 to 37.3% of GDP in 2012 driven by high budget deficits (Figure 2) and a contraction in output. In 2015 it was at 39% of GDP and it is expected to increase moderately to 42.6% by 2017 as a result of higher budget deficits and lower real GDP growth.

Figure 2 Government deficit and public debt



Data source: Eurostat

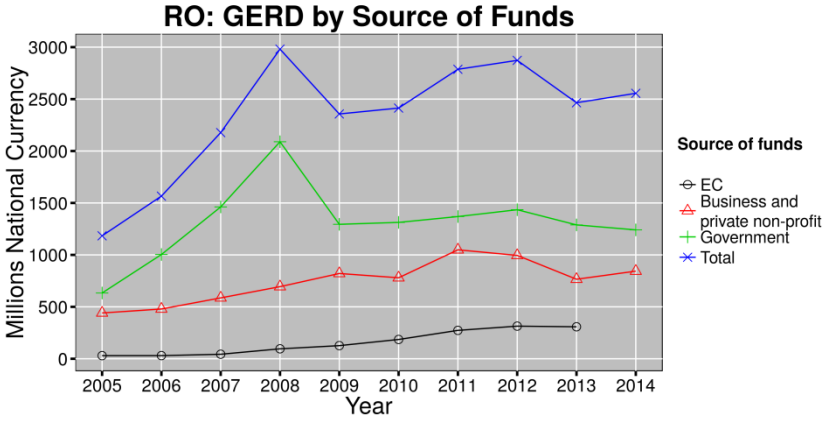
[16] Sources: DG ECFIN, http://ec.europa.eu/europe2020/pdf/csr2016/cr2016_romania_en.pdf

[17] An additional budget allocation to be used only for a significant acceleration of EU funds absorption.

3.2.2 Direct funding of R&D activities[18]

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

Figure 3 Development of government funding of the total GERD



Data source: Eurostat

The government's contribution to the total GERD is the most relevant. Romania was severely hit by the financial crisis, as can be seen from the decline in government funding in 2009, which had large repercussions on the total GERD. The absolute levels of government funding did not recover after the crisis and in 2013 they are still comparable to those from 2009. This can be explained by a political choice to decrease spending on R&I, but also by a prior commitment to satisfy the EU criteria before Romania's accession in 2007, and then, most likely, by a choice to largely decrease spending on R&I. Meanwhile, R&D funded by the private sector doubled nominally from 2005 to 2011, and as Figure 3 shows, it played an important role in the growth of the overall GERD in 2011-2012 and 2013-2014.

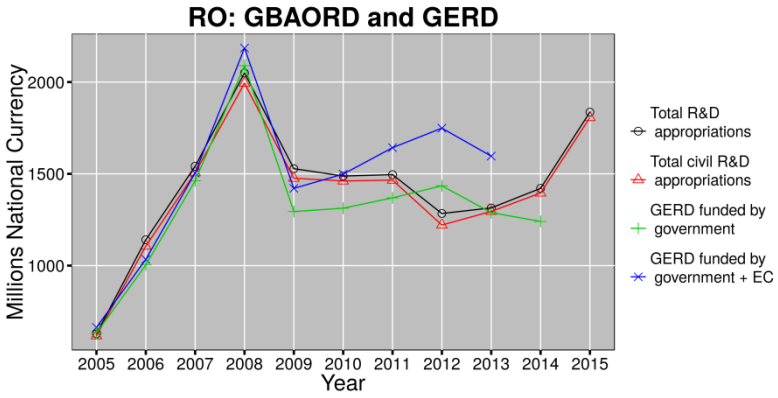
The funding from the EC to the Romanian R&D expenditure, although smaller than the private and public contribution, has been monotonically increasing ever since 2007 with a continuous trend in 2013.

3.2.2.1 Direct public funding from the government

Direct public funding is the main source of the total governmental support to R&D. Figure 4 below shows the time evolution of the total R&D appropriations (GBAORD) and the GERD directly funded by the government in units of millions of national currency. The EC contribution, aggregated to the funding provided by the government, is also shown in Figure 4.

[18] The sources of R&D funding according to the Frascati manual are: Government sector (GOV), Higher education sector (HES), Private non-profit sector (PNP) and Abroad (including EC). In this analysis the public sector as source of funds is given by the GOV part of the total intramural R&D expenditure (GERD), whereas the public sector as a sector of performance is the aggregation of GOV and HES.

Figure 4 R&D appropriations and government funded GERD in millions of national currency, current prices



Data source: Eurostat

Both GERD funded by the government and the total (civil) appropriations (GBAORD) show a sharp decline in 2009 as a consequence of the crisis. In 2013 the total (civil) appropriations are still at levels slightly inferior to those of 2009, yet in 2014 and 2015 they raised significantly. The military R&D allocations are very marginal in Romania, as can be seen from the small difference between the total and civil allocations. The increasing importance of the EC contribution is also visible in the marked upward trend (from 2009) of the government funded GERD aggregated to the EC contribution. The R&D budget appropriations in 2012 and 2013 are inferior to the GERD funded by the government. This effect is likely due to the specific accounting of the structural funds.

3.2.2.2 Direct public funding from abroad

Similarly to a number of MS, also in the case of Romania the EU is the most important external public source of R&D funding. External public funding from other governments and higher education entities as well as from international organizations was marginal, as shown in Table 3, below:

Table 3 Public Funding from Abroad to Romanian R&D (millions of national currency)

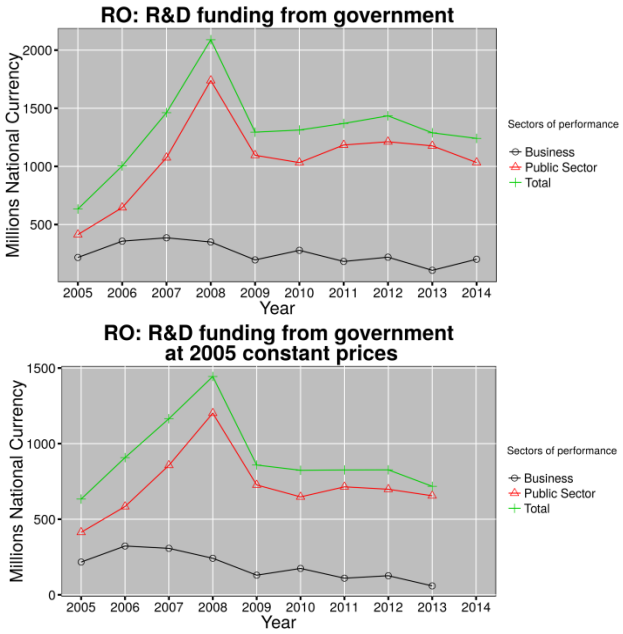
Source from abroad	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	62.19	63.91	98.88	118.30	196.56	268.52	336.26	414.91	382.14	434.45
BES	20.28	22.46	46.24	11.08	46.18	39.57	52.36	77.26	66.51	NA
EC	30.04	30.36	43.51	95.73	126.45	185.77	273.32	314.10	307.77	NA
GOV	2.23	1.04		0.23	5.50	0.06	0.59	0.05	2.05	NA
HES	1.43	1.75		0.11	1.45	2.04	0.98	2.48	0.49	NA
Internatio-nal Organisa-tions	2.97	2.77	3.51	6.00	8.09	28.29	7.70	8.45	2.90	NA
Total as % GERD	5.25	4.08	4.54	3.97	8.34	11.13	12.07	14.44	15.50	17%
EC as % GOVERD	4.74	3.02	2.98	4.58	9.77	14.15	19.96	21.89	23.88	NA

Table 3 clearly shows that the funding from abroad in general and the share of EC funding in particular is becoming more and more important, especially after 2009, amounting to around 14.5% of the total GERD in 2012. EC contribution only, accounts for almost 22% of the GERD funded by the government.

Based on data from DG REGIO, the Structural Funds for the period 2007-2013 for Romania amounted to 19.1 billion Euros out of which 805 million was dedicated to 'Core' R&D activities (i.e. 4.2%). Romania has the third smallest share of SF for Core R&D activities among all EU28.. Compared to the 804 million Euros of Structural Funds for core R&D, the FP funding role in Romania's public funding is not very significant i.e. less than 144 million euros for the whole period.

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

Figure 5 Government intramural expenditure by sectors of performance



Data source: Eurostat

The public sector is the main recipient of the government funded GERD. The volume of the government expenditure received by the public sector decreased significantly from 2008 to 2013. The direct support to business R&D, which has always been low, decreased along the years and in 2013 is even below the 2005 levels.

3.2.3 Indirect funding – tax incentives and foregone tax revenues

Currently, there are two R&D fiscal incentive programs in Romania: the super deduction on qualifying R&D expenses and the accelerated depreciation on qualifying R&D assets. The tax deduction for R&D expenditures was adopted in 2010 (at 20%) and raised to 50% in 2013, but it is only in 2015 that the eligible costs were clarified. The Business Angels Law, adopted in 2015, provides for a 3-year tax exemption for the dividends earned by the transferee. Several incentives are also offered for fostering innovation as for example the law 346/2004 which provides incentives for investors setting up or running SMEs. Moreover, certain investment incentives apply to industrial parks.

Nevertheless, fiscal incentives for R&D are used only marginally in Romania. The main obstacle appears to be the uncertainty about the tax authority's approach to the treatment of R&D costs. Furthermore, according to the Deloitte Romania Corporate R&D Report 2014, 46% of Romanian companies are not familiar with R&D tax incentives. In

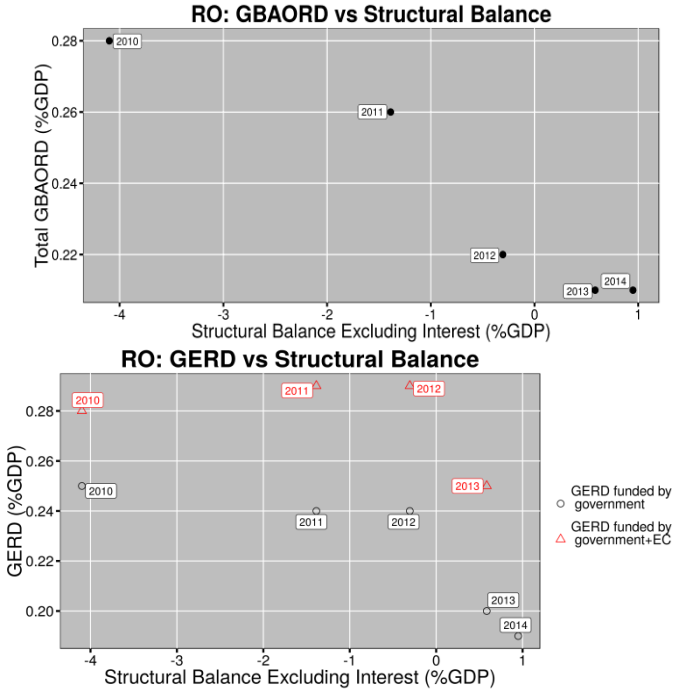
addition, almost half of respondents (46%) consider R&D tax regulations to be unclear and burdened with risk for the company.[19]

The volume of R&D tax incentives cannot be estimated because no such data have been collected.

3.2.4 Fiscal consolidation and R&D

Figure 6, below, shows the scatterplot of the structural balance and a relevant measure of the R&D (GBAORD as % GDP, first panel, and GERD as % GDP, second panel)[20]:

Figure 6 Fiscal consolidation and R&D



Data source: AMECO, Eurostat

Two key observations can be made based on Figure 6. On the one hand, post-crisis fiscal consolidation had a significant negative impact on both GBAORD and GERD funded domestically by the government. While the structural balance has progressively shifted into a minor surplus from the massive deficit, both GBAORD and GERD funded by government lost around 0.06% in terms of GDP. On the other hand, one observes from the right panel of Figure 6 that EU funding was very important for the public funding of the Romanian R&I system during the fiscal consolidation period. In particular from 2010 to 2012 EC contribution is so high that it compensates for the losses in the government funded GERD and keeps the overall direct public support to R&D unchanged.

We need to mention that the quality of data concerning indirect financing through R&D tax incentives is not sufficiently good in order to be able to take it into account in this analysis.

Based on the above analysis, it can be concluded that the Romanian post-crisis fiscal consolidation process has come at the expense of public R&D expenditures.

[19] http://www2.deloitte.com/content/dam/Deloitte/global/Documents/About-Deloitte/CE_RD_Romania_2014.pdf

[20] Structural balance data comes from the AMECO database the other indicators were taken from Eurostat.

3.3 Funding flows

3.3.1 Research funders

The Ministry of Education and Scientific Research and its agencies are in charge of the most important streams of competitive public funding for RDI and some institutional funding programmes. They also implement the relevant operational programmes. The main agencies involved in funding are:

- *The Executive Agency for Higher Education, Research, Development and Innovation Funding* (UEFISCDI), subordinated to the MESR. It is the implementing agency for the National Plan for RDI 2007-2013 (NP2), still operational, with a budget of €131mn in 2013. It will also administer the recently adopted NP3. The programmes under NP2 and NP3 are open to all R&D-performing actors.
- The NASRI implements the programme Nucleu, an institutional funding instrument for the National R&D Institutes (NRDIs). The budget was €70.5mn in 2013.
- *The Intermediary Body for RDI*, coordinated by MESR, implements the RDI-dedicated axis of the Operational Programme Increasing Economic Competitiveness, 2007-2013. Its average annual budget was approx. €120mn. The same structure managed the implementation of the Operational Programme Development of Human Resources. For the programming period 2014-2020, the MESR will similarly coordinate the Implementing Body for the OPs Competitiveness (the RDI priority axis) and Human Capital.

MESR is also in charge of disbursing funding for public higher education. In this capacity, it is advised by the National Council for Higher Education Funding.

The Romanian Academy has its own chapter in the national budget, which it distributes among its 60 research institutes and research centres. The consolidated budget (all sources) for 2014 was €100.7mn. The Academy's public R&D budget for 2016 was set at around €64mn.

The Romanian Space Agency (ROSA), which coordinates national space research and applications programs, elaborates and coordinates the implementation of the National Space Programme.

Several branch ministries (e.g., the Ministry of Economy, the Ministry of Agriculture) manage their separate 'sectoral RDI plans', but these involve only comparatively minor outlays.

There is little funding from philanthropic organisations for research and development in Romania, and even less data collected on the subject. Most of these organisations provide prizes and other opportunities for excellent researchers, or for adolescents and young adults showing academic promise. For instance, the Dinu Patriciu Foundation (now inactive), offered yearly awards for researchers, students, teachers and organisations in education to the tune a quarter million Euros. The Open Society Foundation, no longer a part of the Soros network, had a projects budget of over USD 2.5mn in 2014, some of which went to educational and social innovation projects and to social science research.[21]

3.3.2 Funding sources and funding flows

The allocation of structural funds for R&D has remained surprisingly low when compared to the ambitious target of 1% public expenditures for R&D. For the period 2007-2013, structural funds provided around 20% of public R&D expenditures. The €805m allocated from SF for 2007-2012 positions Romania somewhere in the middle of the East European pack of countries in terms of the prioritisation of R&D: much less than Poland (€4,928m) or the Czech Republic (€2,928m), but considerably more than Bulgaria (€196m) and Hungary (€85m) (Data source: RIO elaboration on DG REGIO data).

[21] FSD, *Raport de activitate 2014*, available at http://goo.gl/zD9CIs.

For the next programming period, the sum allocated from SF has not been substantially increased despite the renewed target of 1% of GDP public expenditures. The commitment to build the ELI-NP will alone necessitate a large portion of this sum. The fact that the absorption rate for R&D structural funds is more than twice higher than the national average suggests a larger allocation would have been both justified and would have responded to existing demand.

Funding for research and innovation remains a relatively small part of total allocations to Romania from structural and investment funds. The share is just 3.48%, below any other country in Europe; the corresponding figure is 5.39% in Bulgaria, 8.94% in Hungary, and 12.56% in Slovenia (S2E 2015, 23).[22]

On the other hand, the general absorption rate for all structural funds allocated for the period 2007-2013 remains very low: only 39% in 10 October 2014 (Source: Ministry of European Funds). [23] A special problem for absorption concerns the transportation infrastructure, where numerous projects are delayed or were cancelled (usually amid accusations of corruption).[24]

Foreign Direct Investments (FDI) registered a recovery after the drop in 2011 (when they hit €1.7bn), to €2.5bn in 2012 and €2.7bn in 2013. They remain concentrated in Bucuresti-Ilfov (61.4% in 2013). The main FDI sectors in 2013 were manufacturing (31%), financial intermediation (14%), trade (11%), and energy (11%). The most prominent branches of manufacturing are the petrochemical (19%), transport vehicles and equipment (18%), metallurgy (13%), and food, beverages and tobacco (12%) (National Bank of Romania data for 2013).

Unfortunately, there are no estimates of FDIs for R&I, as there is no specific category in National Bank data. However, according to *The 2014 EU Industrial R&D Investment Scoreboard* (Hernández et al. 2014), among the top 18 'leading innovators in the EU' posting the best R&D and economic performance, several engaged in FDI projects in Romania among other countries. Romania was the destination of over 6% of such FDIs in manufacturing, and approx. 19% of these companies' FDIs in business services, for almost 10% of their total foreign investments.

The country managed to attract €55mn in EC contributions from FP6, representing 0.4% of the total (for comparison, Hungary, with a population half that of Romania's, attracted 0.9% of the total). The corresponding amount and percentage for FP7 were €143.4mn and 0.4%, respectively.

