European Commission

JRC SCIENTIFIC AND POLICY REPORTS

ERAWATCH COUNTRY REPORTS 2012: Romania

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2014

Report EUR 26276 EN

Joint Research Centre

European Commission
Joint Research Centre
Institute for Prospective Technological Studies

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JRC83910

EUR 26276 EN

ISBN 978-92-79-34518-0 (pdf)

ISSN 1831-9424 (online)

doi:10.2791/3977

Luxembourg: Publications Office of the European Union, 2014

Printed in Spain

ACKNOWLEDGEMENTS AND FURTHER INFORMATION

This analytical country report is one of a series of annual ERAWATCH reports produced for EU Member States and Countries Associated to the Seventh Framework Programme for Research of the European Union (FP7). ERAWATCH is a joint initiative of the European Commission's Directorate General for Research and Innovation and Joint Research Centre.

The Country Report 2012 builds on and updates the 2011 edition. The report identifies the structural challenges of the national research and innovation system and assesses the match between the national priorities and the structural challenges, highlighting the latest developments, their dynamics and impact in the overall national context.

The first draft of this report was produced in December 2012 and was focused on developments taking place in the previous twelve months. In particular, it has benefitted from the comments and suggestions of Mariana CHIONCEL from JRC-IPTS. The contributions and comments from DG-RTD are also gratefully acknowledged.

The report is currently only published in electronic format and is available on the ERAWATCH website. Comments on this report are welcome and should be addressed to jrc-ipts-erawatch-helpdesk@ec.europa.eu.

EXECUTIVE SUMMARY

Romania is the 7th largest country in terms of population in the EU (after Germany, France, UK, Italy, Spain and Poland) with 21.35m inhabitants in 2012 (Eurostat), which account for approx. 4.24% of the EU population. With one of the lowest GDP per capita in EU, Romania had registered high economic growth rates in the years before the recent crisis, followed by a dramatic drop in 2009 (-6.6%) and a slow recovery afterwards.

An intense political crisis had marked year 2012: after street protests, change in political power and attempted suspension of the President, it is only after the elections in December 2012 when the political tensions reduced. The new government introduced changes in its structure, among which the role of the former National Authority for Scientific Research is taken directly by the new Ministry of National Education, while a delegate Minister for Higher Education, Research and Technological Development has been created.

As a response to the economic crisis, Romania is one of the few countries that drastically reduced the public allocation for R&D, reversing the positive trend towards the Barcelona objective. Thus, GERD in Romania (0.48% of GDP in 2011, Eurostat) is four times lower than the EU27 average (2.03% of GDP in 2011, Eurostat). Same proportional gap exists in terms of number of researchers per general population (0.75 full time equivalent researchers per 100 inhabitants, while the EU average is approx. 3.16 in 2011)

The low level of the GERD is due to the low governmental contribution and even lower investment of the business sector (BERD 0.17% of GDP in 2011, Eurostat), which is relying mostly on technology acquisitions. The interest of the companies is even below the threshold of ensuring co-financing and the financial flow for structural funds projects (in the absence of a functional credit guarantee system), as proven by the limited participation rate in the innovation financing scheme (Axis 2 of the Competitiveness Operational Programme).

However the structural funds created important premises for the future transformation of the system. One is the decision for investment (total allocation of €356m, 83% from structural funds) in the large research infrastructure ELI-NP (Extreme Light Infrastructure- Nuclear Physics), which builds on the long tradition and human capital of Romanian nuclear physics. Other 57 public research infrastructures (with an allocated budget of over €350m) and 81 private infrastructures have been created or are under development with structural funds (POS CCE, Operation 2.2.1).

Another example is the massive support for doctoral and post-doctoral schools (the Sectoral Operational Programme "Development of Human Resources" has the target of supporting 12,000 PhDs and 2000 Post-docs), which contributes to the development of potential human resources for RDI.

Given the drastic reduction in funding for most of research programmes, one can estimate that recent infrastructures are underused, while the prospects for research career of the new PhD graduates are blurred. The long term underfinancing has already determined a substantial brain-drain, Romania having among EU countries one of the largest scientific diaspora, with an estimated 15,000 researchers working abroad (World Bank 2011, p21). While the new doctoral schools (funded by Structural Funds (SF)) provided generous financial support for its students, they already experience now difficulties for finding relevant jobs in Romania, becoming candidates for further enlarging the diaspora.

The public RDI sector is quite fragmented (with 264 PROs), while private research is undeveloped. The attempts to privatise some of the public institutes have been delayed, given the experience of the predominant interest of the investors in the real estate and other assets, rather than the continuation of the RDI activity.

The political support to Research and Innovation has been quite low. The National Council for Science and Technology Policy subordinated to the Prime Minster, which should be the coordination body across ministries, has never been operational (World Bank 2011). The role of establishing and implementing the RDI national strategy belonged to the National Authority for Scientific Research (NASR), which was subordinated to the Ministry of Education, Research, Youth and Sport.

The RDI Strategy 2007-2013, which is the first national RDI strategy, was elaborated based on a large future-oriented consultation. It has been conceived to consolidate the competitive project funding and the associated behaviour[1], to streamline the output of research towards international publication and patents, all under a rapid expansion of the research community (i.e. three times increase in order to converge with the EU average).

The National Plan 2007-2013 is the main implementation instrument, concentrating approx. 80% of the public expenditure for RDI, the rest being allocated to the Romanian Academy[2], and the branch academies (i.e. Academy of Medical Sciences, Academy of Forestry and Medical Sciences and Academy of Technical Sciences) and the sectoral plan of several ministries. The National Plan includes a series of programmes similar to FP7, currently implemented by the Executive Agency for Higher Education, Research, Development and Innovation (UEFISCDI), under the coordination of three councils (GD no. 133/2011): a) the National Council for Scientific Research for the programmes 'Human Resources', 'Ideas' and 'Capacities'; b) the National Council for Development and Innovation for the programmes 'Partnerships in priority domains' and 'Innovation'; and c) the Consultative Board for RDI for the programme 'Sustaining institutional performance'.

The Strategy and the Plan have been elaborated under the assumption of the Barcelona objective of a level of government appropriations for R&D of 1% of GDP by 2010, but in 2009 and later the Romanian GBOARD has been three times under the planned value. In response to the budget cuts, the 2009 'Plan to increase the efficiency and effectiveness of RDI expenditure'[3] introduced a funding re-prioritisation, which basically supports the participation of Romania in international programmes, the core financing for the national R&D institutes, leaving little room for new grants (for which the procedures, including evaluation, have been constantly improved).

As a consequence, the systemic targets from the Strategy (e.g. increasing by a factor of three the number of researchers, and by a factor of 10 the number of patents) have been *de facto* abandoned. Also, many of the financing instruments (especially the innovation-related ones) have either been suspended or introduced very late (in 2012).

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[1] The project funding had been introduced by the Research Excellence Programme in 2005.

[2] The Romanian Academy has 52 institutes and 17 research centres, which are financed partially by the state budget, partially from own resources (including competition based grants from the National Plan). The institutional allocation for the Romanian Academy represented 13.8% of R&D public budget in 2010 (NASR, 2010). In quantum the allocation marked a slight increase in the years 2010-2012 despite the general public budget cuts, but the trend is reversed for 2013 (when the allocation is of only 8.3% of the total public budget)

[3] See PROGRESS REPORT regarding the fulfilment of the structural reform conditionalities of the MEMORANDUM OF UNDERSTANDING BETWEEN THE EUROPEAN COMMISSION AND ROMANIA, for the Third Loan Instalment, Chapter 6. Increase the efficiency and effectiveness of public R&D spending, while ensuring adequate funding for ongoing research projects and programmes, MAY 2010

The research output in terms of international scientific publications has been on the rise over the last decade and has recorded a significantly higher growth rate over 2000-2008 than the EU-27 average (13.9% Romania vs. 5.1% EU-27) (European Commission 2011, p. 139). The boom of Romanian journals indexed in Web of Science (from 8 journals in 2005 to 62 ISI indexed of which 56 ISI journals in 2013) can explain only partially this increase (the weight of ISI articles in Romanian journals accounts for 34% in 2012, compared to 28% in 2005). Therefore, the bulk of the increase (i.e. a growth rate of 171% in terms of ISI articles for 2008-2012) has been most likely generated by the request of publication output for grants financed by the national research programmes, by the increasing weight of WoS-indexed publications among the promotion criteria both in higher education and in research institutes, by the financial awards for ISI publication granted under the National RDI plan (which may have generated that researchers performing research activities abroad were encouraged to use co-affiliation the Romanian institution in which they are based).

The scientific production by institution type, measured as the ratio of ISI articles per 100 staff, is concentrated in state universities (59% in 2011), followed at a large distance by the Romanian Academy, national R&D institutes, and medical institutions (with 18%, 18% and 2% respectively), while private universities account for only 0.57% (Ad Astra 2011). The country's S&T specialisation, as reflected by the Revealed Scientific Advantage (RSA),[4] is concentrated in Materials Sciences, Mathematics, Physics and Astronomy, Chemical Engineering and Chemistry (World Bank, 2011).

The ISI publication subject areas for which Romania has Impact Relative to Country/Territory more than 1 in the period 2007-2011 are: Physics (Nuclear, Atomic, molecular, Particles and fields, Condensed matter) , Chemistry (Inorganic and nuclear, Physical, Analytical), Instruments and instrumentation, Polymer science, Nanoscience, Mechanics (data source InCites, accessed March 2013).

Seven competences can also be identified based on articles published in the Scopus indexed journals in 2006-2010: (1) Fluids; Heat transfer; Porous materials; (2) Manifold; Metric; Submanifolds; (3) Membranes; Formal languages; Models; (4) Glass; Ions; Paramagnetic resonance; (5) Nuclei; fission; barriers, (6) Polymers; Azobenzene; Polyimides; (7) Lasers; Pulsed lasers; Kinetics. (Data source Scival Spotlight, accessed March 2013).

While in terms of publications the Romanian output is comparable to the EU average, the value of the PCT patent applications is only 4% of the EU average, with a decreasing trend (IUS 2011). This suggests that the system is simply not focused on delivering such output. Moreover, the applications for national patents are in a very high proportion individuals (45% in 2011), a situation explainable both by the often mainly reputational role of patents, as well as by the ambiguous IPR regime in Romania.

Considering the GERD level and the disconnect of research with the socio-economic environments, the World Bank's 2011 Functional Review concludes that "Romania's RDI sector is in a silent crisis, with seriously negative implications for the country's longer term competitiveness and growth prospects... Romania's government and private sector are investing too little in RDI, and, perhaps as importantly, often investing it poorly" (p. 7).

At system level five interrelated main challenges can be identified:

[4] Defined as the share of a country in documents in a given subject area, divided by the country's share of all documents published (World Bank, 2011).

1) *The RDI system is chronically underfinanced.* Not only is the GBOARD very low, it is also not compliant with the official targets, creating instability and unpredictability in the system, both for organisations and individuals. This also creates unbalance in the system between, for instance, the large investment in research infrastructure and human capital and the low financing of the projects afterwards.

2) Business sector is not innovation ready. The underlying factors for this situation need to be seen in a larger time perspective: starting with the huge technological gaps Romania faced after the end of communism (which included unlike other communist countries a decade of restricted imports of technologies), the strong structural transformations afterwards (with the decay of heavy industry and textiles), the difficulties of recapitalisation when faced with reluctant FDIs (in the context of delayed market economy in the 90's), and the limited credit for investment. Currently, the economy is dominated by low tech industry and the interest for innovation still fades when compared with the opportunities of technology acquisitions. Activating private interest for RDI requires a policy mix for innovation (including IPR, clusters, taxation, education and skills, public procurement of innovation, pre-commercial public procurement etc) beyond the scope of the National RDI Plan or even the structural funds for innovation.

3) *Academic orientation of the research supply.* After a decade of almost complete autarchy in the RDI system, the National RDI Plan 2007-2013 aimed at focusing RDI towards clear outputs in terms of international publications and patents. While the increase in R&D intensity in 2007 and 2008 produced a remarkable change of behaviour in term of publication, the connection with the economic sector has not been achieved yet. The underlying factors are connected to: a) the predominant educational orientation of universities; b) the structural gaps between the national R&D institutes and the current economy; c) the undeveloped science-society dialogue, which result in underuse of socio-economic research capabilities. The technological transfer infrastructure is not only underdeveloped, but also confronted with an undersupply of technologies to transfer. Under these conditions, the most successful connections are to the international scientific communities, as it is for instance the case of nuclear physics.

4) *The RDI system is fragmented.* A large number of PROs (39 research institutes, 109 universities, many research centres) having mostly a subsistence strategy populate the Romania RDI system, while at national level there are no strong anchors in terms of socio-economic objectives with proper political commitment, for stimulating or imposing a restructuring with a thematic (or any other form of) concentration. Hence, the main efforts are administrative, such as better evaluation, while the incentives for concentration remain low (e.g. the recent option for public institutes to join universities). The results are reflected also in the incapacity of reaching critical mass.

5) *High brain-drain and not enough brain-circulation.* Despite the relatively low weight of tertiary education graduates in total population, the supply of PhDs and post-docs is much higher than the capacity of absorption in the public and private R&D organisations or in public institutions (in view of public procurement for innovation) under current settings. The efforts made for mobilising the diaspora[5] had only a very limited impact, given the uncertainties in funding, the high bureaucracy and the difficulties of access in PROs.

The preparation of next planning cycle has begun in 2012. The general principles for the new cycle include the correlation of the smart specialisation strategies and the National RDI strategy 2014-2020 around a reduced set of priorities under the requirement of increasing the socio-

[5] www.romaniainoveaza.ro

economic impact (see Prisecaru 2012, Gheorghe 2012, Resiga 2012). NASR has launched a preparatory project for the identification of smart specialisations, which will provide the first results in March 2012. Also, starting January 2013 a large foresight-based, ten-month project has been launched for the Elaboration of the National Research, Technological development and Innovation Strategy 201-2020 with the associated Plan (which manages the public funds for RDI). The project will also provide recommendations for the structural funds axis dedicated to innovation.

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1 INTRODUCTION

Romania is the 7th largest country in terms of population in the EU (after Germany, France, UK, Italy, Spain and Poland) with estimated 21.35m inhabitants in 2012 (Eurostat), which account for approx. 4.24% of the EU population. The GDP per capita is one of the smallest in EU (€5800 in 2010, Eurostat). The average GDP hides also large discrepancies between the eight regions, Bucharest registering more than double GDP per capita compared with the next region (i.e. West Region and four times as the region with the lowest level (i.e. North East) (2010, NIS data).