These figures appear to be relatively low when compared to other countries (e.g., €442mn in Poland, €294mn in Hungary, €289mn in the Czech Republic for the FP7). However, the gap is much smaller if considered relative to the number of full-time equivalent researchers. For example, with around half the total population, Hungary has almost 50% more researchers (FTE) and about the same advantage in terms of FP7 funds attracted.

So far, the share of total EU funds under H2020 attracted by Romania is the same 0.4% (RIO elaboration on DG REGIO data).

3.4 Public funding for public R&I

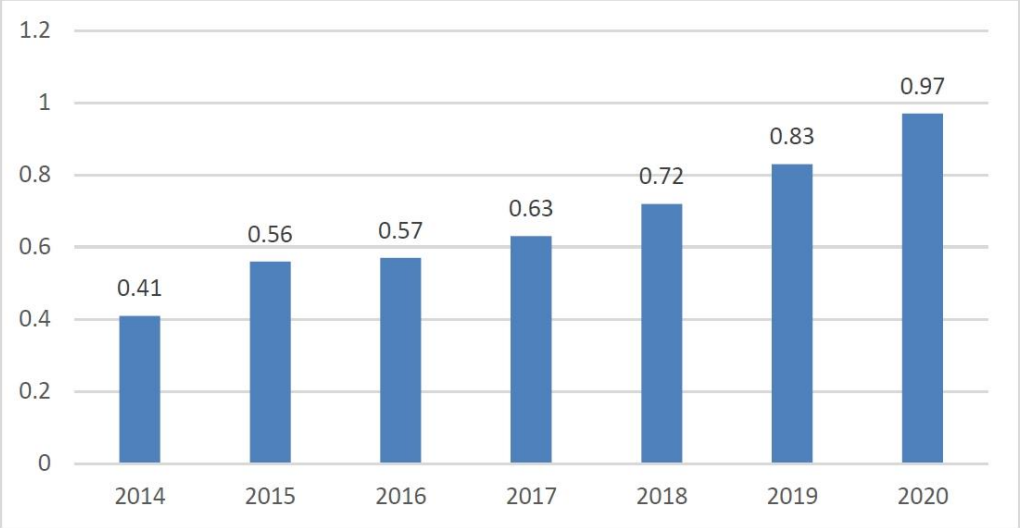
3.4.1 Project vs. institutional allocation of public funding

As mentioned, the NS 2020 set an ambitious target of 1% public expenditures by 2020. However, the multiannual planning has had an ambiguous start. The R&D budget allocated for 2015 is over twice lower than planned for in the Strategy. Conversely, after the change of government late that year, the public R&D budget for 2016 increased by a

[22] Data from https://cohesiondata.ec.europa.eu/.
[23] http://www.fonduri-ue.ro/stadiul-absorbtiei.
[24] HotNews, 16 June 2014, citing the Management Authority for the Operational Program Transportation, available at http://goo.gl/cCxCLE.

substantial 32% relative to the previous year. It remains to be seen how much will be actually allocated, however.

Figure 7 Targets for public R&D expenditures (% GDP)



Source: NS 2014-2020

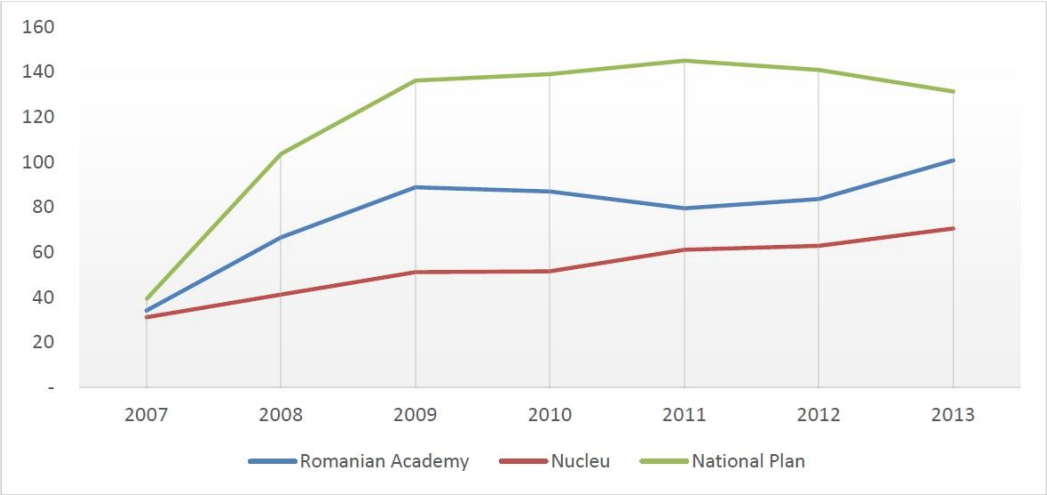
Although it is occasionally claimed that in Romania the share of project-based allocations in total public funding exceeds 80% and even 90%,[25] the situation 'on the ground' is, in practice, different. Specifically, some categories of institutional allocations, while formally 'competitive' in nature, in reality reflect historical funding trends and are awarded on a non-competitive basis. This is the case with the budget of the Romanian Academy and with the Nucleu programme for the NRDIs (Zulean et al., 2015), as explained in further detail below.

Under this interpretation, 59% of public funding was allocated institutionally in 2013, increasing from approx. 45% in the period 2009-2012. Institutional funding, even though sometimes identified as 'competitive' and awarded on the basis of the relevant organisations' 'project portfolios', is directed towards:

- The funding programme of the Romanian Academy, distributed among its approximately 60 institutes and research centers. The allocation is highly proportional to the number of researchers employed. (The detailed allocation procedure is not available on the institution's website.)
- The Nucleu programme for the National R&D Institutes. Each institute has its own Nucleu programme funding a portfolio of projects reflecting the specific R&D strategy of the institute and its objectives (related to the development of the economic sector or branch corresponding to the institute's profile). The MESR's funding scheme reflects a prioritisation of the specific Nucleu programmes, based on institutes' past performance and on the relevance of their R&D portfolio for the development priorities of the corresponding sector/branch. (The full procedure is not available on institutional websites.)

[25] See, for example, EC, *ERA Facts and Figures 2014*, Graph 7; M. Doussineau et al., *ERA Communication Synthesis report*, Luxembourg: Publications Office of the European Union, 2013.

Figure 8 The annual allocation of R&D expenditures by main programmes financed from the national budget (million EUR)



Source: Zulean et al., 2015

3.4.2 Institutional funding

Institutional evaluation is discussed extensively in Romania. An evaluation procedure for "entities part of the national RDI system" was adopted under Government Decision 1062/2011. The procedure was applied only to roughly one third of the national R&D institutes concerned (namely, 32 of the total). All of the evaluated institutes were ranked in the "A" category (further subdivided in A+, A, A-) and no institute is currently classified in the B, C, or D categories. The implications of this classification for the relevant funding instrument remain unclear. The detailed reports of the evaluation process are not publicly available, although some individual organisational assessments may be accessed on institutional websites.

The Romanian Academy uses a similar logic for the periodical evaluation of its institutes. The results are not made public.

In what concerns the (public) universities, they do not receive institutional funding for RDI. While R&D-related indicators have been used as a proxy for the evaluation of academic 'quality', universities continue to receive the bulk of their funding for educational activities. A performance-based funding scheme reserved for universities was introduced as a set of "quality indicators" in 2003 and abolished in 2011. The scheme supplemented the main per-capita financing system which provides the basic funding for universities so as to incentivise performance-oriented organisational behaviours. Theoretically, the 17 composite indicators determined up to 30% of the basic funding allocated. In practice, however, the per-quality funds were almost entirely correlated with the number of students matriculated (the per-capita scheme) and their impact was arguably very limited (Zulean et al., 2015; CNFIS, 2013).

Universities also went through a classification exercise in 2011, doubled by a parallel ranking of academic fields the following year. The classification was designed so as to be tied to specific funding lines available to the best higher education institutions in each of the three classes. While not connected directly to R&D financing, the results also conditioned the right of universities to organise doctoral and masters studies. The exercise was heavily contested, however, and subject to a protracted legal battle. As a result, although the classifications were to be carried out yearly under the law, no other exercise was produced in the period 2012-2016 and its impact on organisational policies was minimal.

An alternative funding model based on the university classification and the academic programme rankings was proposed a few years ago by the National Council Funding Higher Education (CNFIS, 2013). The proposal was scraped by the MESR. The same National Council has also been proposing, for the past three years (2013-2015), methodologies for an 'Institutional Development Fund' for universities. The Fund is actually mandated under the 2011 Law on education, to be granted to the highest-scoring higher education institutions in the three categories defined in the same law (research-intensive, research-and-education, and teaching-intensive). The future of this proposal remains unknown.

For the period 2014-2020, the institutional funding principles expressed in the NS 2020 seek to correlate the funding criteria and amounts going to national R&D institutes, Romanian Academy institutes, and public universities. A dedicated programme for institutional funding was included in the draft NP3. It was meant to integrate the resources now spent through the Nucleu programme and add a similar stream for universities, in correlation with the financing stream of the Romanian Academy. The adopted version of the NP3 no longer includes the chapter on institutional funding, but does provide for an instrument of institutional funding for organisational development. It is not yet clear how the latter will be operationalised.

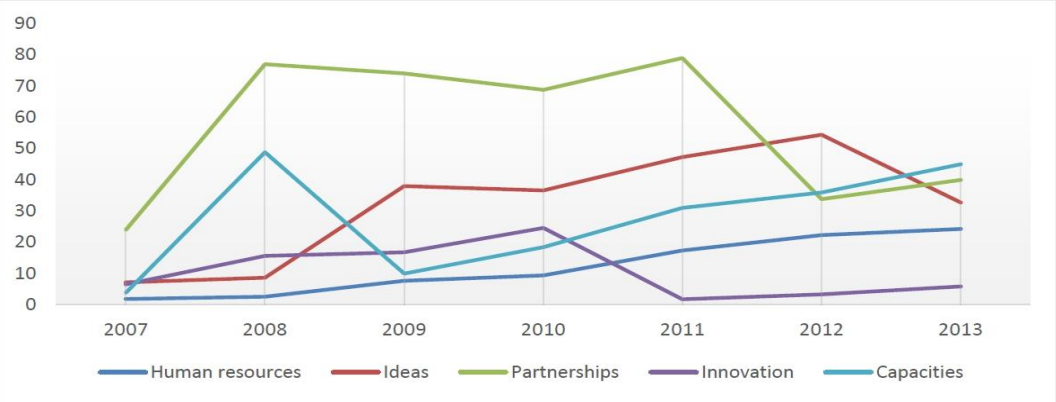
3.4.3 Project funding

The core project-based funding programmes are organised under the National Plan for RDI 2007-2013 (NP2, coordinated by UEFISCDI). The NP2 comprises a set of project-based funding schemes open to all RDI actors. The general structure and procedures are very similar to those of FP7: the programmes *Ideas*, *Human Resources*, *Partnerships*, *Innovation*, *Capacities*. International peer review is standard for these calls. According to the coordinating agency, half of the evaluators in the available pool are based outside Romania (S2E RO 2015).

There are no general statistics on the success rate across NP2 programmes. However, the calls are perceived as selective, though not as much as the FP7 programme (S2E RO 2015, 32). As an illustration, in one of the most recent calls, the person-bound Young Research Teams grants, a little over 13% of the submitted proposals were successful (UEFISCDI data).

This being said, over the implementation of the NP2, the frequent budget cuts not only affected the pace of the calls, but also translated in funding slashes to projects already under way. The National Plan for RDI 2007-2013 received only a third of the programmed allocation.

Figure 9 The annual allocation by programmes under the National RDI Plan 2007-2013 (m EUR)



Data source: UEFISCDI

As the data above shows, *Human Resources*, the person-bound programme in NP2, started very low (the lowest, in fact), but was the only one to maintain a relatively stable rate of growth, even though the crisis years. Almost all other programmes suffered

major cuts in the crisis years and some even more recently. The bottom-up exploratory and fundamental research programme *Ideas* was among the latter.

For the coming programming period (2014-2020), the NP3 – elaborated in 2013 and adopted in July 2015 – has the following main project-based financing programmes, covering the spectrum of activities from idea to market and from short to long term:

- *Development of the national RDI system*
  - Sub-programme 1.1 *Human Resources* supports doctoral and postdoctoral projects, including a new industrial doctorate; projects for young researcher teams; projects aimed at the reintegration of diaspora researchers; mobility; and awards for excellent scientific results.
  - Sub-programme 1.2 *Institutional Performance* provides support for strategic development in POR, and research-business cooperation.
  - Sub-programme 1.3 *R&D Infrastructures* supports investments in regional, national and pan-European RIs; and connecting domestic to international RIs.
  - Sub-programme 1.4 *Support* mainly targets the creation of competence centers and technological services; equipment for RDI policy management; and support for evidence-based policy, access to scientific literature, and science communication.
- *Increasing the competitiveness of the Romanian economy through RDI*
  - Sub-programme 2.1 *Competitiveness through RDI* funds experimental demonstration and experimental development projects; technology transfer projects; projects outsourcing research to public R&D partners; innovation vouchers; innovative solutions; the establishment of R&D departments in companies; technological platforms; and the creation of clusters.
  - Sub-programme 2.2 *Technological Transfer* supports technology transfer broker offices.
- *European and international cooperation*
  - The 6 sub-programmes support bilateral and multilateral cooperation in RDI through complex projects and mobility; participation in Horizon 2020; participation in Joint Programming Initiatives and Joint Technology Initiatives; participation in international initiatives such as EUREKA, EUROSTARS etc.; and the creation of and participation in international R&D consortia and other initiatives.
- *Fundamental and frontier research*
  - The programme supports bottom-up fundamental research projects; frontier projects; institutes of advanced studies; and exploratory workshops.
- *Research in fields of strategic interest*
  - Sub-programme 5.1 supports nuclear physics and high-power lasers research, particularly in connection with the future ELI-NP infrastructure.
  - Sub-programme 5.2 supports participation in activities and projects in atomic and subatomic physics (such as EURATOM, CERN, FAIR, CEA, F4E).
  - Sub-programme 5.3 funds the STAR programme for advanced space research and technology.
  - Sub-programme 5.4 supports research in river-delta-sea systems, particularly in connection with the future DANUBIUS-RI infrastructure.

The overall budget for NP3 is not available as of early 2016; the first round of calls are expected in the first days of May.

3.4.4 Other allocation mechanism

The R&I funding allocated through mechanisms other than institutional and project-based schemes remains very limited. Several branch ministries manage their separate sectoral RDI plans. These include spending for research in agriculture, studies on economic issues, market forecasts etc. The estimated budget for the sectoral plans was below €10m in 2013.

Other public institutions and agencies have small budgets for research contracts, but such data is not centralised.

3.5 Public funding for private R&I

3.5.1 Direct funding for private R&I

The *Innovation* programme of the outgoing NP2 was launched in 2007 with a single instrument, *TPD* (*Technology and Product Development*), covering all types of innovation resulting from research. The programme funded 80% of the project's budget.

From 2012 onward, three targeted funding instruments have been implemented: DPD, *Stimulating high-tech exports* and *Innovation vouchers*. After 2012, private funding for *DPD* and *Stimulating high-tech exports* projects increased to at least 50% compared to 2007, when it was at least 20%. The third instrument, *Innovation Vouchers*, supports projects aimed at solving specific problems for beneficiaries' research, development, and/or innovation. The contribution of service providers may generate innovative solutions that lead to the commercialisation of products, technologies or services developed by the beneficiary. The total budget for the period 2007-2013 was approx. €80mn (523 projects). (UEFISCDI, 2014c)

The following information is available regarding structural funds for RDI:

- The Operational Programme Competitiveness 2014-2020, Priority Axis 1, 'RDI for competitiveness and business development', was allocated €716.3mn for the less competitive regions and an additional €177.5mn for the more competitive Bucharest-Ilfov region. The action lines associated to this axis are:
    - Enhancing research and innovation (R&I) infrastructure and capacities to develop R&I excellence, and promoting centres of competence, in particular those of European interest;
    - Promoting business investment in R&I, developing links and synergies between enterprises, research and development centres, and the higher education sector, in particular promoting investment in product and service development, technology transfer, social innovation, eco-innovation, public service applications, demand stimulation, networking, clusters. Also, promoting open innovation through smart specialisation, and supporting technological and applied research, pilot lines, early product validation actions, advanced manufacturing capabilities and first production, in particular in key enabling technologies and diffusion of general purpose technologies.[26]
- The Operational Programme Regional Development 2014-2020, Priority Axis 1, 'Technology transfer', was allocated €206,5m for the "creation, modernization and extension of the innovation and tech transfer infrastructure, including equipment".[27] The OP is coordinated by the Ministry of Regional Development and Public Administration.

As in the case of other SF programmes, the RDI axis of the OP Increasing Economic Competitiveness 2007-2013, coordinated by the MESR, was arguably affected by excessive bureaucracy.[28] This resulted in a relatively large number of cancelled contracts (at 97, more than 1 in 7). According to the PO's implementation reports, by the end of 2014, of the 745 winning projects just 670 contracts were signed.[29]

[26] Ministry of European Funds, Presentation on OP Competitiveness (April 2014), available at http://goo.gl/DqDbJ6.
[27] Ministry of Regional Development and Public Administration, Presentation on Regional OP (2014), available at http://goo.gl/JfgxCP.
[28] In a Structural Consulting Group survey from 2011 on a sample of 314 SMEs, as reported by Mediafax (http://goo.gl/W1mA5k), the companies accused delays in funding and reimbursements exceeding the contractual terms by a factor of 8, lack of transparency, poor communication with the PO management, and extensive formalities.
[29] POS CCE Implementation Report 2014, pp. 48, 51.

The programmes under this PO managed to attract the interest of an initially reluctant business sector. By the end of 2014, they had funded 395 SMEs and 49 large enterprises. The vast majority of these organisations (as well as of the public ones) are located in the Bucharest-Ilfov region, with the other 7 regions much less successful in attracting funds.

Unlike other financing lines from structural funds, the RDI component exceeded the allocated budget (and not only because ELI-NP represents a large section). An evaluation of the programme is not available yet.

Public procurement for innovation is not yet an established practice in Romania. The legislative framework for public procurement as a whole is particularly complex and limiting, still governed by an Emergency Ordinance dating from 2006 (no. 34) which transposed European directives in the field but has been heavily amended in the intervening period. Beyond the GEO, there are more than fifty other secondary and tertiary norms on the subject (according to the Government's recent National Strategy on Public Procurement), a normative agglomeration which makes the field difficult to negotiate. Moreover, corruption scandals associated with the public procurement process in general may restrain applicability in the near future.

The NS 2020 counts, among its key objectives, on activating public sector demand (objective 'Innovative solutions for the public sector') with the following action lines: support for improving the capacity of the public sector to formulate demand for innovation; a programme of thematic research (on researchers' initiative) supported by public institutions directly interested in the results; support for the public procurement of innovative products and services; a programme for pre-commercial public procurement and the monitoring of new and emerging technologies; establishing a national target concerning the weight of public procurement of innovative products and services within the aggregate public procurement; and a pilot programme to support social innovation.

The NP3, in its adopted form, does not include any of the PPI programs above. However, a new draft law on public procurement is now in the parliamentary approvals phase; it is complemented by a law approving Government Emergency Ordinance 13/2015 on the establishment and functioning of the National Agency for Public Procurement (NAPP). Both initiatives were taken in response to several measures in Romania's Partnership Agreement with the EC, and in particular Romania's obligation to finalize, by July 2015, a National Strategy on Public Procurement (NSPP).

The NAPP should serve as the dedicated structure overseeing the coordination and implementation of the NSPP. An inter-institutional working group was established to this end in 2014 on the order of the prime minister.

Among others, the draft law on public procurement introduces the 'Innovation partnership' for public institutions seeking innovative solutions not available on the market. Participation is open to all economic actors. The public authority may enter into a partnership with several actors performing R&D activities separately.

3.5.2 Public Procurement of Innovative solutions

PCP/PPI landscape

Public procurement for innovation is not yet an established practice in Romania. The public procurement legislation should enter into force until 18 April 2016 and the national public procurement strategy should be implemented by the end of the year. The legislative package on public procurement is currently in the Senate. The committees have passed a vote on it and it has to be voted in plenary perhaps after the 1st of February and then it will go to the Chamber of Deputies.[30] The draft law also introduces the 'Innovation partnership' for public institutions seeking innovative solutions not

[30] http://www.agerpres.ro/economie/2015/12/29/interviu-roxana-minzatu-anap-strategia-in-domeniul-achizitiilor-publice-trebuie-implementata-in-2016-altfel-ce-opreste-finantarea-pe-2014-2020-12-54-24

available on the market, where participation is open to all economic actors. The public authority may enter into a partnership with several actors performing R&D activities separately.

In October 2015, the Romanian Government adopted the National Strategy on Public Procurement (GD 901/2015). The strategy should ensure efficiency and value-for-money, as well as transparency and responsible allocations, among others by reducing legislative clutter in the field. The strategy also mandates an Electronic System for Public Procurement within the National Agency for Public Procurement (NAPP) which should ensure adequate monitoring and supervision of relevant actions. It envisions the drafting of four major items of legislation in the field to transpose relevant EU directives: a law on acquisitions, a law on utilities, one on PPPs, and one on review procedures concerning the award of public contracts.

The National Strategy 2020 (NS2020) also mentions that activating public sector demand should be one a key objective (the objective 'Innovative solutions for the public sector'). To attain this objective the strategy envisages the following action lines: support for improving the capacity of the public sector to formulate demand for innovation; a programme of thematic research supported by public institutions directly interested in the results; support for the public procurement of innovative products and services; a programme for pre-commercial public procurement and the monitoring of new and emerging technologies; establishing a national target concerning the weight of public procurement of innovative products and services within the aggregate public procurement; and a pilot programme to support social innovation.

PCP/PPI initiatives

Romanian procurers participate in the buyers groups of the EU funded Cloudforeurope PCP project (National institute for research and development).[31]

The Romanian Action Plan for Green Public Procurement was published in 2008 and covers 2008-2013. The document establishes specific targets for products and services categories which may be procured by public institutions, according to EU legislation. The main covered categories are: cleaning, buildings, lighting, food, furniture, IT, paper and buses.[32]

3.5.3 Indirect financial support for private R&I

An important source of indirect funding was introduced in 2010 as a 20% tax deduction for companies' R&D expenditures. The threshold was raised in 2013 to 50%. However, in the period 2010-2012 BERD declined further. Informal feedback from private actors indicates that the 20% tax deduction was impractical, both in bureaucratic terms and given the multiannual deductibility format. The 50% introduced by law in 2013 suspended in practice the 20% scheme, as new implementation norms were not released as well.

Starting March 2015, the 50% tax deduction can be implemented after the adoption of the requisite procedures. Furthermore, an order by the Minister of Public Finance (256/2015) has recently introduced additional clarifications concerning the tax deduction, including the type of eligible expenses and how expenses including other activities besides R&D are to be counted towards the deduction.

There are, so far, no systematic assessments of these measures.

[31] http://ec.europa.eu/digital-agenda/en/news/innovation-procurement-initiatives-around-europe.
[32] http://www.buy-smart.info/green-procurement/procurement-standards-in-europe/romania/romania2.

3.6 Business R&D

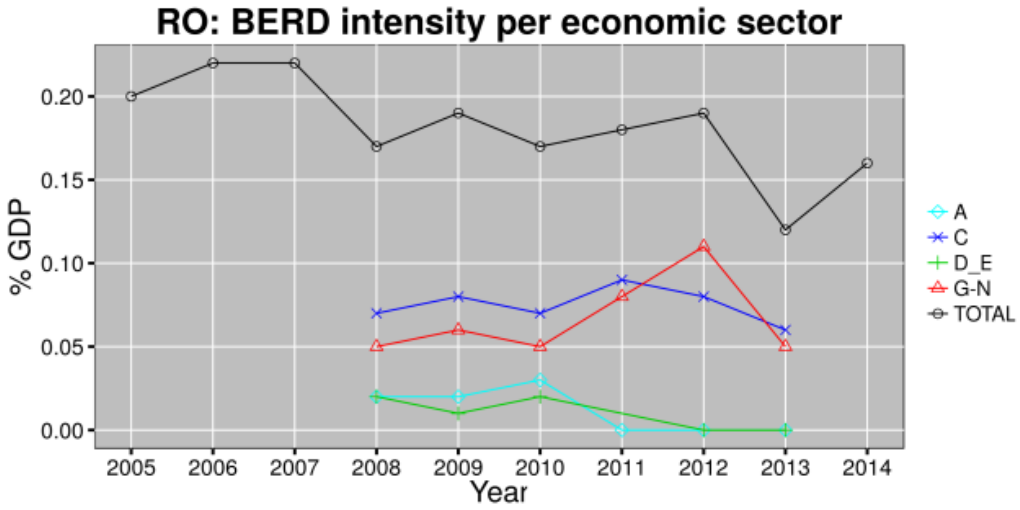
The private R&D intensity in Romania is very low and it has been decreasing in the last decade. In 2014 it was 0.16% of GDP. From a sectorial point of view it is driven mainly by manufacturing and services. One of the most important barriers to develop a strong private R&D sector is the structure of the Romanian economy. Romania has several multinational companies which have high productivity, but lack in-house research activities. Thanks to them, the country has an increasing share of high-tech exports compared with its neighbours and a high share of medium high-tech export, but there is only a very low number of SMEs innovating in-house.

3.6.1 The development in business R&D intensity

As one can see from Figure 10, BERD intensity in Romania is very low and decreasing in the last decade. In 2014 it was 0.16% of GDP (2005: 0.2%), which is the lowest among the countries that have joined the EU since 2004. From a sectorial point of view it is mainly driven by manufacturing and services that together account for more than 80% of the BERD expenditure in the period under scrutiny.

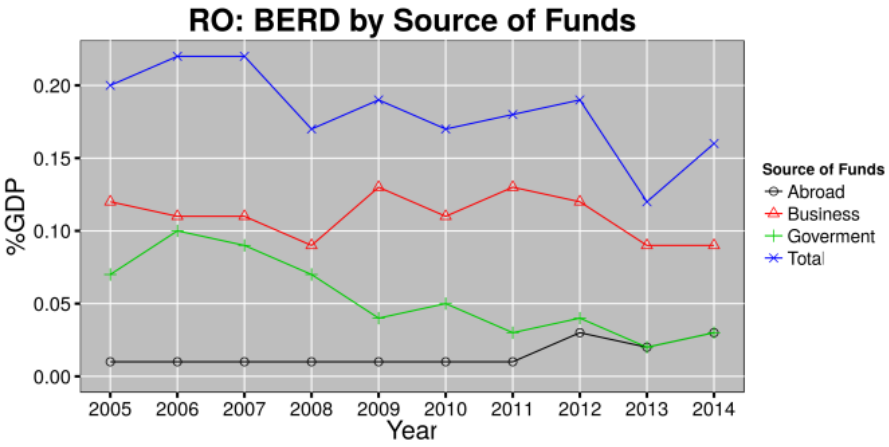
Romania is specialised in labour-intensive industries (preparation and spinning of textile fibres, sawmilling, wearing apparel and accessories), in capital-driven industries (cement), and marketing-driven ones (footwear). In terms of innovation, Romania is specialised both in low-innovation sectors (wearing apparel, leather) and in medium-high innovation sectors (textiles, basic metals). Romania's competitiveness is affected by a weak R&I capacity. Manufacturing plays a stronger role in Romania than in most other EU countries (24.8 % of total value added, compared to 15.5 % EU average), but the country is a modest innovator.

Figure 10 BERD intensity broken down by most important macro sectors (C= manufacture, G_N=services, A= Agriculture, D-E= Utilities)



Based on Figure 11, in the period 2012-2013 the total R&D intensity decreased due to the simultaneous decrease of public and private support provided to business R&D. This is followed by a subsequent increase in the period 2013-2014. Businesses are the main funders of the Romanian BERD. The level of funding coming from them is practically stagnating in terms of GDP (fluctuation of +/- 0.02% of GDP) in the last decade, which shows that companies were not able to expand their research activities. Since 2012 the importance of external funding (Abroad) seems to be growing, reaching 20-25% of total BERD, although in itself it is still a minor resource, representing only about 0.03% of GDP. Most of it comes from private funding.

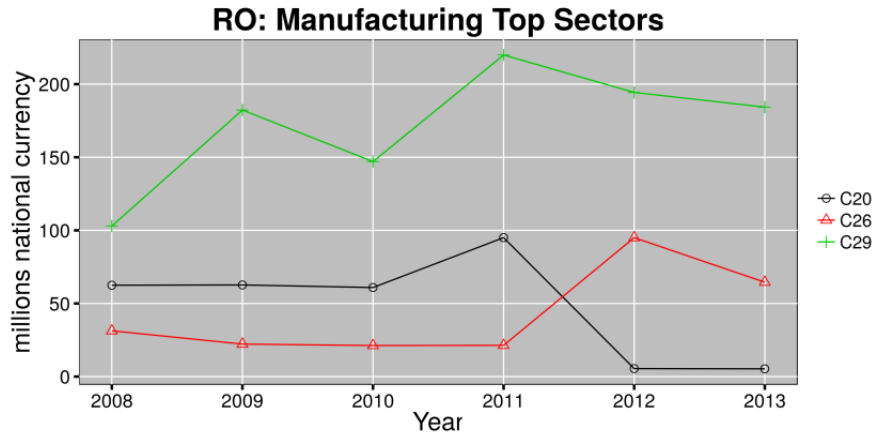
Figure 11 BERD by source of funds



3.6.2 The development in business R&D intensity by sector

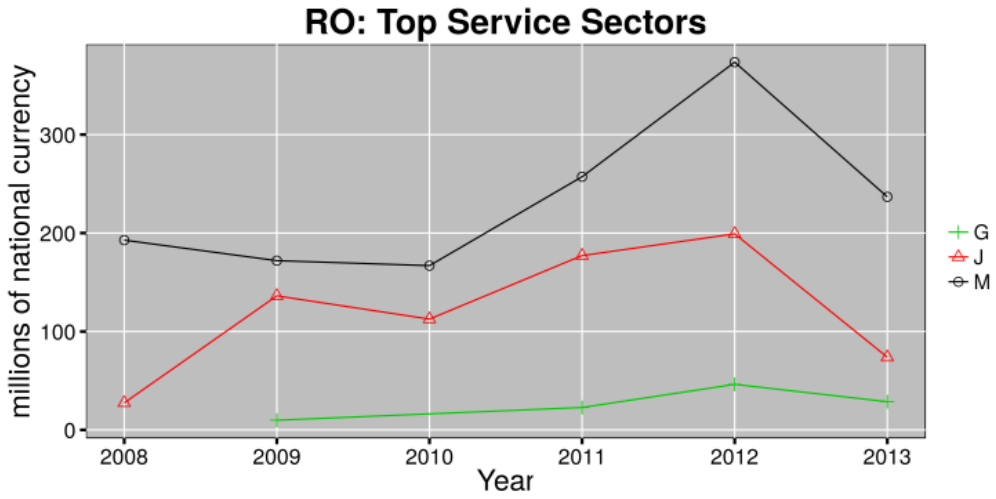
In terms of sectorial distribution, unsurprisingly the automotive sector (manufacture of motor vehicles) dominated by Renault is the leading manufacture sector in Romania. On Figure 12, we notice a general growth of its BERD between 2008 and 2011 and a slight decrease afterwards. The other two more important sectors in terms of BERD (chemicals, computer and electronic products) have "switched places" in terms of importance since 2011-2012, with BERD in the manufacture of chemicals practically disappearing from the country. The biggest Romanian chemical producer Oltchim is in insolvency procedure since 2013.

Figure 12 Value added for top sectors in manufacturing (C20=manufacture of chemicals and chemical products; C26= manufacture of computer, electronic and optical products, C29=manufacture of motor vehicles, trailers and semi-trailers)



The main contributors to business R&D in the services sector are somewhat more knowledge intensive services sectors, such as professional and scientific services, and information and communication services. Both of them had a generally increasing trend since the crisis and up until 2012 and a drop in 2013. Although the third most important sector and despite its moderate growth, wholesale and retail trade had a marginal contribution to the country's total BERD.

Figure 13 Value added for the leading service sectors (G= Wholesale and retail trade; repair of motor vehicles and motorcycles, J=information and communication, M=professional, scientific and technical activities)



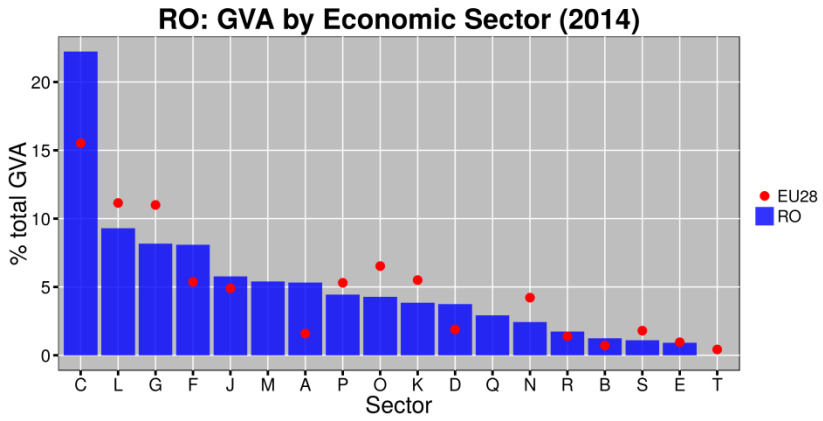
3.6.3 The development in business R&D intensity and value added

When looking at the contribution of the various sectors to the total gross value added (GVA, Figure 14), we notice that manufacturing is by far the most important sector in this respect in spite of performing less R&D in 2012 than business services. Construction, real estate activities and transportation are also important. The shares of other sectors in GVA are close to or below 5%.

Comparing Figure 13 and Figure 14, we observe that the leading services sectors in terms of BERD are contributing to less extent to the GVA. One explanation could be that these are smaller sectors within the country's economy (information and communication and professional business services) or that they are operating with a low margin due to the strong sectorial competition (retail and wholesale trade).

Figure 14 economic sectors as percentage of the total GVA.

Top 6 sectors in decreasing order: 1) manufacture, 2) real estate activities, 3) whole sale and retail trade, 4) construction, 5) information and communication, 6) professional, scientific and technical activities



According to Figure 15, sectors of manufacturing with the highest GVA have a technological intensity of low to medium. Food, beverage and tobacco sector is surprisingly the leader of the series. GVA in the automotive industry is only about half of the former in spite of receiving the highest amount of BERD.[33]

Figure 15 GVA in manufacturing.