The structure of the economy is considerably different from the EU average, as agriculture represents 32.6% of employment[6] (compared to 5.3% EU average), services only 39.2% (compared to 71.9% EU average), while the employment in manufacturing is slightly closer to the EU average (28.3% compared to 22.9%) (Eurostat data 2011).

Four branches cumulate half of the Romanian industrial production: coke and petroleum (14%), food products (13%), motor vehicles (13%) and metallurgy (10%). Other relevant branches include: metal products (5%), rubber and plastic (5%), machinery and equipment (5%), electrical equipment (3.5%) and computers and optical equipment (3.5%) (NIS data, 2011). The main high-tech fields in Romania (i.e. electronics, ICT, biotechnology and measurement equipment) have registered good results including in the period 2009-2010 (Cojanu et al 2012)

GERD in Romania (0.48% in 2011, Eurostat) is four times below the EU27 average; the number of researchers per population indicates the same proportional gap (0.75 full time equivalent researchers per 100 inhabitants, while the EU average is approx 3.16 in 2011). Thus the entire system is dramatically under-dimensioned in relation with the country. A first implication of this situation is that the system may lack critical mass for becoming a real driver of economic competitiveness. A second implication is that while the scientific output of the system may seem very modest, it needs to be considered in relative terms.

Long term underfinancing has determined a substantial brain-drain. Romania is one of the countries with the largest net-losses of researchers and doctoral candidates caused by unattractive conditions in the labour market for researchers (European Commission, 2011). Therefore, Romania has one of the largest scientific diaspora among the European countries, with an estimated 15,000 Romanian researchers under foreign affiliations (World Bank 2011, p21).

The low level of GERD is the result of both the governmental contribution, which failed to follow the Barcelona targets (with a temporary increase in 2007 and 2008), and by the even lower investment of the business sector, which - with few exceptions - is relying mostly on imported technologies. The interest of the companies is even below the threshold of ensuring co-financing for structural funds projects, as proven by the limited participation rate in the innovation financing scheme (Axis 2 of the Competitiveness Operational Programme).

6 The employment includes "persons who during the reference week performed work, even for just one hour a week, for pay, profit or family gain" (Eurostat) In agriculture only a small fraction of employment (1/7 acording to Albu et al, 2012) are employees, the rest being family workers, self-employed or employers.

However, the structural funds created important premises for the future transformation of the system. One is the decision to invest (total allocation of €356m, 83% from structural funds) in the large research infrastructure ELI-NP (Extreme Light Infrastructure - Nuclear Physics), which builds on the long tradition and human capital of Romanian nuclear physics. Other 57 public research infrastructures with an allocated budget of over €350m have been created and more than 50 private infrastructures are under development funded from structural funds (POS CCE, Operation 2.2.1).
Another example is the massive support for doctoral and post-doctoral schools (the Sectoral Operational Programme "Development of Human Resources" has the target of supporting 12,000PhDs and 2,000 Post-docs), which contributes to the development of potential human resources for RDI. Unfortunately, for the moment, the access of these graduates into the R&D system is quite low, given the scarcity of projects and the restrictions on employment in the public sector, thus favouring even further brain-drain.

RDI has been quite low on the list of government priorities. While *de jure* there is a National Council for Science and Technology Policy subordinated to the Prime Minster, this council has not been made operational (World Bank 2011). The role of establishing and implementing the RDI national strategy belonged to the National Authority for Scientific Research (NASR), which was subordinated to the Ministry of Education, Research, Youth and Sport. Very recently (December 2012) that NASR has become part of the new Ministry of National Education, a measure associated with the creation of a delegate Minister for Higher Education, Research and Technological Development.

The RDI Strategy 2007-2013 has been elaborated based on a large foresight consultation. The National Plan 2007-2013 is the main implementation instrument, concentrating approx. 80% of the public expenditure for RDI, the rest being allocated to the Romanian Academy, the branch academies and the sectoral plans of several ministries. The National Plan includes a series of programmes mirroring the FP7 programmes, currently implemented by the Executive Agency For Higher Education, Research, Development and Innovation (UEFISCDI), under the coordination of three councils (GD no. 133/2011): a) the National Council for Scientific Research for the programmes 'Human Resources', 'Ideas' and 'Capacities'; b) the National Council for Development and Innovation for the programmes 'Partnerships in priority domains' and 'Innovation'; and c) the Consultative Board for RDI for the programme 'Sustaining institutional performance'.

The financing lines of the Plan are project-based and open for competition for all R&D units and companies. However, institutional funding is also available at national level. While the Programme 'Sustaining institutional performance' has not been implemented, the already existing Nucleu programme has continued, providing institutional support for national R&D institutes (approx. 25% of the NASR budget). The institutes of the Romanian Academy also receive exclusive access to financing under the priority programme of the Romanian Academy. Universities do not receive explicit research financing, but in the new system based on evaluation, research is a dominant indicator.

The Strategy and the Plan have been elaborated under the assumption of the Barcelona objective of governmental appropriations for R&D of 1% of GDP, but the crisis interrupted the initial planning and, in 2010, Romanian GBOARD was three times under the planned value. As a consequence, the systemic targets (e.g. increasing by a factor of three the number of researchers, and by a factor of 10 the number of patents), have been *de facto* abandoned. Also, many of the financing instruments (especially the innovation related ones) have either not been implemented, interrupted or introduced very late (in 2012).

The research output in terms of international scientific publications has been on the rise over the last decade (Table 1) and has recorded a significantly higher growth rate over 2000-2008 than the EU-27 average (13.9% Romania vs. 5.1% EU-27) (European Commission 2011, p. 139). The boom of journals from Romania indexed in Web of Science (from 8 journals in 2005 to 62 ISI indexed, out of which 56 ISI journals in 2013) can explain only a part of this increase (as the weight of ISI articles in Romanian journals accounts for 34% in 2012, compared to 28% in 2005). Therefore, the bulk of the total increase (i.e. a growth rate of 171% in terms of ISI articles for 2008-2012) has been most likely generated by the request of publication output for grants financed by the national research programmes, by the increasing weight of WoS-indexed publications among the promotion criteria both in higher education and in research institutes, by the financial awards for ISI publication granted under the National RDI plan (which may have generated that researchers performing research activities abroad were encouraged to use as co-affiliation the Romanian institution in which they are based).

Table 1 : Number of journal articles with Romanian authors indexed in ISI and Scopus during 2002-2012

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
ISI-indexed	2,148	2,196	2,328	2,548	2,950	4,025	5,340	6,348	6,875	6,761	6926
out of which in Romanian journals	436	512	527	710	886	1,631	2,543	3,239	3,353	2,868	2419
Percentage of papers published in RO ISI journals	20.30 %	23.32 %	22.64 %	27.86%	30.03%	40.52%	47.62%	51.02%	48.77%	42.42%	34.93%
Scopus-indexed	2,116	2,209	2,331	2,603	2,976	3,622	5,378	7,188	7,712	8,503	8,346
out of which in Romanian journals	686	638	705	860	845	1,097	2,279	3,468	3,655	3,976	3358
Percentage of SCOPUS indexed papers published in RO journals percentage	32.42 %	28.88 %	30.24 %	33.04%	28.39%	30.29%	42.38%	48.25%	47.39%	46.76%	40.23%

Data source: InCites for ISI-indexed and Scival for Scopus-indexed, retrived 8 April 2013.

The number of cites per ISI indexed publications for the period 2002-2011 has been only 4.02, compared with an world average of 9.81 and EU27 average of 10.68 (data source: InCites). Also, the number of international co-publications with other European countries is one of the lowest in Europe (European Commission 2013).

The country's S&T specialisation, as reflected by the Revealed Scientific Advantage (RSA)[7] is concentrated in Materials Sciences, Mathematics, Physics and Astronomy, Chemical Engineering and Chemistry, and is less strong in ICT, Health, Earth Sciences, or humanistic and social research, although these latter fields receive larger financial support from the 2007-2013 National

[7] Defined as the share of a country in documents in a given subject area, divided by the country's share of all documents published (World Bank, 2011).

RDI Plan. This is a consequence of the fact that in Romania the science/research system has grown independently of the production system and most of the public funding is not targeted towards the fields where Romania could consolidate its current and potential comparative advantage (World Bank, 2011).

The ISI publication subject areas for which Romania has Impact Relative to Country/Territory more than 1 in the period 2007-2011 are: Physics (Nuclear, Atomic, molecular and chemical, Particles and fields, Condensed matter) Chemistry (Inorganic and nuclear, Physical, Analytical), Instruments and instrumentation, Polymer science, Nanoscience, Mechanics (data source InCites, accessd March 2013, see Annex 1 for details).

Seven competences can also be identified based on articles published in tha Scopus indexed journals in 2006-2010: (1) Fluids; Heat transfer; Porous materials; (2) Manifold; Metric; Submanifolds; (3) Membranes; Formal languages; Models; (4) Glass; Ions; Paramagnetic resonance; (5) Nuclei; fission; barriers, (6) Polymers, Azobenzene; Polyimides; (7) Lasers; Pulsed lasers; Kinetics. (Data dource Scival Spotlight, accessed March 2013, see Annex 2 for details).

The scientific production by institution type, measured by the ratio of ISI articles per 100 staff, is concentrated in state universities (59% in 2011), followed at a large distance by the Romanian Academy, national R&D institutes, and medical institutions (with 18%, 18% and 2% respectively), while private universities account for only 0.57% (Ad Astra 2011). While for publications the Romanian output is comparable to the EU average, in what regards the PCT patent applications, the value for Romania is only 4% of this average, and with a decreasing trend (IUS 2011). This situation suggests that the system is simply not focused on delivering such output yet. Moreover, for the period 1990-2008, more than half of the applications are concentrated in 9 companies: EximProd Grup (22), Biotehnos (20), Institutul de Stiinte si Proiectari energetice (20), Turbomecanica (15), Electromagnetica (10), Condmag (9), Antibiotice (8), Policolor (7).

Table 2: EPO patents

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Patent applications	7	4	10	8	16	16	17	16	14	21
Granted patents	3	2	0	5	4	4	7	4	3	2

Source: European Patent Office.

The national patents have traditionally a very high proportion of physical persons as owners, a situation explainable both by the primarily reputational role of such patents and by the ambiguous IPR regime in Romania. However, the number of such patents has a clear descending trend, while the patents owned by universities and research institutes improved. Unfortunately, the number of patents granted to companies decreased by a factor of three in the last decade.

Table 3: Number of national patents by main owners 2001-2012

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

Data source: OSIM

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. Four scientific and technological parks complement 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[8] and through the introduction of the profession of "innovation manager" into the national classification of occupations. (UEFISCDI 2012)

Considering the GERD level and the disconnect of research with the socio-economic environments, the World Bank's 2011 Functional Review concludes that "Romania's RDI sector is in a silent crisis, with seriously negative implications for the country's longer term competitiveness and growth prospects... Romania's government and private sector are investing too little in RDI, and, perhaps as importantly, often investing it poorly" (p. 7).

The percentage of students in the 18-25 population almost converged to the EU27 average in 2010. However, given the very low base in the 90's and the low enrolment of older adults, the share of the population with tertiary education remains considerably below the EU average. More recently, higher education has been confronted with a substantially decreasing cohort of students given the new standards for the secondary level graduation, the *bacalaureat* (a 46% graduation rate in 2011 and 40% in 2012, compared to rates of over 80% only 4 years ago). As response to this situation, the Government has launched a debate for the introduction of the "professional bacalaureat", which would not provide access to higher education but facilitates the entrance on the labour market.

Student enrolments by field in 2011 were highest in economics (21.2%), university-pedagogy (26.3%), technical sciences (28.3%) and law (12.5%), and lowest in medicine & pharmacy and artistic fields (5.4% and 1.1%, respectively) (NIS, 2012).

The public RDI sector is quite fragmented: 39 National R&D institutes[9]; 52 institutes and 17 research centres under the Romanian Academy; 23 institutes and 12 clinics under the Academy of Medical Sciences 23 institutes and 91 research and production centres under the Academy of Agriculture and Forestry Sciences; alongside 55 public and 54 private universities. The attempts to privatise some of the public institutes have been delayed, given the experience of the predominant interest of the investors in the real estate and other assets, rather than the continuation of the RDI activity[10].

As traditionally research has been concentrated in research institutes, the universities are relatively new players in this field, with very few full-time researchers. Still, universities are highly competitive on the national RDI calls, given both their limited resources and the increasing pressure for publication in institutional evaluations and in academic promotion.

[8] With a budget of €4m, the project is financed under the Operational Programme "Developing Administrative Capacity (PO DCA), intervention field 1.2. Increase responsibility in public administration The project site is http://www.romaniainoveaza.ro/