Top 6 manufacturing sectors: 1) Food & Beverage, 2) Textiles, wearing apparel, leather and related products, 3) Motor vehicles, trailers and semi-trailers, 4) Coke and refined petroleum products, 5) Fabricated metal products, except machinery and equipment, 6) Electrical equipment

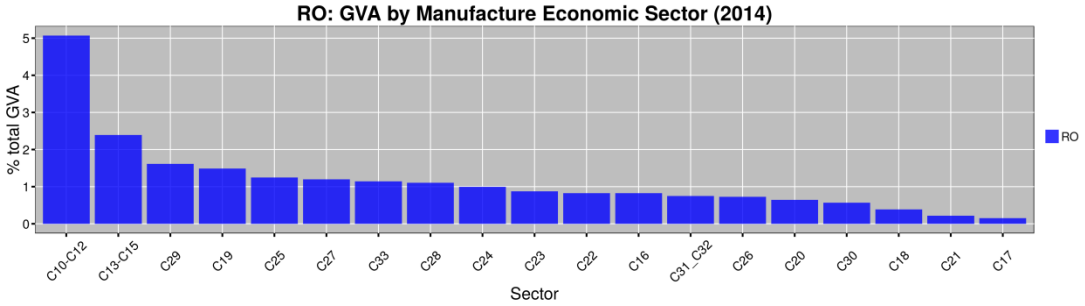
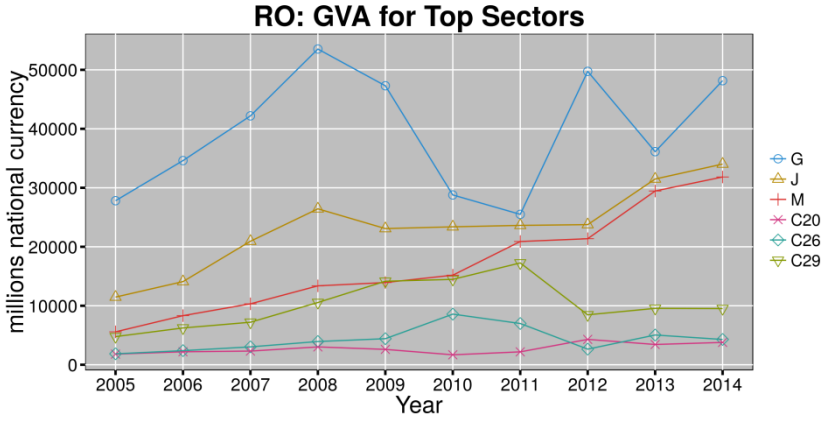


Figure 16 shows that from the six most R&D intensive sectors, the wholesale and retail trade sector was the main contributor to VA throughout 2005-2012. It has been however, the sector facing the strongest decline during and in the aftermath of the crisis with operating margins compressing significantly as a result of weakening domestic consumption. This is followed by more knowledge intensive services sectors, such as ICT and professional & scientific activities as well as the automotive industry, a typically medium high-tech sector. High-tech economic sectors (chemicals as well as computer, electronic and optical products) are less important in the national economy. Except for wholesale and retail, all other sectors managed to increase or to maintain their VA at factor cost throughout the last decade closing largely the gap between them and the wholesale sector.

Figure 16 value added at factor cost for the leading manufacture and service sectors in Figures 12 and 13.



[33] The Romanian exports of agro-food products constantly increased since early '90s. Yet, the analysis of export flows indicates that this increase was based mainly upon unprocessed products or products with low processing level. These changes in the composition of export flows reveal the beneficial effect of the foreign direct investments in the Romanian food industry. At the same time, in order to avoid the loss of market segments, many domestic processors had to improve the quality of their products and to increase their efficiency. The improvement of the performance and supply of products of the Romanian food industry was also stimulated by the explosion of modern retail structures (supermarkets and hypermarkets) after the year 2000, which significantly increased the demand of higher quality products, at lower prices.

There was a decrease in the number of employees in the manufacture of chemicals and chemical product, which is in line with the decline in BERD and the fluctuations in the VA of this sector. At the same time, we have noticed an increase in the number of employees in the manufacture of motor vehicles, trailers and semi-trailers which is combined with an increase in the VA. The services sectors J: information and communication and M: professional, scientific and technical activities do not show an increase in the employment but they show an increase in the number of scientists and researchers, which gives an indication of a certain "upskilling" of the labour force in these sectors.

3.7 Assessment

The 1% target for public R&D expenditures set for the period 2007-2013 was *de facto* abandoned in 2009. Consequently, the NP2 received only a third of the programmed allocation. Such sharp cuts have predictably had structural effects on R&D in this country. For example, continued brain-drain, motivated by the poor funding opportunities and poor experiences in contracting, is depleting the country's human resource for research, development and innovation. Romania has substantially fewer researchers FTE today than it did a decade ago, despite some growth in higher education personnel. For much the same funding-related reasons, research organisations have adopted standby strategies focused on organisational survival rather than performance. A recent set of interviews with the managers of several R&D institutes (Pascu & Voinescu, 2014) confirms that financial constraints appear to be the main (perceived) obstacle to competitiveness.

The lack of predictability affected the system in other structural ways as well. For example, the considerable investment in research infrastructures over the past years, chiefly through structural funds, has not been complemented by the relevant resources for projects. Partly for this reason, research infrastructures (RIs) remain underused.

Similarly, the large number of PhDs trained with SF and traditional university funds are experiencing difficulties in finding opportunities for a research career. Compared to the EU average, Romania has almost one fourth of the researchers per capita, a GERD that is five times smaller, and R&D expenditures in Euro per capita 19 times lower. From this perspective, the number of doctorate graduates produced annually, which is close to the EU average, is simply a resource not sufficiently capitalised on by the system.

The doctoral schools and postdoctoral scholarships and the flux or new researchers they generated have been also unable to provide an impetus for change in the conservative hiring practices in PROs.

The arguably low level of political interest in RDI, as expressed in, for instance, the falling government expenditures for R&I even during times of economic optimism, is also made obvious by low allocations of structural funds for R&D. As noted previously (3.3.2) these are much lower than those of many countries in Central and Eastern Europe. Just approximately €1b was allocated for 2014-2020, representing 15% of the public R&D expenditures required to reach the strategic goal of 1% of GDP by 2020. This is so even though the absorption rate for R&D funds was 100%, compared to a more typical 40-50% in other fields.

The undependable funding, whether under the NP2 or SF, may have affected the morale of private research and development actors, at least judging by the findings of opinion polls.[34]

[34] See note 24 above.

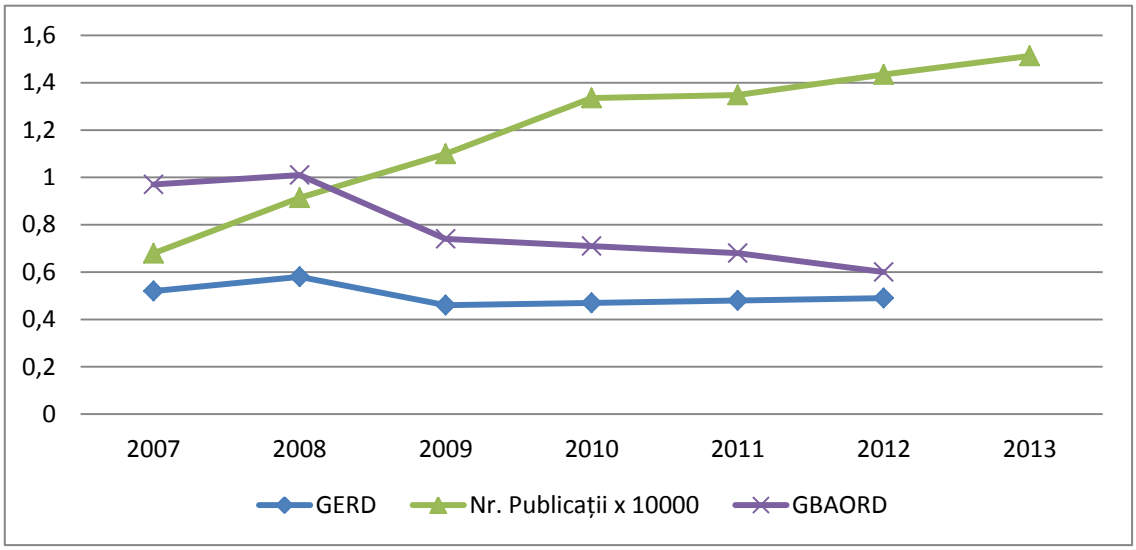
4. Quality of science base and priorities of the European Research Area

4.1 Quality of the science base

In what concerns R&D productivity, Romania is currently doing better than the EU average in publications per full-time equivalent researcher. This is, however, conspicuously not the case relative to the country's population. The number of researchers per capita is over 3.5 times below the EU average. Patenting activity is very modest.

The launch of the NP2 (2007-2013) roughly coincided with tougher publication standards for career advancement in higher education and in other research organisations. This combination probably explains why, even after competitive project funding was cut dramatically starting 2009, the number of publications continued its uphill trend (albeit at a slower pace).

Figure 17 R&D financing indicators and number of publications 2007-2013



Source: Zulean et al., 2015 (Eurostat and Scopus data)

As noted, relative to population research performance is quite poor. In 2013, Romania produced 0.69 publications per 1,000 of population, which is below half the EU28 average (1.43). The international profile of this type of output remains somewhat modest, with a 30.3% share of co-publications being international (36.4% in the EU28). International scientific co-publications per million of population, at 210, are well below half the EU average (520).

Since 2000, the percentage of publications in the top 10% most cited only increased from just a bit below 5 to just a bit above that figure, with an average of 5.28. This is less than half the corresponding EU28 figure (11.29). The number of public-private co-publications per million of population was 10.19 (or a share of 0.5% of all publications) in 2011-2013, compared with 87.07 (or 1.8% of the total) for the EU28 (SciVal data).

Individuals used to make up the largest category of national patent holders in Romania, probably due to the 'prestige' factor traditionally associated with patent-holding. According to the Romanian Patent Office (OSIM), the share of individual holders did, however, decrease from around 60% in 2001 to a little fewer than 29% in 2013. So has the share of patents awarded to companies (from 25% to around 17% over the same time frame). These gaps have been made up by universities (3% to 19%) and research institutes (5% to a little fewer than 35%). Note, however, that year-to-year fluctuations are substantial.

Under a different classification of patent holders but with more recent data, some 37% of all 'Romanian' inventions are owned by 'academic & government' entities, closely followed by individuals (35%) and, at some distance, by business (28%) (Thomson Reuters 2015, 12). See section 5.6 for additional patent data and details on sources.

Indicator (2013)	Romania	EU average
Number of publications per thousand of population	0.69	1.43
Share of international co-publications	30.3%	36.4%
Number of international publications per thousand of population	0.21	0.52
Percentage of publications in the top 10% most cited publications	4.96	10.55
Share of public-private co-publications	0.5%	1.8%

4.2 Optimal transnational co-operation and competition

4.2.1 Joint programming, research agendas and calls

For the period 2014-2020, the NP3 provides for a range of measures in support of the internationalisation of RDI. Specifically, six sub-programmes under Programme 3, European and international cooperation, support bilateral and multilateral cooperation in RDI through complex projects and mobility; participation in Horizon 2020; participation in Joint Programming Initiatives and Joint Technology Initiatives; participation in international initiatives such as EUREKA, or EUROSTARS; and the creation of and participation in international R&D consortia and other initiatives. Sub-programme 5.2 funds the participation in activities and projects in atomic and subatomic physics (such as EURATOM, CERN, FAIR, CEA, F4E).

In 2010, Romania was last among 21 member states in the share of the public R&D budget (GBAORD) allocated to transnationally coordinated research, at 0.27%. This was compared to a European average of an 4.27% and a peak value of 5.87% in France.[35]

Survey data from 2014 suggests a different picture today, with Romania ranking 7th among the European states. (However, the survey is based on the reported percentage of individual organisations' R&D budget dedicated to joint research agendas with EU countries; only a fraction, possibly the most active, of the total number of organisations responded.)[36]

[35] M. Doussineau et al., *ERA Communication Synthesis report*, Luxembourg: Publications Office of the European Union, 2013. The 2010 figures include contributions to ESA, which Romania was not providing at the time. The country's contribution in 2011 was €5.7m and it has increased steadily since then. Nevertheless, over 3.3% of the Bulgarian and the Slovak GBAORD, respectively, was coordinated transnationally in the same year, even though neither country contributed to ESA at the time.

[36] EC, *European Research Area Facts and Figures 2014*, p. 17.

In absolute numbers, Romania's financial commitment amounts to €25mn per year, the largest contributions being to ESA (€16mn) and CERN (€6mn). The country currently contributes to 16 international organisations: International Centre for Genetic Engineering and Biotechnology (ICGEB, Trieste), International Seismological Centre (Newbury, UK), European Physical Society (Geneva), International Centre for S&T Information (Moscow), EUREKA, ESF (Strasbourg), COST, TERENA (Amsterdam), CEENET (Austria), EUROGEOSURVEYS, European Space Agency (ESA), ITER, GSI-FAIR GmbH, CERN, Unified Centre for Nuclear Research (Dubna), and SCAR. Romania has recently become a full member of the European Organisation for Nuclear Research.

In the period 2012-2014, Romania also allocated approx. €1mn per year for the participation in the transnational programme Ambient Assisted Living (AAL). In 2014, UEFISCDI hosted the 6th edition of the AAL Forum. For the period January 2013-September 2014, UEFISCDI supported 6 JTI Clean Sky projects (total €7.6mn), 3 ENIAC projects (€0.9mn), and one JTI FCH project (€40,000). (UEFISCDI 2014a)

For the programme EUREKA, 62 projects (approx. €11mn) were financed since 2008, out of which 10 in the category CLUSTERS, 38 traditional, and 14 EUROSTARS. (UEFISCDI 2014a)

4.2.2 RI roadmaps and ESFRI

The main transnational cooperation project in which Romania is directly involved is the Extreme Light Infrastructure – Nuclear Physics (ELI-NP), a pan-European infrastructure which is to be built in Romania with structural funds. In December 2012, the contract for the first stage of the investment (€180mn) was signed, while the construction works started in July 2013. Access to ELI-NP will be granted for most of the eligible time based on the evaluation of the scientific cases by the international scientific board.

In addition to the construction of the laser, a €1bn project for the construction of a Science Park next to the town of Măgurele hosting the laser is now on the public agenda. The Măgurele Science Park, with a surface of 40 hectares, is already part of Ilfov County's strategy to promote entrepreneurship and developing research and innovation.[37] A steadfast domestic political commitment is still needed, however, as well as and the approval of the European Commission for structural funds.

The Danube International Centre for Advanced Studies for River-Delta-Sea Systems – Research Infrastructure (DANUBIUS-RI) obtained the status of a Flagship Project in the EU Strategy for the Danube Region. DANUBIUS-RI is the second major distributed RI project with the status of a Flagship Project in RDI.[38]

There is no up-to-date national roadmap for research infrastructures, but the Ministry of Education and Research is expected to launch a project to this end in early 2016.

4.3 International cooperation with third countries

Partnerships with third countries include (UEFISCDI, 2014a):

- *The Swiss-Romanian cooperation programme 2011-2016*. Based on the November 2010 agreement between the Romanian Government and the Swiss Federal Council, the programme includes thematic research calls with a total value of €8.6mn. The shared contribution is 85% Swiss and 15% Romanian. The programme also includes doctoral and post-doctoral scholarships, total value €5.5mn.
- *The research collaboration framework Romania-France*. Based on a 2011 agreement between the Romanian Ministry of National Education and the French National Research Agency, the framework supports joint research projects. A total of 22 projects amounting to €5mn were financed over the period 2011-2013.

[37] See http://goo.gl/lT24jr.
[38] See waterjpi.eu (http://goo.gl/JmWMGs).

- *The cooperation programme between Romania and Norway, Iceland, and Liechtenstein under the SEE Financial Mechanism 2009-2014* supports joint research projects. It has a budget of €23.5mn from the donor countries and a 15% co-financing from the Romanian part, funded through the Partnerships programme. A number of 23 projects were financed in the areas of Health and food safety; Social sciences and humanities; Environmental protection and management; and Renewable energy.

4.4 An open labour market for researchers

4.4.1 Introduction

In discussing Romania's competitiveness problems, the European Commission noted in its 2015 Country Report that the "underfinancing in the research and development affects the system in structural terms, resulting in a brain drain and decreased quality of human skills." (EC CR 2015, 24-25).

Hiring in the public sector, including R&D, was virtually halted for four years, between 2009 and 2013. In 2009, the Government decided that any recruiting in the public sector – including the formally autonomous public higher education system – may be done only provided that 7 other people leave for every new hire. It was only as late as the summer of 2013 that a new government decided on a 1:1 replacement scheme, but even that only after removing existing vacant positions (except for strategic sectors such as defence).

Such policies exacerbated the staff shortage in a research and innovation system which, with over 3.5 times fewer researchers per capita than the EU average, remains massively undersized. Only 28% of these researchers were active in the business sector in 2013, compared with a 48% EU average in 2013 (Eurostat data).

The supply of human resources in Romania exceeds the capacity of absorption by the traditionally underfinanced system. Among EU countries, Romania has one of the largest scientific diaspora, with an estimated 15,000 active researchers working abroad (World Bank, 2011, 21). While the new doctoral schools – mainly funded through Structural Funds – provided comparatively generous financial support for their students, the latter already experience difficulties in finding relevant jobs in Romania, turning instead into candidates for the diaspora. The postdoctoral programmes, on the other hand, have arguably failed to achieve at least one of their original purposes, which was to replenish the research staff of PROs. Many postdocs hired in research organisations under the aforementioned programmes were already tenured faculty attracted by the substantial scholarships, often exceeding their humble wages by a factor of 2 or more.