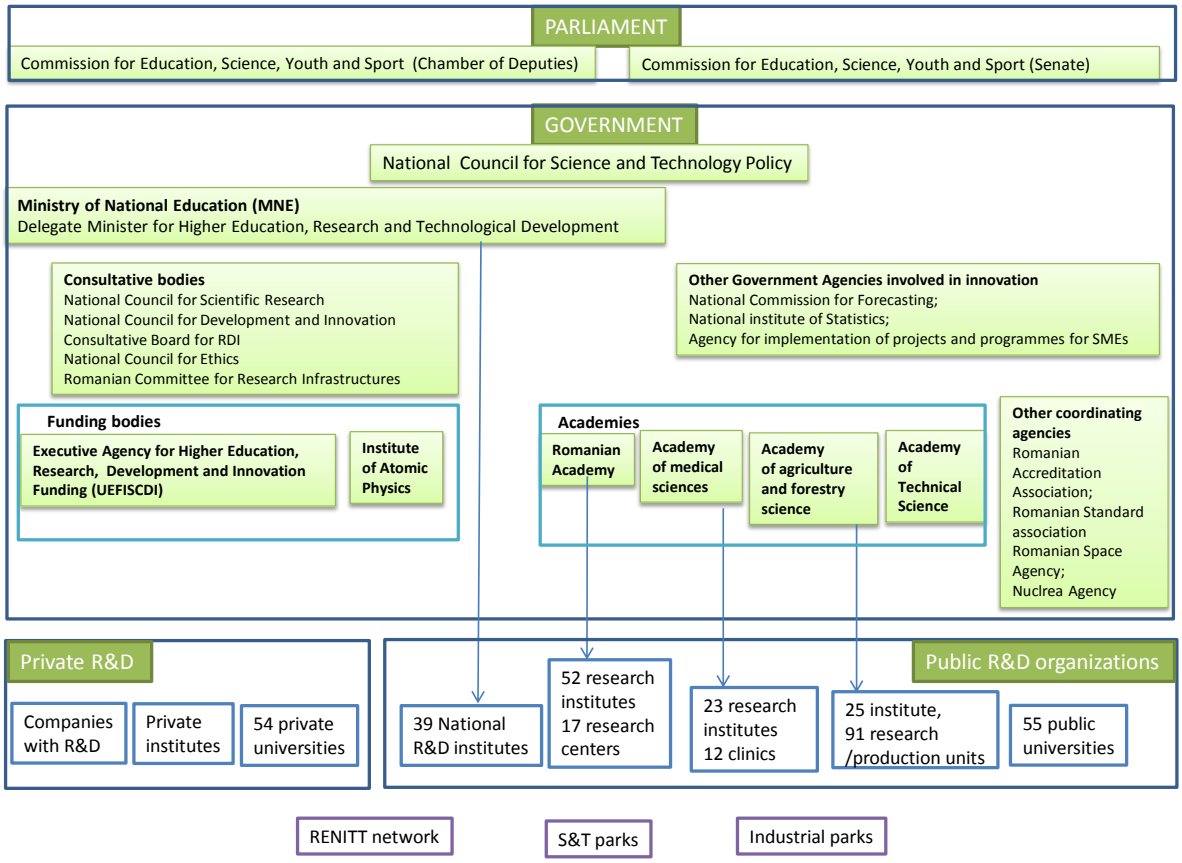
[9] All the National R&D institutes are in the process of subordination to the Ministry of National Education, many of them being for a long period subordinated to different ministries: 17 subordinated to NASR, 8 to the Ministry of Economy, 7 to the Ministry of Agriculture and Rural Development, 2 to the Ministry of the Information Society, 2 to the Ministry of Labour, Family and Social Protection, 2 to the Ministry of Health and one to the Ministry of Environment and Climate Change.

[10] A notorious case is represented by the privatization in 2003 of the Institute for Food Research, where the value of land is estimated to be 30 times larger than the one actual paid. (www.ziare.com)

56 private institutions are members of the Romanian Employer Organisation from Research and Design. However, the total number of registered companies with R&D as main activity has been 841 in 2011: 596 companies in NACE 7219 *Other research and experimental development on natural sciences and engineering*; 161 companies in NACE 7220 *Research and experimental development on social sciences and humanities*, and 84 companies in NACE 7211 *Research and experimental development on biotechnology*. Out of these 841 companies, 354 have no employee in 2011 and 401 have 1-10 employees. Cumulating 5000 employees, the 841 companies registered in 2011 total revenues of €158m, the top 20 of these companies concentrating more than half of the revenues.

The National Council for Science and Technology Policy subordinated to the Prime Minster, which should be the coordination body across ministries, has never been operational (World Bank 2011). Hence, the RDI policies have been elaborated at the level of the National Authority for Scientific Research, which under the new government restructuring (see chapter 2.5) has transferred its attributes directly to the Ministry of National Education.

Figure 1. Overview of Romania's R&D system governance structure



2 RECENT DEVELOPMENTS OF THE RESEARCH AND INNOVATION POLICY AND SYSTEM

2.1 National economic and political context

According to the World Bank Atlas method, the country belongs to the upper middle income group with a GDP/inhabitant of €5,800 in 2010, which represents less than a quarter of EU average (Eurostat).

Out of the over 21m inhabitants, only 11% lived in the urban areas in 2011 (compared to the 41% EU27 average), the rest being almost equally distributed between rural and intermediate areas (Eurostat). Between the urban and rural population there are considerable gaps in terms of income, basic facilities, level of education and age structure[11].

According to the Global Competitiveness Report 2011-2012, Romania ranks 77 out of 150 countries. It is classified as an efficiency-based economy, while most of the EU countries are either innovation-based or in transition towards an innovation-based economy.

The national economy has been hit hardly by the global financial crisis, which became more visible in the country at the end of 2008, as reflected by the dramatic decline of the GDP growth rate, from 7.3% in 2008 to -6.6% in 2009. The GDP registered a positive value (2.2%) only in 2011 (Eurostat). During the crisis (2008-2011), the high and medium-high tech companies registered an added value growth of 24%, which is higher than the rest of the manufacturing sector (Cojanu 2012).

During the same period of crisis, the flow of foreign direct investment (FDI) reduced dramatically from €9.5b in 2007 to only €1.8b in 2011, of which 61% have been concentrated in Bucharest and the surroundings. In terms of the structure of FDI stock, 31% comes from manufacturing (the main sectors being oil, transportation, metallurgy, and food industries), followed by the financial sector (18%), trade (11%) and constructions (11%) (see National Bank of Romania 2011). In the recent years, Romania became one of the most attractive destinations for wind energy investments. The wind energy installed capacity increased from 623MW in 2011 to a projected 1440 MW in 2014. The largest wind energy park in Europe (Fantanele-Cogealac) is situated in Romania, in Constanta County.[12]

Faced with the crisis, the Romanian Government decided in 2010 (Law 118/2010) a 25% cut in the salaries for all the public employees and also the blocking of almost any hiring in public sector[13]. While the reduction of salaries has been gradually eliminated in 2012, the hiring restrictions are still in place, except for extraordinary cases such as the medical staff.

[11] National institute of Statistics (NIS) provide date on two categories rural (45.1% of population in 2011) and urban (54.9% in 2011). The share of population over 15 years with higher education is 20.3% in urban areas and only 3% in rural areas. Rural areas are confronting large underemployment, as 41.5% of rural occupied population is "independent worker" (data from NIS 2012b).

[12] http://www.ziare.com/mediu/energie-regenerabila/energia-regenerabila-ia-avant-cele-mai-importante-investitii-din-2012-1207865

[13] A hiring in public sector is permitted conditioned of reduction of 7 employees.

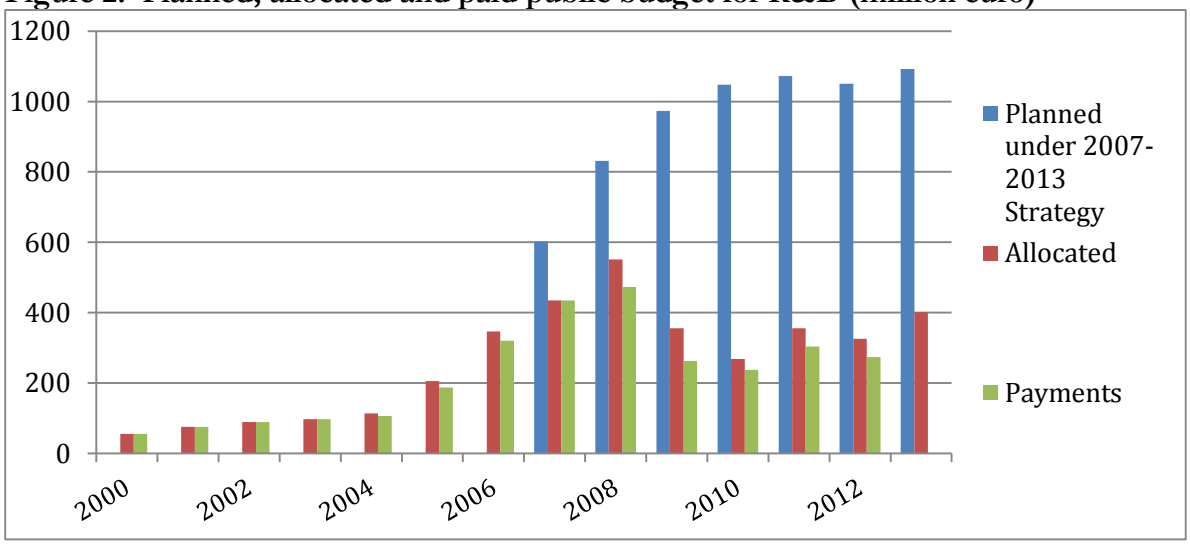
Romania has a very low rate for the absorption of the allocated structural funds. Although by 2012 78% of funds had been contracted, the actual payments to beneficiaries amount to 22.2% of the funds, and only 9.7% of them have been reimbursed by the European Commission.[14]