One of the key objectives of the National Strategy for RDI 2007-2013 was to reach the EU average in researchers per population. However, as the allocated budget was only one third of the programmed funding, the objective seems to have been de facto abandoned. For the period 2014-2020, the new objective in terms of researchers is to double their number and simultaneously reach a share of 45% in the business sector. This implies the number of researchers in business would have to increase almost fourfold.

4.4.2 Open, transparent and merit-based recruitment of researchers

Government Decision 286/2011 on the general principles of employment in the public sector makes allowance for specific, field-based regulations set out by the authorities coordinating public resources.

Law 319/2003 on the Status of research staff stipulates that vacancies for positions in research institutions are to be announced publicly, among others in a daily newspaper with national circulation. It further sets the deadline for applications at a minimum of 30 days; provides that selection panels should include research or university personnel from within and/or outside the institution (depending on the position sought) with a scientific title equal or higher than the one required for the vacant post; establishes that the

examination format must be approved by the scientific council of the institution; and mandates that the candidate's file should include, among others, a list of publications and a copy of the candidate's 5 most representative works.

More specific provisions on obtaining scientific titles are set out in Order 4478/2011 of the Ministry of Education, Research and Youth (as it was then called). The Order provides for criteria for specific scientific titles to be met in Mathematics and the natural sciences, Engineering sciences, and Biomedical sciences.

The Euraxess Romania portal (www.euraxess.gov.ro) supports Romanian and foreign researchers in finding a job in Romania and provides information regarding visa procedures, residence and labour permits, and social and medical services. It also includes materials on funding opportunities, the taxation of research activities, the regime of intellectual property rights in Romania, and a general FAQ.

Given the low number of job vacancies in Romania's underfunded R&D system, one may regard Euraxess as an important portal in the research labour market (see statistics below). The relatively large concentration of job vacancies (10 organisations account for 48% of job vacancies in 2013-2014) seems to be directly related to the internationalisation efforts of these organisations.

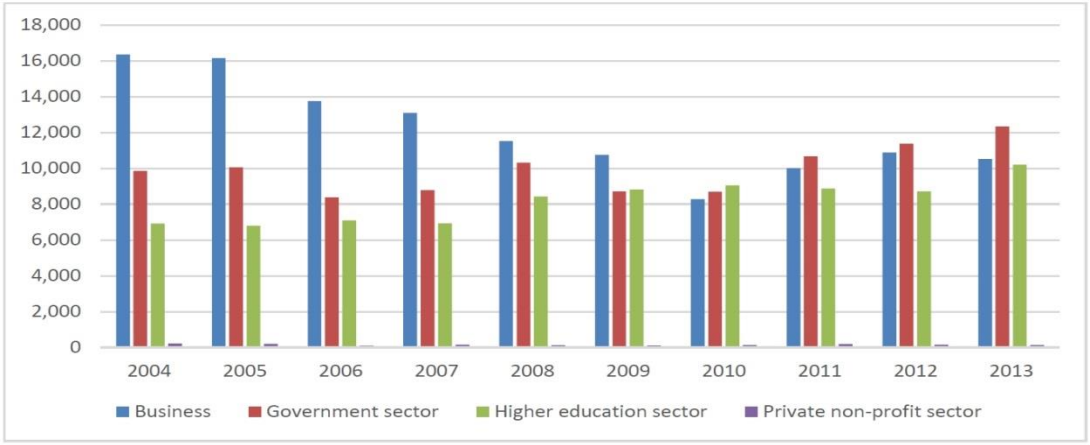
Table 4 Statistics on the use of euraxess.ro

	No. organisations with at least one job vacancy	**No. job vacancies**	**No. unique viewers**
2013	72	308	10150
2014	55	203	8076

Source: UEFISCDI

Inter-institutional mobility at national level is low in both institutes and universities. Typically, academics advance in their careers in the university they graduated from. This localised organisational culture in both institutes and universities often renders recruitment an internal affair, despite formal compliance with procedural steps. The fact that, in higher education and elsewhere, career advancement (promotion) actually entails a full recruitment procedure – opening up a position and organizing an open competition, in which one's 'up for promotion' staff may take part on an equal footing with any outsiders – essentially incentivizes such procedural formalism coupled with insider preference.

Figure 18 Number of R&D personnel by sector of performance



Data source: Eurostat

For the period 2014-2020, the National Strategy sets out the following measures in relation to 'Labour market in research': integrating doctoral students and young doctors in RDI projects; encouraging the attraction of established researchers from abroad as project directors in a host Romanian institution; mandatory publication of all vacancies in Euraxess; PRO adherence to the European Charter and Code for Researchers; new policies on the electronic identity of researchers for access to digital research services.

While the integration of PhD students in R&D projects is already encouraged under the outgoing and the incoming National Plans for RDI, and while attracting foreign researchers is supported by a dedicated financing line in the new SF cycle, the other measures are awaiting implementation.

4.4.3 Access to and portability of grants

International access to grants, i.e., the ability of researchers affiliated to foreign institutions to apply for grants in Romania, is restricted. However, Romania has specific financing lines dedicated to encouraging foreign researchers willing to become affiliated to a Romanian institution.

For competitive projects under several NP2 programmes, grants have been portable based on a request by the project director or principal investigator and subject to specific restrictions (e.g., the transfer to a new institution is possible only once, and only during the first half of the project).

4.4.4 Doctoral training

By the end of 2014, over 6,800 doctoral students had been supported by scholarships granted through doctoral schools under the Operational Programme Development of Human Resources (PO Implementation Report 2014). The programme also supported over 2,700 postdocs (S2E RO 2015). Additional doctoral students were supported from the regular funds allocated to universities or self-financed through tuition fees.

As a result, Romania scores above the EU average – and much higher than the comparison group – for new doctoral graduates (ISCED 6) per thousand population aged 25-34. The average yearly growth rate during 2007-2012 was 15.1 %.[39]

An analysis of the actual set-up and procedures of doctoral studies was carried out in 2011.[40] It showed a large diversity of practices. Since then, doctoral studies have been regulated more consistently under Government Decision 681/2011 on the code of doctoral studies in universities. According to the GD, only specific research organisations have the right to organise doctoral studies – universities, university consortia, university-research institute partnerships, and the Romanian Academy. These organisations can operate one or more doctoral schools.

In theory, only universities classified research-intensive (the other two classes are teaching-intensive, and research-and-education universities) are allowed to organise PhD programmes. Given that the process of classification, to be run annually, was cancelled *de facto* after the first round, the implications of the original regulations in this respect remain unclear.

The application of the principles of Innovative Doctoral Training is mentioned in the NS 2014-2020, but further implementation norms are required. In February 2015, the Ministry of Education and Scientific Research revised the methodology for the habilitation of PhD advisers, a decision that was criticised for its alleged lowering of professional standards. The Bucharest Court of Appeals overturned the order of the minister in October 2015, but the decision is not final.

[39] EC, Research and Innovation performance in the EU: Innovation Union progress at country level, 2014, p. 239.
[40] See the field-based analyses at http://www.studii-doctorale.ro/diagnoza/pe-domenii-sectoriale-si-tematice.aspx.

4.4.5 Gender equality and gender mainstreaming in research

Romania scores well above the EU average in terms of the share of women in research (2011 data), despite not being mentioned among the 17 states which the European Commission identified as having developed gender equality strategies in public research.[41] This may be due to the communist-era legacy of promoting gender-parity in research, which also explains in part the very modest institutional culture of gender mainstreaming. According to the ERA survey 2014, slightly below 20% of surveyed Romanian organisations had developed Gender Equality Plans, and just fewer than 40% implemented recruitment and promotion policies for female researchers.

Thus, the country has achieved gender parity in most fields of science, among which natural sciences (46.8% female researchers), agricultural sciences (51%) and social sciences and humanities (49.8%), with a solid predominance of women researchers in the health sciences (59.1%). The gender parity ideal remains to be attained only in engineering and technology (39%), but even here Romania is doing better than most CEE countries, not to mention Western Europe. The same is true of the share of women among researchers in the business sector, where the country enjoys a 10 to 20 point advantage relative to most Western European lands (37.8%). (UNESCO 2015, 87, 96, 2012 data)

The picture appears to be similar once one takes into consideration access to the top of the hierarchy in R&D organisations. Romania was significantly better than the EU average in terms of the share of PROs headed by women and the share of gender-balanced research evaluation panels in funders.[42] Likewise, according to the Glass Ceiling Index compiled by Deloitte, which "measures the relative chance for women, as compared with men, of reaching a top-level position" in research, in 2010 Romania was the most 'gender-equal' country in the EU28 and showed improvements compared to 2004. It clearly dominated the field in terms of women with a 'Grade A' position among academic staff (35.6%) (Deloitte, Researchers' Report 2014, 34-5).

Romania has recently adopted a National Strategy for Equal Opportunities for Men and Women, 2014-2017. While the document does provide for increasing women's participation in decision-making (alongside other interventions in, e.g., education, the labour market and employment mobility, increasing awareness of wage disparities and the reconciliation of family and working life, and combating gender violence), it contains no specific provisions on gender-related measures in higher education and R&D.

Also recently (2015), amendments to the 2002 Law on equality of opportunity have restored the Agency for Equal Opportunities for Men and Women (ANES), disestablished half a decade ago and replaced with a department with a more limited range of prerogatives. Among others, ANES is tasked with elaborating and applying the Romanian government's strategy on equality of opportunity; harmonising the relevant legislative framework with EU regulations; and ensuring and monitoring the integration of the 'gender perspective' in all national policies and programmes.

4.5 Optimal circulation and Open Access to scientific knowledge

4.5.1 e-Infrastructures and researchers electronic identity

The 'Research labour market' subsection of the NS 2020 announces policies on researchers' electronic identity for access to digital research services. These access-to-knowledge policies are directly connected in the NS 2020 with the establishment of a Registry of Researchers in Romania (which should include foreign participants to domestically funded projects), aimed at increasing transparency and collaboration.

[41] EC, ERA Facts and Figures 2014, p. 29.
[42] EC, ERA Facts and Figures 2014, pp. 30-1.

Beyond relating these measures to the need to secure an analytical base for evidence-based policy in research, the Strategy does not offer any additional details, and neither does the newly adopted NP3. The latter does include the aforementioned Registry among the objectives of Sub-programme 1.1 *Human Resources*. It also lists "transparency and accessibility of information" among the principles guiding its programmes.

The Ministry of Education and Research is expected to launch a project operationalizing the Registry early in 2016.

ERRIS (www.erris.gov.ro), the online booking platform for research infrastructure services launched in mid-2015, is also open to e-infrastructures.

4.5.2 Open Access to publications and data

Access for a broad range of research organisations to scientific literature is mentioned among the objectives of the NS 2020, as well as those of the National Reform Programme 2014. This objective has been achieved through the project ANELIS PLUS, continuing the earlier ANELIS started at the turn of the decade.

As for open access, the NS 2020 specifically mentions as an objective "encouraging the publication of the results of publicly funded Romanian research under the (gold) open access standard." The National Plan for RDI 2015-2020 implementing the Strategy makes no reference to such a policy.

The main fundamental and exploratory research components of the outgoing NP2 programmes, while not implementing a systematic open access publication policy, did include terms related to the dissemination of projects' research outputs. Project directors had the obligation to maintain an updated web page of the project's activities and outputs. Principal investigators in programme *Ideas* were also required to make books published as part of the project available online; and, where the volumes are also available in printed format, to distribute them internationally.

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

5.1 General policy environment for business

Romania has one of the lowest GDPs per capita in Europe. In 2014, GDP per capita PPS was at a little above half the EU28 average (Eurostat). As noted previously, there are large discrepancies among the country's 8 development regions. Bucharest-Ilfov whose GDP per capita PPS is 30% higher that the EU28 average (2013), is more than twice richer than the second-richest region; the gap compared to other regions gets much wider.

As noted by the Commission in its 2015 Country Report, Romania has the second-lowest labour productivity in the EU. After experiencing a relatively sharp decline of approx. 4 % during the first crisis years and a more moderate decrease afterwards, labour productivity started to grow again in 2013. The document reads the early decline as a sign of the economy's low adjustment capacity (EC CR 2015, 22).

In the World Bank's *Doing Business 2015* rankings, Romania currently occupies the 48th position and is scoring higher than previously – as do, in fact, the vast majority of the other countries. In the overall index, the country is doing slightly better than, e.g., Slovenia, Hungary, Turkey, and Italy. It is also cited in the same publication as the nation with the highest level of improvement in 'Paying taxes' reforms (i.e., making paying taxes easier and less costly) (WB 2015).

In terms of individual indicators, Romania ranks relatively well, absolutely and also in comparison with comparator countries, on Getting Credit (7), Starting a Business (38), and Protecting Minority Investors (40). In absolute terms especially, the country lags behind in Dealing with Construction Permits (140) and Getting Electricity (171), the latter due to both long completion times and high costs.

According to the *Doing Business* country profile, Romania is in the middle of the pack in Resolving Insolvency (46), Enforcing Contracts (51), Paying Taxes (52, but considerably better than comparator countries in the CEE), Registering Property (63), and Trading Across Borders (65).

Except for the fluctuating RDI project co-financing under SF schemes and the NP2, support for business R&D investment has been limited: the 50% tax deduction for R&D expenditures lacked implementation norms for several years; SME access to bank loans remains limited – even when needed to co-finance structural funds projects.

The labour market has been relatively stable after the country recovered from the crisis, with persistently low levels of unemployment at around 7%. Nevertheless, Romania is still plagued by structural problems such as social exclusion. Poverty is widespread and the labour force as a whole has weak digital skills. Education is loosely connected to the needs of the economy, and higher education is distrusted by business owners (WEF 2014). Lifelong learning is at the lowest levels in Europe.

The government that went out of office at the end of 2015 had planned an increase in the minimum wage, but the current technocratic government postponed the measure until its impact on employment and competitiveness would be better assessed. As of this writing, the measure is still debated by the government with the main unions and businesspersons' organisations. Some of the latter, but not all, oppose the minimum wage hike.

Tax compliance seems to have improved lately, though taxation policies are still generally perceived as changing too often. Tax collection has therefore improved as well, with some additional efforts by the authorities to diminish the high levels of VAT fraud. At least as serious is the problem of undeclared work, which the Fiscal Council estimated

in 2012 at 1.5 million persons,[43] that is, one third of the number of official wage-earners. Constructions, transportation, and textiles are the most exposed fields. Recently, the economic publication *Ziarul Financiar* estimated the annual losses to the budget at €2.7bn.[44]

5.2 Young innovative companies and start-ups

According to WTO statistics, Romania's exports in telecommunication, computer, and information services amounted in 2014 to just below USD 3bn, a 19% increase over the previous year and a massive 50% up compared with 2012. This figure is double than the crisis-era low in 2010, and upwards of 3.5 times as much as a decade before. Computer services account for two thirds of the figure.

In recent years, the technology start-up movement has shown signs of an awakening. Especially in the field of technology, and particularly Internet-related technology, several entrepreneurial hubs, clusters and accelerators have also emerged. The 'hubisation' movement has led to business plan competitions, pre-acceleration and acceleration programmes and pitching sessions, mostly in the field of ICT (e.g., How to Web, Innovation Labs, RICAP). So far, these innovative technology companies seem to have emerged primarily in significant urban agglomerations such as Bucharest, Cluj, Timisoara, Iaşi or Braşov.[45]

There seem to be two main limiting factors preventing an explosive growth in tech start-ups and, presumably, other types of innovative companies. There is the availability of capital and of local capital more specifically. This is dealt with in additional detail in section 5.4 below. The gist is that many start-up ideas never come to fruition because of lacking funding opportunities; or, just as significantly, they go elsewhere. As one young entrepreneur noted, success stories "attributed to Romanian origins were in fact companies that moved to the UK or US in order to get access to capital and network. We have met some of the big funds. Their policy is usually: come to our country to get investment."[46]

The second factor is partly cultural and partly related to skills. A cofounder of the How To Web Conference observed, in this context, that "There is too much focus on building product features and too little understanding of what a product or business means. The outsourcing and product cultures are very, very different [in Romania versus the West] and product creators need different skills."[47] For further information on this, see section 5.4.

Perhaps the best known and probably most successful concerted effort to create an ecosystem to spawn innovative companies is the "Cluj IT Cluster" (CITC) (www.clujit.ro/en/), a cluster of organizations active in the field of ICT established at the end of 2012 with the stated goal of "creat[ing] an ecosystem suitable for the development and manufacture of innovative software services and products, with high value added, through: close collaboration between the cluster's members, exchange of knowledge and ideas, public-private partnership and support of research…" Currently, 4 universities, 9 public institutions and around 35 companies with some 4000 employees are involved in the cluster, which has forged strategic alliances with international foundations with similar goals (such as Steinbeis) and works together with the Regional Development Agency North-West. The CITS is at the centre of Cluj Innovation City, an urban development project that envisages a €300mn investment over the next 15 years and aims to bring together over 20,000 IT specialists and to develop a surface of over 300 hectares. The CITC hosts international events such as the Cluj IT Innovation Days,

[43] http://www.capital.ro/top-10-munca-la-negru-peste-15-milioane-de-romani-lucreaza-fara-acte.html
[44] http://www.zf.ro/companii/statul-pierde-2-7-mld-euro-pe-an-din-munca-la-negru-9676293
[45] See, for example, the distribution by city of the approx.. 300 tech start-ups on Romanian Startups, probably the most important platform for tech startups in the country (http://goo.gl/on850J).
[46] Andrada Fiscutean, "Childhood's end for Romania's startups", *ZDNet*, 21 Jan. 2015, available at http://goo.gl/h8zedF.
[47] Andrada Fiscutean, "Childhood's end for Romania's startups", *ZDNet*, 21 Jan. 2015, available at http://goo.gl/h8zedF.

and member organizations provide e-learning infrastructures for internship programmes. The cluster runs several projects funded under structural funds programmes (such as Brained City).

Several Romanian technology projects have received funding using US crowdfunding platforms. In 2014, five such projects managed to raise thousands of dollars on kickstrater.com or indiegogo.com. The highest amount (USD 95,000) was obtained from the platform kickstarter.com for a board game developed by NSKN Games.[48] While there are a number of domestic crowdfunding platforms,[49] most projects do not raise money and even those that do raise minor amounts for small arts projects or campaigns.

Similarly, the number of private sector sponsors of such events is steadily increasing, mainly as part of their CSR campaigns (Carrefour, Orange), but also through internal innovation programmes (Microsoft, Intel, Cisco).

There are only relatively few university spin-offs in Romania. This is not surprising considering the strong teaching orientation in Romanian universities.

5.3 Entrepreneurship skills and STEM policy

With general government expenditures on education (all levels) at 3.2% of GDP in 2014 (real allocated figure was around 3.5%), Romania ranks last in the EU. The figure is also a little above half of that mandated under the law (6%). The negative impact on the quality of education was demonstrated, among others, by poor results in PISA surveys. According to the 2012 PISA, Romania was the second worst performer in the EU28 in reading and science, and the third worst in Mathematics (European Commission, 2015).

The main challenges for the Romanian education system are early school leaving (rate of school leavers was 17% in 2013, against a 12% EU average); and the quality and labour-market relevance of higher education. In addition to the disconnect between higher education and the labour market, the efforts to strengthen vocational education and training and apprenticeships schemes remain feeble, after two decades in which these alternatives were progressively eliminated or marginalised. These problems are reflected in the high number of young people who are not in education, employment or training (youth unemployment reached 24 % in 2014, well above total unemployment level) (European Commission, 2015).

Romanian universities compete in a red ocean of high-income urban young students. Hence, "rural, poor and under-represented minority attainment in higher education is disproportionately lower than urban, higher income student attainment". According to the same source, "Romania has currently the highest proportion of graduates in the social sciences in the EU. In 2008, 72% of students graduated with degrees in soft disciplines, with 58% of Romania's graduates receiving degrees in the social sciences" (World Bank, 2014). More up-to-date official data on private higher education suggests a similar figure: between two thirds and three quarters of the students studied law or economics in the period 1997-2013 (INSSE 2015).

One of the causes of this state of affairs is an overly regulated system, in which "[i]nstitutions have little autonomy to make decisions at the programmatic and degree-granting levels" (World Bank, 2014), while "the funding model is not agile enough to provide incentives for modernization, efficiencies, innovation, or equity" (World Bank, 2014).

[48] Ioana Nita, "Proiecte româneşti de tehnologie care au primit finanțare pe platformele americane de crowdfunding în 2014" [Romanian technology projects with funding from American crowdfulding platforms in 2014], *Ziarul Financiar*, 30 Dec. 2014, available at http://goo.gl/hMA81BB

[49] http://multifinantare.ro, http://www.wearehere.ro, http://potsieu.ro and others.

Furthermore, there are no institutional incentives in higher education to either vocationalize academic curricula or to impart generic skills and competences, a situation which reflects the accumulation-focused primary and secondary education curricula. Academic education favours theory to the extent that the mandatory internships are mostly *pro forma*, in the softer disciplines and to some extent even in technical ones. In the latter case, technical universities do occasionally partner with big companies, primarily in fields such as technology and information, in order to adapt training. Entrepreneurship education, is rarely provided in a consistent way, if at all, in either schools or higher education institutions.

An aspect in which Romania has been doing better than the European average is the growth rate in new STEM graduates as a share of the relevant age population. With respect to new graduates (ISCED 5) in science and engineering per thousand population aged 25-34, the indicator has experienced a growth rate of 7.1 %, slightly above the EU, over the period 2007-2012.[50]

The National Qualifications Framework was adopted in 2013 (Government Decision 918/2013). With 573 qualifications described in terms of outcomes, it was developed in line with the European Qualifications Framework for Higher Education (World Bank, 2014). However, in tertiary institutions there remains a lot of formalism in adapting courses and curricula to qualifications and the accompanying competencies as defined in the National Registry of Higher Education Qualifications (RNCIS).

5.4 Access to finance

Venture capital and business angels networks

The venture capital (VC) market is underdeveloped in Romania. While there are seven visible venture capital providers on the market,[51] in 2013 Romania recorded only €3mn in venture capital investment. Furthermore, between 2007 and 2012 VC investments reportedly fell by some three quarters.[52] According to the European Commission, "[t]here is no appropriate regulatory framework, including investor and entrepreneur protection, for venture capital and other alternative sources of financing." (EC CR 2015).

There have been recent, but as yet relatively limited efforts to remedy some of the regulatory barriers. A law supporting business angels was adopted in April 2015 (the Law on stimulating individual investors – business angels). It sets out that income earned as dividends for shares acquired by individual transferees shall be tax exempt for a period of 3 years. Also, the positive difference between the sale price and the purchase price resulting from the transfer of ownership of the assignee's shares is exempt from tax, provided the transfer occurs no sooner than 3 years since acquisition. The range of investment is €3,000 to 200,000 and most sectors are eligible (exceptions are banking and financial services, real estate, steel industry, shipbuilding, the military, gambling, and consulting). The law's supporters estimated a number of 500 business angel investments during the first year after adoption.

Both the supply and the demand of VC are underdeveloped. On the one hand, the "local culture does not favour serial entrepreneurs. Most of the people who start a company never consider selling it. Moreover, highly educated young people tend to prefer a position in a multinational corporation because it is being perceived as more secure", while "the entrepreneurs tend to overrate the value of their business". According to the same source, "there is a lack of awareness related to the milestones that a company has to fulfil once it becomes part of a VC portfolio". On the other hand, "a trend analysis

[50] EC, Research and Innovation performance in the EU: Innovation Union progress at country level, 2014, p. 239.

[51] Advent International Romania (loans around $5 millions), AIG New Europe Fund (loans around $10m with refund rate of 35 %), Global Finance International Ltd. (loans $2-3m to companies with a turnover of minimum $6m), Danube Fund (provides loans between $0.5-2, refund rate of 30%), Environmental Investment Partners (loans $1-3m to the companies with minimum sales of $0.8m and 3 years of activity, refund rate 35%), ORESA Venture Romania (loans $1m), and Romanian Investment Fund (Cyprus) LTD.

[52] http://ec.europa.eu/enterprise/policies/finance/data/enterprise-finance-index/venture-capital/index_en.htm.

would showcase that, rather than seeing more international funds scouting for deals in Romania, we observe more and more Romanian entrepreneurs raising early stage financing directly abroad, after they have relocated their business to Western Europe or North America" (Cioara et al., 2013). A young entrepreneur noted, in the same spirit, that success stories of "Romanian origins" had to move to the UK or the US to access capital. "We've met some of the big funds. Their policy is usually: come to our country to get investment."[53]

Four Romanian banks – joined by a fifth the following year – signed on in 2014 to the JEREMIE initiative of the European Investment Fund (EIF). The amount available for 2014 was €120mn, in addition to two other JEREMIE instruments already on the market, under which 2,000 loans exceeding €180mn had been awarded.[54] The budget available for 2015 was increased to €250mn.

Catalyst Romania, a risk capital backed by private equity and venture capital firm 3TS Capital Partners, was also launched with funding (€10m) from JEREMIE. The first investments in technology-based companies were made in 2014, and included a few specialized web media and online service portals, social gaming, and telecom companies. Catalyst Romania targets SMEs active mainly in the technology and media sectors, providing investments in the range of €0.5-2mn. It has recently invested over €1mn to acquire a minority stake in Timişoara-based web-survey company 123ContactForm, and over €1.5mn in wearables company Vector Watch, to be used mostly for its R&D work in Bucharest. To his date, Catalyst Romania remains the most important growth and venture capital fund specifically dedicated to this country.

For the period 2014-2020, both the NS 2020 and the Strategy for SMEs provide for the creation, within the de minimis aid programme, of an investment fund with starting capital and seed capital for innovative entrepreneurs; as well as an investment fund with venture capital and growth capital for innovative start-ups.

For the period 2014-2020, the NS 2020 sets out the following measures aimed at the "Creation of a stimulating environment for private sector initiative": adopting procedures for the 50% tax deduction; establishing, within the de minimis aid programme, an investment fund with starting capital and seed capital accessible to innovative entrepreneurs; establishing an investment fund with venture capital and growth capital for innovative start-ups; creating, within the de minimis aid scheme, a credit system for innovative SMEs (microcredit, credits for current capital, and credit for development investments) with subsidised interest; creating an individual guarantee system available to innovative SMEs to cover the technological risk. Implementation plans are not available yet for any of these measures.

5.5 R&D related FDI

There is no official data on FDI for R&D. Research is included by the National Bank of Romania, which publishes periodic reports on FDI, in the broad category of "Professional, scientific, technical, and administrative activities and support services."

In general terms (not exclusively related to R&D), Foreign Direct Investments recovered somewhat after the drop in 2011, from a low of €1.7bn to €2.5bn in 2012 and €2.7bn in 2013. As mentioned previously, FDIs remain concentrated in the Bucuresti-Ilfov region (61.4% in 2013). The main FDI sectors in 2013 were manufacturing (31%), financial intermediation (14%), trade (11%), and energy (11%) (National Bank of Romania data for 2013).

Among the top 18 'leading innovators in the EU' showing the best R&D and economic performance, several engaged in FDI projects in Romania among other countries. Romania was the destination of over 6% of these FDIs in manufacturing, and almost

[53] Andrada Fiscutean, "Childhood's end for Romania's startups", *ZDNet*, 21 Jan. 2015, available at http://goo.gl/h8zedF.
[54] "Patru banci vor acorda IMM-urilor credite de 120 de milioane de euro cu dobanda redusa" [Four banks will grant Romanian SMEs low-interest loans], available at http://goo.gl/XRsZrI.

19% of the top companies' FDIs in business services, for almost 10% of their total FDIs (Hernández et al. 2014).

5.6 Knowledge markets

Until very recently, intellectual property rights were governed in Romania by a law passed in 1991, a Government Ordinance on R&D dating from 2002, and a more recent Government Decision (2008) updating some of the obsolete methodologies. Given the age of this legal framework and the time frame in which it was designed (barely 1 year after the change of regime in 1990), the laws were criticised for discouraging large-scale investments in R&D, triggering endless IPR conflicts between employers and their employees, leading to incoherent IPR policies in academia, and generally for being responsible for the low level of private investments in technological development and innovation.

The legal framework for the protection and sharing of intellectual property was considerably improved by Law no. 83/2014 on service inventions, which intends to clarify the rights of intellectual property revenue sharing between employers and their employees generating such inventions. The new law responds to complaints by various business actors, multinationals among them, regarding the limited flexibility of the previous legal framework. The rights of the employer are now better protected under the law, and therefore at least the legal barrier has been partly cleared.

Romania ratified the Unitary Patent in February 2013. Law 8/1996 on author rights was updated in 2014.[55]

There has been traditionally a large share of individual holders of national patents in Romania. Part of the explanation resides in the primarily reputational role of patents and other part in the until recently ambiguous IPR regime in the country. However, the number of individual patents has experienced a clear descending trend, while patents owned by universities and research institutes have increased in number as well as share of the total. Unfortunately, the number of patents granted to companies decreased by a factor of three over the last decade.

Table 5 Number of national patents by main owners 2001-2013

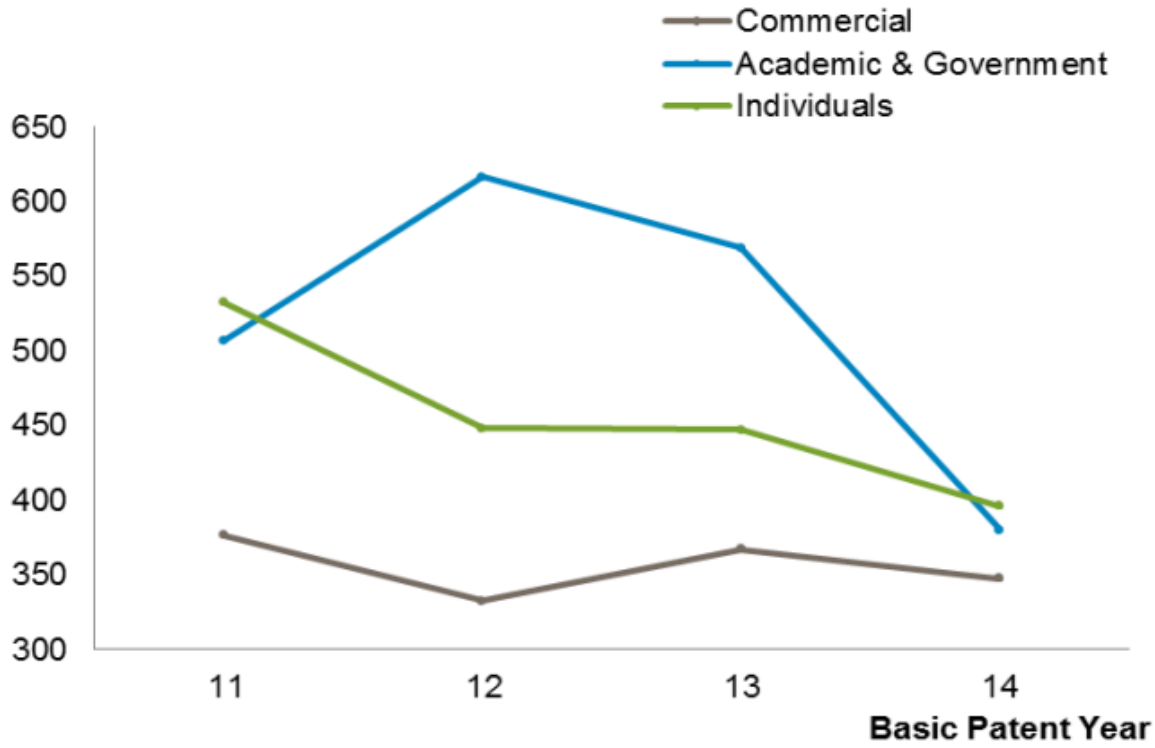
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Physical persons	591	377	599	423	461	528	282	327	391	307	223	216	117
Companies	252	159	205	156	210	174	153	110	140	89	97	88	70
Research institutes	50	38	28	24	36	33	31	55	137	62	67	90	142
Universities	29	14	20	14	14	6	4	18	66	89	87	83	77
Other	71	31	13	13	11	9	8	5	12	8	17	9	N/A
TOTAL	993	619	865	630	732	750	478	515	746	555	491	486	406

Data source: OSIM, 2013

[55] http://www.euroavocatura.ro/legislatie/1137/Legea_drepturilor_de_autor,_Actualizata_2014__Legea_8_1996.

According to a more recent analysis commissioned by UEFISCDI and carried out by Thomson Reuters's IP Analysis Unit, after 2011 some 37% of the new patented inventions are owned by academic and public entities (with one university strongly dominating the field), 35% by individuals, and 28% by the commercial sector (with Continental and Renault recently increasing patenting activity).[56] As suggested by the OSIM data, the number and share of inventions fluctuated substantially over the past years, however.

Figure 19 Patents



Source: Thomson Reuters IP Analysis (2015)

In terms of country of origin, 86% of the total set of applications was first filed in Romania, with the rest originating in the US (6%), with the EPO (3%), or in Germany (2%), France (1%) and other countries (2%).

The patenting activity in 2011-2015 is dominated by the Stefan cel Mare University in Suceava, with 2.3 times the number of patents of the second-ranking actor, another large regional university (Transilvania U. in Braşov). Among the top 20 patent generators there are 15 public entities, universities and research institutes specifically, and five multinational companies in automotive and IT. The latter account for a comparatively small share of the total set of inventions, but have somewhat intensified their patenting activity over the past two years or so.

However, the multinationals have geographically wide-spread invention portfolios, with a large share of their filings in the USA, WIPO, EPO and (presumably attributable to Renault) France. Virtually all Romanian entities have geographically restricted portfolios, with only five out of the 15 top-twenty organizations filing any applications outside Romania.

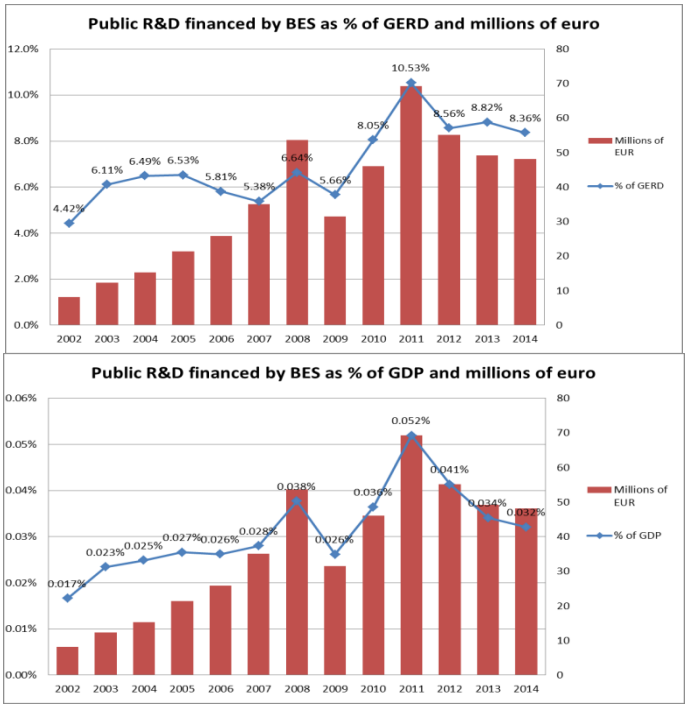
[56] The data set includes filings in Romania, filings with inventors and assignees with a Romanian address, and patents from Romanian public organizations and authorities.