An intense political crisis has marked year 2012: after street protests, change in power and attempted suspension of the President, it is only after the elections in December when the political tensions reduced. The new government introduced changes in its structure, among which the role of the former National Authority for Scientific Research is taken directly by the new Ministry of National Education, while a delegate Minister for Higher Education, Research and Technological Development has been created.

2.2 Funding trends

The Strategy 2007-2013 was elaborated under the assumption of government appropriations for R&D of 1% GDP from public funds in 2010. The 2009-2010 budget cuts in the public RDI had vast negative consequences that annihilated the improvements of the few previous years with higher RDI funding. In response to the budget cuts, the 2009 'Plan to increase the efficiency and effectiveness of RDI expenditure' introduced a funding re-prioritisation and several reform measures to maximize the social and economic impact of RDI investment and allow the release of the EU's RDI financial assistance to Romania. This was followed in 2010 by the launch of the 2011-2013 National Reform Programme (NRP), which comprises among other RDI measures, the ambitious target of 2% of the GDP for public and private RDI investment by 2020 (1% for public RDI investment and 1% for private RDI investment) to narrow the gap to the EU RDI investment level. The discrepancy between targets and reality is similar to the allocation for education, which by law is expected to be 6% of GDP but has never substantially exceeded 4% and was often even less[15].

Figure 2. Planned, allocated and paid public budget for R&D (million euro)



Source: NASR.

[14] Declaration of the Minister for European Affairs Leonard Orban at the end of his mandate, 12.12.2012, http://www.recolta.eu/cat-este-rata-de-absorbtie-a-fondurilor-structurale-si-de-coeziune/

[15] The budget for education represented 4.29% of GDP in 2009 (Eurostat) and registered similar values in 2010, 2011 and 2012. The fiscal strategy 2012-2014 envisages for 2013 an increase of 36% in nominal terms and a further increase of 15% in 2014, which would enable reaching the 6% target. However, the already approved budget for education in 2013 is only 6.59% higher than in the previous year.

The problems created by the large discrepancy between the planned and allocated amounts each year has been doubled by the chaotic multiannual planning. Therefore, as response to the 50% reduction of the budgets for the undergoing projects simultaneously with the launch of new competitions, on April 2013 all the members of the National Council for Scientific Research resigned[16].

The structure of expenditures in the National RDI Plan 2007-2013 is the following: Human Resources - 9%, Ideas - 26%, Partnerships - 45%, Innovation - 7%, Capacities - 13%.[17]

"Currently 13.7% is allocated to research, innovation and entrepreneurship from the total of Structural Funds available to Romania, compared to an overall 25% at the level of EU. A large part of the Structural Funds for R&I has been focussed on programmes for developing R&I infrastructure and human resources which have been developed as complementary to the national R&D programmes. The massive reduction of the R&D budget in 2009 however hampered this complementarity."(European Commission 2013, p 224)

The structural funds for RDI have been concentrated in the Axis 2 of the Competitiveness Operational Programme, with a total budget for 2007-2013 of €715m (excluding ELI-NP). In the five years of implementation, 1200 projects have been submitted and 500 selected. 400 projects are currently underway, cumulating €430m with a co-financing reaching €120m. 44% of these funds have been contracted by organisations from Bucharest and its surroundings (i.e. Ilfov County). Unfortunately, after a few years with a relative interest from the business sector, the number of applications from the business sector dramatically decreased and contracts cumulating €29m have been terminated at the request of the beneficiaries. Currently, while the amounts allocated for public organisations have been completely contracted, only 62% of the money dedicated to companies have been contracted and 18% actually paid (Gheorghe 2012).[18]

[16] http://www.ziare.com/scoala/universitati/motivul-cheie-pentru-care-au-demisionat-in-bloc-cercetatorii-din-cncs-interviu-1229865

[17] For the years 2013, the calculus included the allocated values.

[18] While an in-depth analysis of the causes for this situation is missing, one can estimate to be the same as the cause for the low absorption of structural funds at national level: bureaucracy incompatible with business activities, a not functional credit or guarantee system for ensuring co-financing, doubled by the frequent delays in payments.

Table 4: Synthetic RDI indicators

	2009	2010	2011	EU27
GDP growth rate	-6.6	-1.1	2.2	- 0.3 (2012)
GERD (% of GDP)	0.47	0.47	0.48	2.03s (2011)
GERD (euro per capita)	25.9	26.7	30.7	510.5s (2011)
GBAORD - Total R&D appropriations (€ million)	348.1	353.26	352.11	91,277.1 (EU27 total 2011)
R&D funded by Business Enterprise Sector (% of GDP)	0.19	0.18	0.17	1.26 (2011)
R&D performed by HEIs (% of GERD)	24.7	24.5	22.9	24% (2011)
R&D performed by Government Sector (% of GERD)	34.9	36.8	40.7	12.7% (2011)
R&D performed by Business Enterprise Sector (% of GERD)	40.2	38.3	36.0	62.4% (2011)
Share of competitive vs institutional public funding for R&D[19]	65%	65%	66%	70%

Even under these budgetary constraints, Romania managed to ensure a consistent international presence and bilateral cooperation. Thus Romania became a member of European Space Agency, a candidate country for CERN, a member of FAIR and ITER.[20]

Other international collaboration programmes include: The Swiss-Romania cooperation programme 2011-2016[21]; the Cooperation Programme Romania - Norway, Iceland, Liechtenstein[22], under the SEE Financial Mechanism 2009-2014; and the Framework for research collaboration between Romania and France established in 2011 (UEFISCDI, 2012). Romania is also participating in five Joint Technology Initiatives (JTIs): "Clean Sky" (aeronautics), ENIAC (nanotechnology), "Fuel Cells" (energy), ARTEMIS (embedded systems), IMI (health) (Prisecaru 2012).

Romania is part of 9 pan-european infrastructures projects: Extreme Light Infrastructure – ELI; Facility for Antiproton and Ion Research – FAIR; Production and study of rare isotope radioactive beams - Spiral2; Underwater Neutrino Observatory - KM3NET, European Bio-Banking and Biomolecular Resources - BBMRI, ERICON – Aurora Borealis, Research Infrastructures Network for Research in Biodiversity - LIFE WATCH.

Romanian participation in FP7 projects is rather modest: with 756 participants in 575 projects (position 19 among EU member states) and a total budget allocated for Romanian participants of €96m, Romania ranks 19 among the EU countries in terms of budget share (EC, FP7 Country Profile).