5.7 Public-private cooperation and knowledge transfer

5.7.1 Indicators

Funding: publicly-performed R&D financed by business enterprise sector

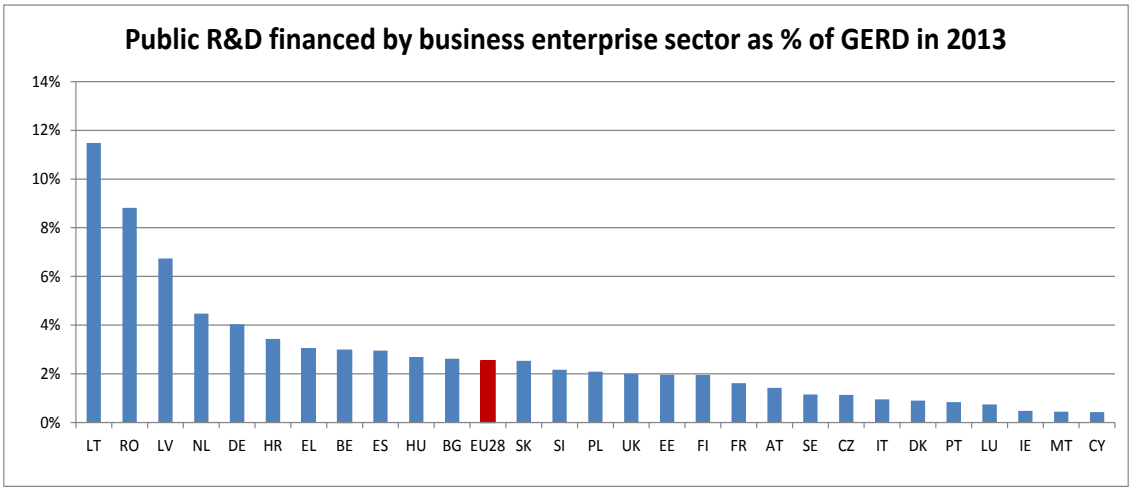
Figure 20 Public R&D financed by business enterprise sector in Romania as % of GERD (in €MLN) and % of GDP

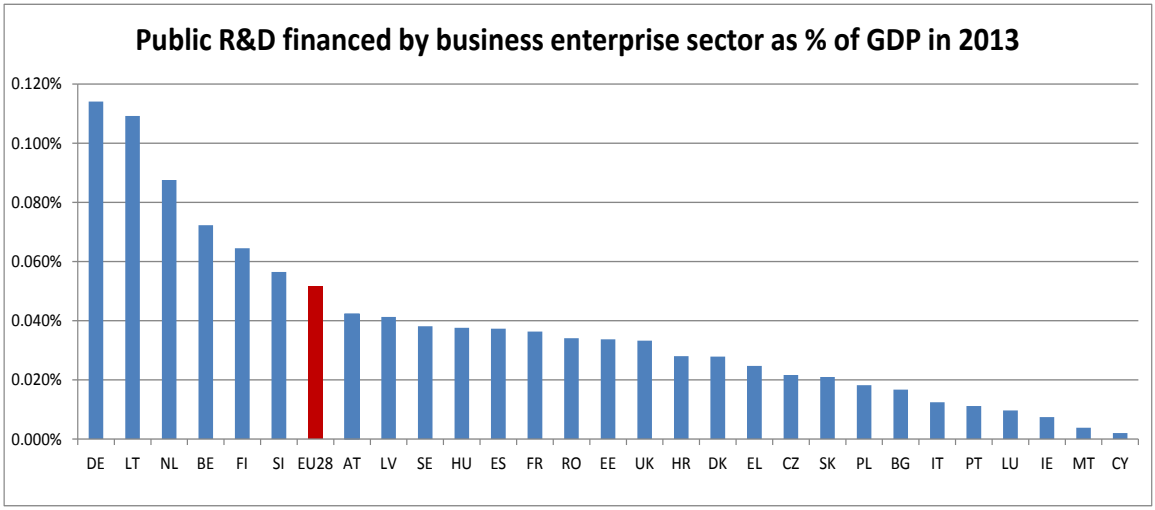


Source: Eurostat

The level of public R&D expenditure funded by the Romanian business enterprise sector (BES)- as a percentage of GERD increased considerably between 2008 (6.64%) and 2011 (10.53%), followed by a drop in 2012 (8.56%) and a subsequent minor rise in 2013 (8.82%) and a drop in 2014 (€48m, 8.36% of GERD).The indicator expressed as a percentage of GDP follows the same trend as the one expressed as a percentage of GERD, with the highest value 0.052% recorded in 2011. The upturn from 2008, 2009 and 2010 reflect the general rising trend of GDP growth in this period which has caused a subsequent increase in all the private investments including private investments in publicly performed R&D. However, this increase in private funding did not result in an overall increase in GERD.

Figure 21 Public R&D financed by business enterprise sector as % of GERD and as % of GDP in 2013 in Member States[57]





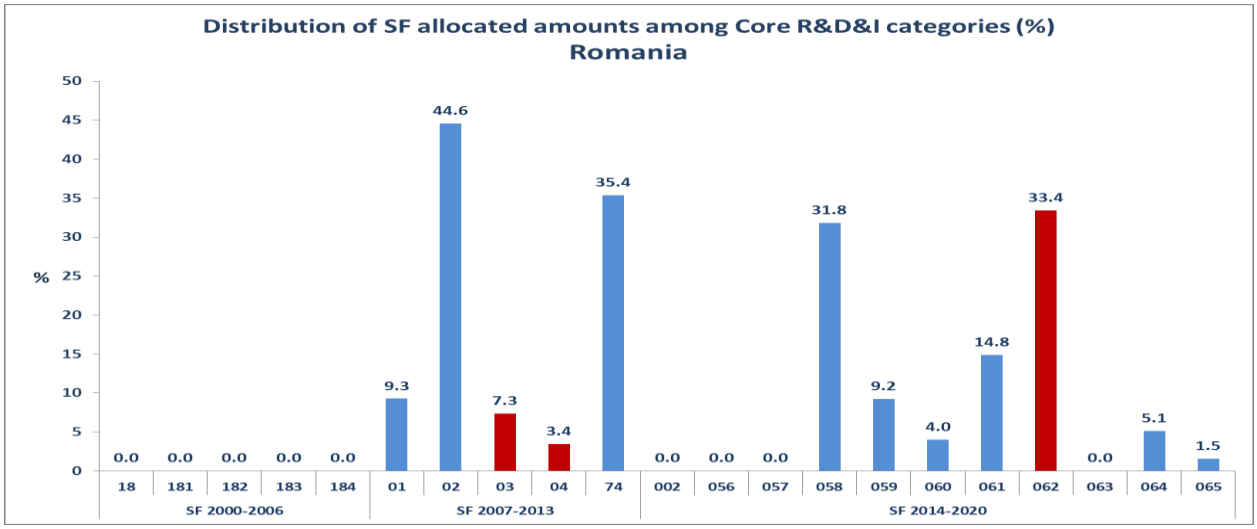
Source: Eurostat

The two charts in Figure 21 show the values of public R&D financed by BES in all EU-28 as percentages of GERD and GDP respectively. Romania's level is one of the highest among the EU-28 when expressed as percentage of GERD, however when expressed as percentage of GDP the level is well below the one of best performers and the EU-28 average. This difference is due to the fact that the Romanian R&I system is underfinanced. In 2013, the GERD was only 0.39% of GDP, the lowest among all the EU MS.

In general, the weak business-academia cooperation in Romania may have several sources on both demand and supply side. On the demand side, in Romania there is still a limited capacity for knowledge transfer caused mainly by the low interest and involvement of companies in research and development activities, including the cooperation with research institutions. This is complemented by the poor understanding of the need for quality control and certification, which leads to a low degree of conformity with advanced quality standards, a reduced interest in issues such as industrial and intellectual property and also an unclear perception about the advantages that the applied research provides to industry. On the supply side, there is a traditional low level of industry-academia relations, a lack of entrepreneurial culture and skills among researchers and a lack of bodies aimed at facilitating knowledge transfer.

[57] 2013 was chosen as the latest data series providing a full comparison within EU-28.

Figure 22 Structural Funds for core R&D activities 2000-2006, 2007-2013 and 2014-2020[58]



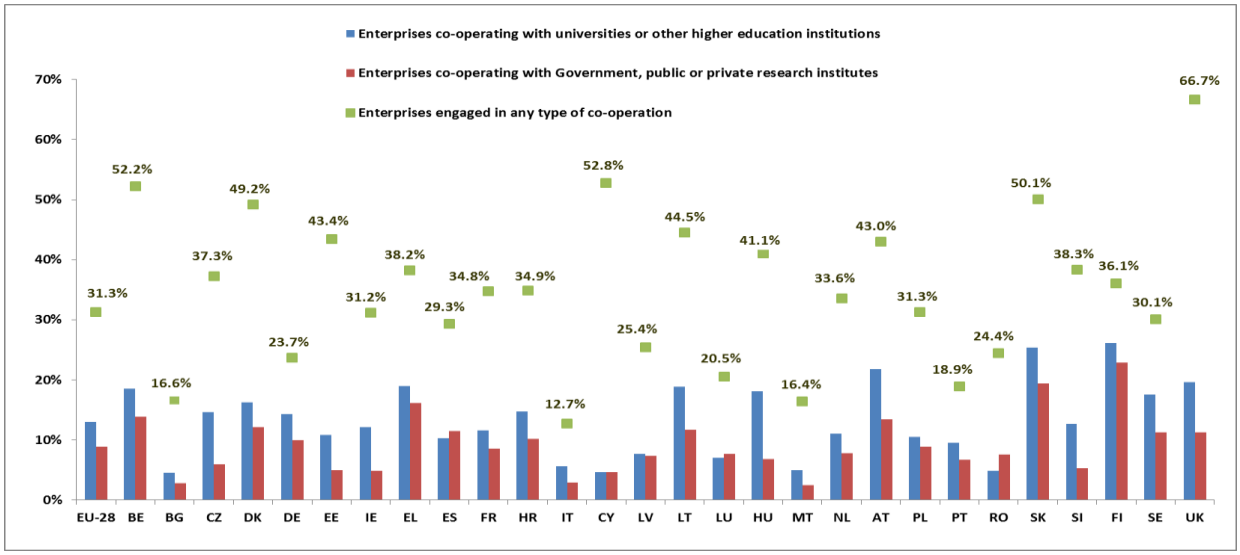
Source: DG Regional and Urban Policy, European Commission.

Note: *We use the categories: 182 (2000-2006), 03 and 04 (2007-2013) and 062 (2014-2020) as proxies for KT activities.*

Romania has allocated 33.4% of its structural funds for core R&D activities to "Technology transfer and university-enterprise cooperation primarily benefiting SMEs" in the 2014-2020 programming period, which is much higher than the EU average of 15.7% for the current programming period. In the programming period 2007-2013 it was 10.7%, which is low in comparison to the EU average of 30.1%.

[58] Figure 22 provides the Structural Funds allocated to Romania for each of the above R&D categories. The red bars show the categories used as proxies for KT. Please note that the figures refer to EU funds and they do not include the part co-funded by the Member State. The categories for 2000-2006 include: 18. Research, technological development and innovation (RTDI); 181. Research projects based in universities and research institutes; 182. Innovation and technology transfers, establishment of networks and partnerships between business and/or research institutes; 183. RTDI infrastructures; 184. Training for researchers.
The categories for 2007-2013 include: 01. R&TD activities in research centres; 02. R&TD infrastructure and centres of competence in specific technology; 03. Technology transfer and improvement of cooperation networks; 04. Assistance to R&TD particular in SMEs; 74. Developing human potential in the field of research and innovation.
The categories for 2014-2020 include: 002. Research and Innovation processes in large enterprises; 056. Investment in infrastructure, capacities and equipment in SMEs directly linked to Research and Innovation activities; 057. Investment in infrastructure, capacities and equipment in large companies directly linked to Research and Innovation activities; 058. Research and Innovation infrastructure (public); 059. Research and Innovation infrastructure (private, including science parks); 060. Research and Innovation activities in public research centres and centres of competence including networking; 061. Research and Innovation activities in private research centres including networking; 062. Technology transfer and university-enterprise cooperation primarily benefiting SMEs; 063. Cluster support and business networks primarily benefiting SMEs; 064. Research and Innovation processes in SMEs (including voucher schemes, process, design, service and social innovation); 065. Research and Innovation infrastructure, processes, technology transfer and cooperation of enterprises focusing on the low carbon economy and on resilience to climate change.

Figure 23 CIS survey 2012 – share of enterprises cooperating with academia



Source: Eurostat

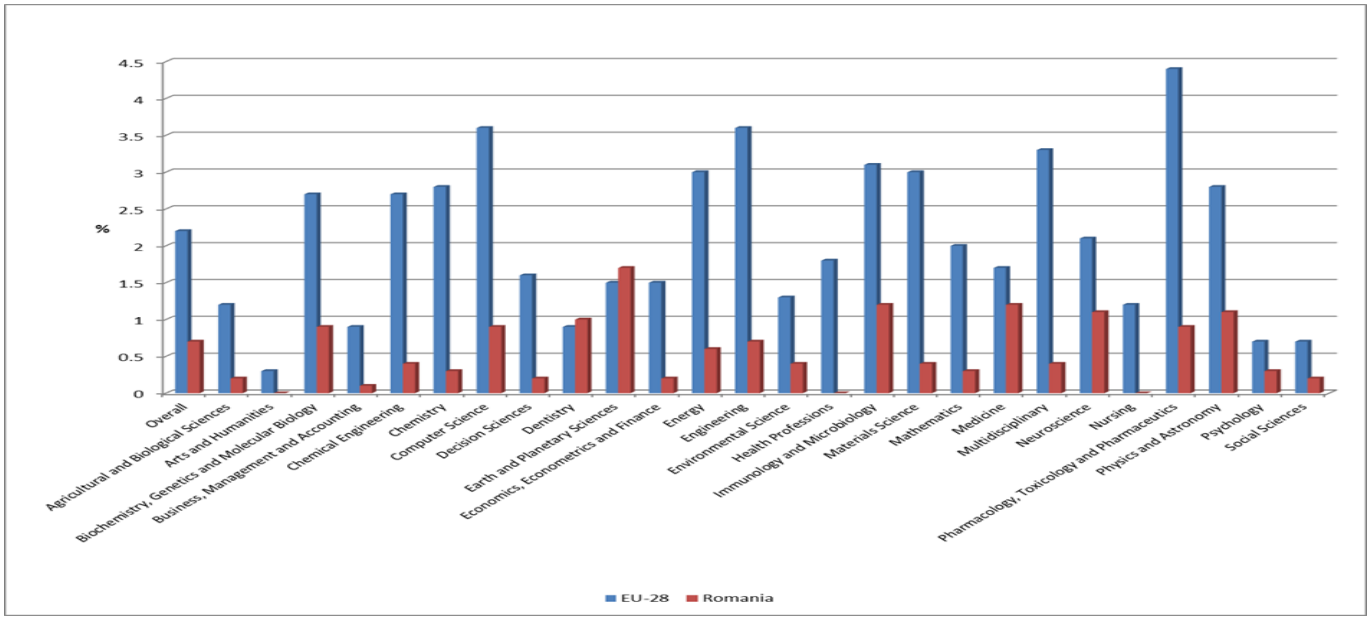
Figure 23 illustrates the level of cooperation activities of innovative companies in the EU-28, according to the CIS 2012. The percentage of "enterprises engaged in any type of co-operation" (green dot) in Romania is 24.4%, below the EU-28 average of 31.3%. One-fifth of them (4.9%) cooperates with universities and higher education institutions, compared to 4.5% in Bulgaria and 18% in Hungary. Slightly more – 7.6% cooperate with government or public or private research institutes, compared to 2.8% in Bulgaria and 6.8% in Hungary. Both indicators are below the values of the EU-28 average, which are 13.0% and 8.9% respectively. The latest Innovation Union Scoreboard ranks Romania as 'Modest innovator' (together with Bulgaria and Latvia) with an innovation performance well below that the one of the EU average.[59]

Technology Transfer Offices (TTOs), incubators and technological parks

The network for innovation and technological transfer (ReNITT) has 45 accredited entities, out of which: 12 technology transfer centres, 12 centres for technological information, 15 technological and business incubators, whereas 4 scientific and technological parks complement the ReNITT. The activities of these entities are still rather modest, but efforts are being made to enhance their institutional capacity by a project financed by structural funds and through the introduction of the profession of innovation manager into the national classification of occupations.

[59] Innovation Union Scoreboard 2015

Figure 24 Co-publications by field 2003-2013 in Romania



Source: Scopus database

Figure 24 shows the 2003-2013 average percentages of academia-industry co-publications by field in Romania compared to the European average. The percentage of co-publications almost did not change in the last ten years (2003-2013) with 0.6% of academia-business publications in 2013. Moreover, in 2013 Romania had only 3.9 public-private co-publications per million of population compared to 29 for the EU-28 (and 4.4 for Bulgaria, 12.8 for Hungary). The domains with highest percentage of co-publications, yet still far from the EU-average (excluding multidisciplinary publications), are earth and planetary sciences, medicine, immunology and microbiology, nanoscience and physics and astronomy. However, Romania has substantially lower rates of public-private co-publications than the EU average in all fields, except the Earth and Planetary sciences and Dentistry.

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

There has been traditionally a large share of individual holders of national patents in Romania. Part of the explanation resides in the reputational role of patents and part in the until recently ambiguous IPR regime. However, the number of individual patents has experienced a clear descending trend, while patents owned by universities and research institutes have increased in number as well as share of the total and the number of patents granted companies decreased by a factor of three over the last decade.

Companies

There is no available data on the total number of spin-offs and start-ups in Romania.

5.7.2 Policy measures

The public network for innovation and technological transfer (ReNITT) has 45 accredited entities, out of which: 12 technology transfer centres, 12 centres for technological information, 15 technological and business incubators. Four scientific and technological parks complement the ReNITT. The activities of these entities are still modest, but efforts are being made to enhance their institutional capacity though an SF-funded project and the introduction of the profession of 'innovation manager' in the national classification of occupations (UEFISCDI, 2012).

The National Strategy for Research, Development and Innovation 2014-2020 (NS 2014-2020) was adopted in October 2014. Under the NS 2014-2020, smart specialisation is supported through a mixture of instruments which cover a broad range of activities, from

the idea to the market, such as projects initiated by companies, competence centres and transfer infrastructure, and innovation incubators. Given the variety of PROs in Romania, the strategy also provides for the creation of a legal framework setting out clear, simple procedures and supporting initiatives aimed at merging public research organisations. At the same time, the NS 2020 supports actions for more strongly correlated investments in research infrastructure, and the concentration of doctoral and post-doctoral topics financed by structural funds around the smart specialisation fields.

For the period 2007-2013, the main inter-sectoral collaborations were supported by:

- The NP2 programmes Partnerships and Innovation. Several new instruments were launched in 2012 as part of the programme: support for high-tech export, development of products, systems and technologies (which received 88 applications cumulating over €45) and vouchers for innovation.
- The Operational Programme for RDI, where most of the projects are based on intersectoral collaboration.

For the period 2014-2020, the same type of project financing is supplemented by:

- Competence centres (NP3), meant to support longer term collaboration between PROs and business; and an inter-sectoral mobility programme.
- The technology transfer infrastructure supported through the Regional Operational Programme.
- Venture capital funds (NS 2020).

Legal and organisational framework

The knowledge transfer between industry and academia is primarily supported by:

- The National RDI Plan 2007-2013;
- The University in Society Summer Conference (UNISCO);
- The Sectoral Operational Programme on Increasing Economic Competitiveness (SOP-IEC);
- Programmes supporting research collaboration between national and foreign research organisations;
- Programmes supporting the participation of national teams in projects involving inter-governmental research infrastructures;
- Programmes supporting the individual mobility of researchers.

The National Strategy 2014-2020 sets targets in terms of activating the business sector and economic impact, following the Innovation Union Scoreboard indicators. The targets are ambitious in comparison with the situation, but for most of them the 2020 values are considerably lower than the EU average.

The Human Resources Programme of the 2007-2013 National RDI Plan has a few mobility schemes allowing PhD students to conduct innovation projects in firms, such as projects supporting the mobility of PhD candidates and post-doctoral research projects for the development of an independent career for young Romanian PhD researchers by granting them access to top research infrastructure.

In 2012, the Sectoral Operational Programme on Increasing Economic Competitiveness launched the first call for support to the development of 'Poles of Competitiveness' in Romania. The 'Poles of Competitiveness' are described as an association, in a defined geographic area, among undertakings, research centres and educational institutions engaged in collaborative partnership in order to generate synergies around a set of innovative projects aimed at one or more markets. Also, the priority axis 2 of this operational programme 'Promoting innovation in enterprises' supports the secondment of highly qualified personnel from research organisations to SMEs for a period of maximum of 3 years.

Within the RDI Operational Programme, where most of the projects are based on intersectoral collaboration, for the period 2014-2020 the same type of project financing is supplemented among other by competence centres, which are meant to support longer term collaboration between PROs and business and by an intersectoral mobility programme.

Law 120/2015 on stimulating individual investors – business angels was promulgated in May 2015, primarily in order to improve access to funding for SMEs. The law provides that income earned as dividends by individual transferees for acquired shares shall be exempt from tax for 3 years. Also, the positive difference between the sale price and the purchase price resulting from the transfer of ownership of the assignee's shares is exempt from tax, provided the transfer occurs after a period of 3 years since acquisition.

A draft law on public procurement introduces, for the first time, the concept of an "innovation partnership" for public institutions seeking innovative solutions that are not available on the market. Participation is open to all economic actors.

Conclusions

Romania is characterised by a modest level of public-private cooperation in R&D, as shown by the low level of business investments in publicly-performed R&D expressed as percentage of GDP, as well as by the percentage of innovative companies collaborating with HEIs and PROs. Technology transfer and entrepreneurship in universities are relatively recent activities and only the major universities have developed their own technology transfer offices. Technology transfer activities from universities to business firms are relatively limited due to low demand from industry and also a relatively weak offer from universities, but many universities are currently actively involved in strengthening their technology transfer capacity. Other critical problems are the degree of interaction between companies and public research performers and the low level of commercialisation of research results. The legal framework, the financial instruments to stimulate research activity and research results commercialisation, as well as the current fiscal incentives to foster innovation activities in enterprises could be further improved.

While the public innovation and technology transfer infrastructure is mostly outdated and limited in results, there have been signs of a healthier dynamics from the business sector. For the new cycle of Structural Funds, the challenge is to connect the funding to the interests of businesses and avoid formal clusters focused more on Structural Funds absorption than on raising innovation-based competitiveness.

5.8 Regulation and innovation

The authors were unable to locate any studies or analyses (or other policy actions) that examine specifically the impact of regulation on innovation.

5.9 Assessment of the framework conditions for business R&I

Romania improved substantially its ranking in the *Global Competitiveness Index* (GCI) from 78 in 2013-2014 to 56 in 2014-2015. Out of the 12 GCI pillars, the country exhibits strengths in macroeconomic environment, market size, and technological readiness, while its weakest point remains innovation. The most problematic barriers to doing business are, according to the GCI, access to financing, tax rates, the inadequate infrastructure, and corruption, although strides have been made in this last respect over the past years.

According to the *Global Innovation Index 2014*, where Romania occupies a similar position (55th), the country is better positioned in creative outputs (especially online, where it ranks 41), and displays significant problems in investment (rank 120), trade and competition (rank 116), and innovation linkages (rank 108).

Despite a stable recovery after the crisis and a relatively constant low level of unemployment, Romania still confronts structural challenges in poverty and social exclusion. The labour force has weak digital skills, while education, including higher education, is weakly connected to the needs of the economy. Participation in lifelong learning is at the lowest level in Europe.

According to the Romanian government's recent *Strategy for the SME sector*, there are currently a number of financial instruments for business from internal and external financing sources, but it is generally difficult for them to reach the SMEs. For example, various SMEs do not meet the eligibility conditions for European funds on projects, as they do not have the necessary funds to co-finance the project, their own obligatory participation of 15% of eligible expenditures can sometimes be a prohibitive amount.

The chief factors restricting growth in innovative companies are the limited availability of local capital and an absence of entrepreneurships culture. Many business ideas either never materialize or do so abroad due to missing funding opportunities. The changes on this front – such as a new law on business angels, funding lines for SMEs backed by JEREMIE, or a risk capital fund dedicated to Romania exclusively – are promising yet still too recent to assess in terms of outcomes.

Secondly, with poor entrepreneurial skills, which either higher nor secondary education provide systematically, there is little experience in pitching ideas, and in developing the business itself once the venture capital funds are obtained.

The renewal of the older IPR framework criticised for discouraging large-scale investments in R&D and generating conflicts between employers and employees, is equally relatively recent. The new law should respond better to the concerns of business companies. Whether this will really incentivise multinationals to substantially expand R&I activities in Romania is still too early to assess.

The same applies for the new tax deductions for R&D expenditures[60]. It was only in 2015 that the needed methodologies and clarifications were provided.

[60] The previous 20% tax deduction has proven to be somewhat unappealing, but the new 50% tax deduction has the potential to become a trigger for R&D activities in the business sector.

6. Conclusions

Meeting structural challenges

The policy mix in Romania related to the five identified structural challenges is discussed in Table 6, which lists relevant policy actions, assesses their appropriateness, efficiency and effectiveness, and provides links to relevant evidence (based on evaluations or empirical analyses).

Table 6. Policy measures addressing structural challenges in Romania.

Structural challenge	Policy actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
(1) Increase public R&I expenditure and the allocation of Structural Funds for R&D	The National Development Plans and the National Reforms Programmes and two of its Operational Programmes (OPs) provide strong arguments for increasing R&D resources; the R&I-oriented Plans and OPs also contain objectives and special instruments to achieve them.	The government has made progress in identifying the causes of structural weaknesses of the R&I system, but the implementation of the solutions is delayed and/or absent. Romania has the second lowest rate of Structural Funds (SF) absorption in the EU (62.2%). The implementation of the SF Programmes is significantly affected by the quality of governance which is determined by the administrative capacity, still weak in comparison to other European countries, by poor institutional coordination and fragmentation, frequent legislative and institutional changes, and by insufficient policy capacity. Between March and October 2010, the World Bank undertook six sectorial reviews on behalf of the Romanian Government. The reviews indicate that Romania has a poor institutional capacity at the central structure of the government to coordinate policies and resource commitments across sectors that would better align and achieve medium-term budgets and strategies.
(2) Improve the R&I governance	The National RDI Strategy 2014-2020 adopted in October 2014 provides for the creation of The National Council for Science, Technology and Innovation Policy (NCSTIP) to replace the National Council for Science and Technology Policy (NCSTP). Romania adopted a set of additional	Despite changes and improvements in policy formulation, there is a lack of coordination between the relevant policy actors, a fragmented institutional setting, and unpredictability at the level of the advisory councils of the MESR, unreliable funding, and a limited evaluation culture. The public R&I sector needs a reorganisation. The evaluations of the research institutions brought improvements to institutional mid-term strategies, but a comprehensive approach aiming at a possible concentration of institutional resources is still lacking.

Structural challenge	Policy actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
	strategies which include a broad range of innovation-related objectives and measures (e.g., for competitiveness, for the SME sector), but their resources and implementation plans remain unclear.	Broader coordination of innovation policies is still missing and important governance reforms are delayed. There has been no progress in building a regional system of innovation governance or regionalisation. The Assessment of the 2014 NRP and convergence programme shows there is a lack of formal coordination between the Innovation Strategy, Competitiveness Strategy, Industrial Policy Strategy and SMEs Strategy.
(3) Improve the framework for private investment in R&I and build synergies between science and industry	The National Strategy for Competitiveness 2015-2020, approved in September 2015, identifies several significant economic sectors with competitive potential. The National RDI Strategy 2014-2020 includes a smart specialisation piece. A 20% tax deduction was adopted in 2010 and was raised to 50% in 2013, but only in 2015 its implementation details were clarified. The National RDI Strategy 2014-2020 sets targets in terms of activating the business sector and economic impact, following the Innovation Union Scoreboard indicators. The Governmental Strategy for the SME sector and business environment was adopted in 2014. The Regional Operational Programme (ROP) and the Priority Axis 4 'Strengthening regional and local business environment' provides funding for regional and local business support structures.	The business sector shows signs of an increasing interest in innovation, as revealed by the emergence of hubs, especially in ICT. The tax deduction for R&D expenditures has the potential to become a powerful trigger for R&D activities in the business sector. The IPR legal framework was changed under the Law no. 83/2014. The law clarifies the rights of intellectual property revenue sharing between employees and their employers producing such inventions. Romania has shown limited progress in addressing the recommendation to ensure a better link between research, innovation and industry, in particular by prioritising research and development activities that have the potential to attract private investment. Some public-private cooperation initiatives, associated with the development of clusters, succeeded in gathering policy makers, public research institutions, big companies and SMEs. Well-targeted support measures would be helpful to support their further development. Despite the current scarcity of resources, Romania's performance on knowledge transfer might be improved provided that the necessary funds are allotted according to identified priorities. The main risks are mainly related to the implementation process. The overlapping of measures and programmes and the overlapping of the implementing agencies should be avoided.

Source: own.

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Abbreviations

ANES – Agency for Equal Opportunities for Men and Women (Agentia Nationala pentru Egalitatea de Sanse intre Femei si Barbati)
ABRDI – Advisory Board for Research, Development and Innovation (Colegiul Consultativ pentru Cercetare-Dezvoltare si Inovare)
BERD – Business enterprise expenditure on R&D
CNFIS – National Council Funding Higher Education (Consiliul National pentru Finantarea Invatamantului Superior)
EIF – European Investment Fund
ELI-NP – Extreme Light Infrastructure – Nuclear Physics
EPO – European Patent Office
ERRIS – Engage in the Romanian Research Infrastructure System (platform)
FTE – Full-time equivalent (researchers)
GERD – Gross domestic expenditure on R&D
GBAORD – Government budget appropriations or outlays for research and development
ISCED – International Standard Classification of Education
KT – Knowledge transfer
MESR – Ministry of Education and Scientific Research (Ministerul Educatiei, Cercetarii, Dezvoltarii si Inovarii)
MNC – Multinational company
NAPP – National Agency for Public Procurement (Agentia Nationala pentru Achizii Publice)
NASRI – National Authority for Scientific Research and Innovation (Autoritatea Nationala pentru Cercetare Stiintifica si Inovare)
NCSR – The National Council for Scientific Research (Consiliul National al Cercetarii Stiintifice)
NCSTP – National Council for Science and Technology Policy (Consiliul National pentru Politica Stiintei si Tehnologiei)
NP2 – National Plan for Research, Development, and Innovation, 2007-2013
NP3 – National Plan for Research, Development, and Innovation, 2015-2020
NRDI – National R&D institute (Institut national de cercetare si dezvoltare)
NRP – National Reform Programme (Programul National de Reforma)
NS2020 – National Strategy for Research, Development, and Innovation, 2014-2020 (Strategia Nationala de CDI)
NSPP – National Strategy on Public Procurement (Strategia Nationala de Achizitii Publice)
OP – Operational programme
OSIM – Romanian Patent Office (Oficiul de Stat pentru Inventii si Marci)
R&D – Research and development
RA – Romanian Academy (Academia Romana)
RDI – Research, development, and innovation
ReNITT – (Romanian) network for innovation and technological transfer (Reteaua Nationala pentru Inovare si Transfer Tehnologic)
RI – Research infrastructure
ROP – Regional Operational Programme
SF – Structural funds
SME – Small and medium enterprise
SOP-IEC – Sectoral Operational Programme on Increasing Economic Competitiveness (Programul Operational Sectorial Cresterea Competitivitatii Economice)
STEM – Science, technology, engineering, and mathematics
TTO – Technology transfer office
UEFISCDI – Executive Agency for Higher Education, Research, Development and Innovation Funding (Unitatea Executiva pentru Finantarea Invatamantului Superior, a Cercetarii, Dezvoltarii si Inovarii)
UNISCO – University in Society Summer Conference
VC – Venture capital
WIPO – World Intellectual Property Organization

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Annex 1 – List of the main research performers

Top public R&D performers (no. of publications, 2000-2013)

Note: Given differences in personnel numbers and structure, as well as in institutional funding allocations, the ranking below lists the top 7 universities and the 3 best-scoring NRDIs and, respectively, institutes of the Romanian Academy. (Data source: Zulean et al., 2015)

Bucharest Polytechnic University – 13097

University of Bucharest – 8556

Babes-Bolyai University, Cluj – 7888

Gheorghe Asachi Technical University, Iasi – 5177

Al. I. Cuza University, Iasi – 5127

Timisoara Polytechnic University – 4597

Technical University of Cluj – 4416

Horia Hulubei NRDI of Nuclear Physics and Engineering – 3701

NRDI for Laser, Plasma and Radiation Physics – 2569

NRDI for Materials Physics – 2408

Petru Poni Institute of Macromolecular Chemistry (Romanian Academy) – 2642

Ilie Murgulescu Institute of Physical Chemistry (Romanian Academy) – 1547

Simion Stoilow Institute of Mathematics (Romanian Academy) – 1471

Annex 2 – List of the main funding programmes

Name of the funding programme	Timeline	Budget	Target group
Programme NUCLEU	ongoing (no limit)	approx. €70m (2014)	National R&D institutes
Research Programme of the Romanian Academy	ongoing (no limit)	approx. €65m (2016)	Institutes of the Romanian Academy
Programme Ideas of the National RDI Plan 2007-2013	2007-2015	approx. €110m	R&D organisations, researchers
Programme Capacities of the National RDI Plan 2007-2013	2007-2015		R&D organisations
Programme Innovation of the National RDI Plan 2007-2014	2007-2015		Companies or consortia of companies and R&D organisations
Programme Partnerships of the National RDI Plan 2007-2013	2007-2015		Consortia of R&D organisations and companies
Programme Human Resources of the National RDI Plan 2007-2013	2007-2015		Researchers

Annex 3 – Evaluations, consultations, foresight exercises

Foresight for the elaboration of the National RDI Strategy 2014-2020 (adopted by Government Decision in October 2014). The elaboration was outsourced by the National Authority for Scientific Research to an outside consortium, which carried out the extensive, RIS3-aware foresight exercise in 2013 and early 2014. The process is described at www.cdi2020.ro.

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