According to the Romanian RDI Scoreboard (ROSCORD), the companies with the largest RDI investment in 2010 were the car producer Automobile Dacia (€29.7m), the chemical company Oltchim (€26.1m), the pharmaceutical company Synevo (€26.1m) and Nokia (€7m). It is worth mentioning that, in the meantime, Oltchim was barely saved from bankruptcy by the state, while Nokia left the country. The Scoreboard also reveals that out of the 1061 big companies included

[19] The estimation of the institutional funding includes the allocation for the Romanian Academy and programme NUCLEU, the latter being in fact project based but not competition based.

[20] *International Thermonuclear Experimental Reactor*, http://www.ancs.ro/ro/categorie/1629/programe-internationale-iter

[21] www.swiss-contribution.ro

[22] www.eeagrants.org ; http://www.uefiscdi.gov.ro/Public/cat/786/European-Economic-Area--EEA.html

in the analysis, only 89 have registered R&D expenditures in 2010. Looking at the sectoral concentration of top 25 companies with the largest R&D expenditures, the sectors with more than one company are: electrical equipment (5 companies), ICT (3), pharmaceuticals (3), machinery (3) car manufacture (2), energy production (2). (see Ciupagea 2011)

The public funds are mostly competition-based, but a part consists of institutional funding, which is based on institutional assessment. Such funds have been granted by the programme Nucleus[23] (a continuation of the former Plan, targeting the national R&D institutes) and through the budget of the academies (allocated for their institutes). The National Plan 2007-2013 also has a dedicated programme "Support for institutional performance" (enhanced also GD no. 133/2011), which was in fact never functional. One can estimate that, in the context of very low predictability of competition-based funds, the institutional grants ensured the basic functionality of many institutions, while at the same time delaying structural changes.

The access of companies to public R&D programmes is not restricted. The certification procedure which functioned for few years has been eliminated, as it has been perceived by the companies as a bureaucratic barrier (UEFISCDI 2012). The participation of the companies in the National RDI Plan projects is encouraged and conditioned only by state aid regulations.

The most intense collaboration between public and private entities is encountered in the rather broad thematic area of Innovative Materials, Products and Processes under the Partnership programme (Pislaru 2012, p 170).

2.3 New policy measures

The preparation of the next planning cycle has begun in 2012. The general principles for the new cycle include the correlation of the smart specialisation strategies and the National RDI strategy 2014-2020 around a reduced set of priorities under the requirement for an increasing socio-economic impact (see Prisecaru 2012, Gheorghe 2012, Resiga 2012). NASR has launched a preparatory project[24] for the identification of smart specialisations, which provided the first results in March 2013. Also in January 2013, a large foresight-based ten-month project was launched for the Elaboration of the National RTDI Strategy 2013-2020, together with the associated Plan (which manages the public funds for RDI) and with recommendations for an axis of the structural funds allocated for innovation.

In 2012 important steps were made for the starting of two strategic projects financed by structural funds. ELI-NP is at a more advanced stage, having received the approval of the European Commission for the allocation of the structural funds; construction is expected to start in 2013[25]. The scientific case for "Danube International Centre for Advanced Studies in the River – Delta – Sea systems" was finalised in 2012 and the plans for 2013 include the socio-economic study, the feasibility study, and obtaining the status of a Flagship Project in the European Union Strategy for the Danube Region (see Stanica 2012).

In August 2012, a new set of innovation support instruments were launched under the National RDI Plan, namely: Support for high-tech export (which received 8 applications and has an estimated impact of an increase by a factor of 3.7 in high-tech export compared to the public contribution); Development of products, systems and technologies, having received 88

[23] The Nucleus programme has maintained at approximately 25% of the NASR budget.
[24] Project "Analysis of R&D-based economic growth potential – identification of smart specializations", collaboration with JASPER, the consultant for European Commission and European Investment Bank.
[25] http://europa.eu/rapid/press-release_IP-12-973_en.htm

applications cumulating over €45m; and Vouchers for innovation (UEFISCDI 2012). The explicit general policy of the National Council for Development and Innovation is to increase pressure for higher socio-economic impact, a policy reflected in: new eligibility criteria related to patents and RDI patent returns; higher weights of the socio-economic impact criteria in the evaluation, reaching 55% in certain calls; bonuses for high returns from innovative goods and services (Talpes 2012).

The evaluation of the national institutes for scientific research also started in 2011. GO no. 6/26 January 2011 stipulates that RDI units and institutions included in the national system are evaluated by the Consultative Board for Research, Development and Innovation, according to a procedure that is established by NASR in consultation with the Consultative Board for RDI, the Romanian Academy, the National Council for Scientific Research and other national consultative councils, and is approved by government decision. The new evaluation procedure replaces the former accreditation system and ranks the R&D units by their research performance and the economic effect of their research into five performance classes: A+, A, A-, B and C. The new evaluation system allows highlighting the best performance of the 'champions' of the R&D system. The evaluators should include at least 50% foreign experts selected from EU or OECD member states to guarantee neutrality and international quality. The evaluation is finalized by certification, and only certified RDI units can benefit from a new system of basic institutional financing that entered into force on 1 January 2012 and is aimed at supporting the RDI infrastructure. To be certified, the R&D unit must reach level A- or higher (with those with lower grades subjected to reorganisation, consolidation, or closure). Certification or re-certification is granted for a period of maximum five years. All R&D units (e.g. universities, national RDI institutes, research institutes of the Romanian Academy or under other ministries) that want to apply for public RDI funding need to go through the certification process (competitive funding does not require certification and is available to all research entities). (Ranga 2011) Unfortunately, the results show that this is rather a formal exercise as out of 32 institutes evaluated by now, 31% are classified as "A+", 45% as "A" and 24% "A-", which means none is subject for reorganisation, consolidation of closure.

Government ordinance 92 of 18.12.2012 changes some of the elements of the law of education, drastically reducing some of the restrictions for academic staff: eliminates the age limit (i.e. the retirement age for professors and rectors); eliminates the restriction of maximum 8 PhD students per professor; eliminates the conflict of interest in simultaneously holding a position in the public administration and the position of rector; eliminates the compulsory role of the accreditation procedure (habilitation) for conducting PhD theses.

2.4 Recent policy documents

The Law on National Education no. 1/ 5 January 2011 introduced a set of changes in the system of public university funding based on the number of students. Specifically, on the basis of the results of the national classification of universities (into educationally-intensive, education-and-research, and research-intensive universities) and of the ranking of study programs, the law provides a number of funding instruments designed to consolidate the institutional profile of higher education institutions. The Law stipulates that the government funds excellent research programmes in all the three types of universities, in order to encourage competition, but also that it will allocate funding for doctoral and master's programmes predominantly to the research-intensive universities and/or high-ranking programmes. The first classification was completed in the second half of 2011, with 12 of the approximately 100 Romanian universities making it in the research-intensive group. The results of the ranking exercise were published a few months later,

though the ranking did not cover programmes – as set forth under the law – but rather academic fields. The results of both types of exercises were contested and the methodology is currently under substantial revision. Furthermore, although the results should have been clearly reflected in the new funding instruments for the current academic year, this had not been the case.

Another important provision of the Law on National Education is the guarantee of researchers' inter-institutional (national) mobility and of the portability of grants, under the principle "the grant follows the researcher". The law also refers to the organisation of doctoral research programmes (e.g., it introduces the right of the Romanian Academy to organize doctoral programmes, etc.) and their evaluation, as the basis for receiving public funding. (Ranga 2011)

A recent policy document is the Governmental Programme 2013-2016 (December 2012). The most important RDI related aspects are connected to the objective of increasing R&D deductibility from 120% to 150% and zero taxation for the profit invested in technological transfer. The measure has been already introduced in the new Fiscal Code, creating also a controversy connected to the fact that the deduction now applies in the case of multinationals also for the R&D activities carried in other countries.[26]

2.5 Research and innovation system changes

After the parliamentary election in December 2012, the new government adopted a set of measures which also affect the RDI system. Thus, according to the Government Ordinance of 22.12.2012 the Ministry of Education, Research, Youth and Sport is reorganised by splitting into the Ministry of National Education and the Ministry of Youth and Sport, while the National Authority for Scientific Research (NASR) is dissolved, with all attributes taken over by the new Ministry of National Education (MNE). Furthermore, there will also be a delegate Ministry for Higher Education, Scientific Research and Technological development within the MNE. Additionally, the different research institutes formerly subordinated to other different ministries become subordinated to the new Ministry of National Education. These measures are expected to improve the representation of RDI in the government and also to reduce the variability of functional rules for the different national institutes.

2.6 Regional and/or National Research and Innovation Strategies on Smart Specialisation (RIS3)

Romania is a country with a centralised administration, and the eight regions which follow the European structure are mainly statistic entities, without real autonomy. A new project of law has been proposed in February 2013, which support multiannual budgets managed by regional councils of the eight regions[27], but the political debates continue around the future architecture of the regions, a resolution being expected by June 2013.

Despite the fact that the eight regions in Romania have only statistical meaning and that even their borders are under discussion, the country generically complied to the procedure of elaborating smart specialisation strategies at this level. Without proper institutional framework

[26] http://www.hotnews.ro/stiri-esential-14102536-prevedere-controversata-codul-fiscal-ajutor-pentru-cercetare-sau-metoda-repatriere-profiturilor.htm

[27] http://jurnalul.ro/stiri/observator/noi-regiuni-romania-consilii-regionale-636027.html

and with a poor coordination at national level, the RIS3s risk to be not only formal processes, but compromise the credibility of innovation strategic orientation.

The elaboration of the new national RDI strategy has a prerequisite the correlation with the smart specialisation options, but the real decision mechanisms enabling are not clear, while the calendar is partially overlapped. The eight Regional Development Agencies (RDA) are currently being in different stages of the elaboration process. The most advanced is the RDA-West, which initiated collaboration with the World Bank in this respect. The Region North-East has also become a member of the Smart Specialisation Platform (I3S) in March 2013, while other regions have elaborated preparatory studies.

In March 2013 has been launched the "Analysis and Evidence Base of the R&D&I Market in Romania" (JASPERS/ARUP 2013). Its "objective was not to set the priorities for Smart Specialisation in Romania, but to highlight areas of interest that can be analysed and investigated further, supported by the involvement of stakeholders and the development of a vision for innovation at a regional and national level". The study identified the following fields: Food and agriculture (based on employment, GVA and relatively significant research in both agriculture overall and biotechnology), ICT sector (telecommunications and software, based on clusters and publications); Engineering and technology (motor vehicles, other transport, electronics, machinery and equipment and technical textiles); and Energy and Environment (based on the investment in renewable energy and the environmental research) as holding potential interest.
The input from the JASPERS/ARUP study will be integrated in the project "Elaboration of the National RTDI Strategy 2014-2020", where a further evidence-base is built and a large consultation process is deployed.

The Ministry of Economy has also announced the elaboration by September 2013 of a Strategy for Industrialisation of Romania, with a strong focus on technological parks capable of attracting foreign direct investments.[28]

2.7 Evaluations, consultations

The Mid-Term Evaluation of the National Strategy and of the National RDI Plan 2007-2013 (Technopolis 2012) was issued in January 2012. The report underlines: the policy maturity in the system, as well as the latter's complexity; the exceedingly large number of priorities; the similarities with FP7 and the associated neglect of institutional development; unclear complementarity with structural funds; too much transformation, too fast, and difficult to communicate; improved but still complex evaluation. The report also suggests for the next cycle a focus on three sectors (agriculture, health and energy), correlation with structural funds, a stronger orientation towards institutional development (including the long-term orientation of research organisations), and the reduction of complexity in the monitoring process. The report does not assess the crucial issue of the ability to maintain the Strategy and Plan for RDI under the massive cuts after 2008. Un updated version of the evaluation has been elaborated as part of the project "The Elaboration of National RTDI Strategy 2014-2020" (See Ionita et all 2013)

[28] http://economie.hotnews.ro/stiri-companii-14429236-vosganian-dezvoltarea-parcurilor-industriale-parte-din-strategia-reindustrializare-tarii.htm

3 STRUCTURAL CHALLENGES FACED BY THE NATIONAL SYSTEM

In spite of steady improvements over the recent years, the performance of the Romanian RDI system is well below that of the EU-27, the country being part of the *'Modest Innovators' group* in the 2011 Innovation Union Scoreboard classification (IUS 2011). The IUS Summary Innovation Index had an average annual growth rate of 5% in the last five years. This places Romania among the growth leaders in the Modest Innovators group (next to Bulgaria), but also among the overall growth leaders (next to Bulgaria, Estonia, Portugal and Slovenia). IUS 2011 identifies Romania's relative strengths in Human resources, Firm investments and Economic effects, while relative weaknesses are in Open, excellent and attractive research systems, Linkages & entrepreneurship, Intellectual assets and Innovators.

Some indicators have recorded a high growth, e.g. Community designs (46.4%), Community trademarks (39.5%), Licence and patent revenues from abroad (21.5%) and International scientific co-publications (12.4%), while others showed a decline, e.g. PCT patent applications in societal challenges (-9.8%), Innovative SMEs collaborating with others (-5.3%) and R&D expenditure in the business sector. (IUS 2011).

Table 5: Innovation Union Survey indicators for Romania (EU=100%)

HUMAN RESOURCES	
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	87
Percentage population aged 25-64 having completed tertiary education	54
Open, excellent and attractive research systems	
International scientific co-publications per million population	46
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	39
Finance and support	
R&D expenditure in the public sector as % of GDP	38
FIRM ACTIVITIES	
R&D expenditure in the business sector as % of GDP	15
Linkages & entrepreneurship	
Public-private co-publications per million population	17
Intellectual assets	
PCT patents applications per billion GDP (in PPS€)	4
PCT patents applications in societal challenges per billion GDP (in PPS€) (climate change mitigation; health)	2
OUTPUTS	
Economic effects	
Medium and high-tech product exports as % total product exports	105
Knowledge-intensive services exports as % total service exports	100
License and patent revenues from abroad as % of GDP	55

A similar picture of the country's low innovation performance is given by the Innovation Union Competitiveness Report (European Commission 2011), which places Romania in the group of countries with "Low knowledge capacity systems with a specialisation in low knowledge-intensive sector", next to Bulgaria, Poland, Turkey and Croatia.

In 2011, the Knowledge-Intensive Activities (KIAs) represented only 20.5% of the total employment in Romania (compared to 35.5% EU average), while total employment in high-tech manufacturing amounted to 0.6% (compared to 1.1% EU average). The gap is smaller when considering the medium-high tech employment: 4.1% in Romania and 4.5% EU average (Eurostat data)

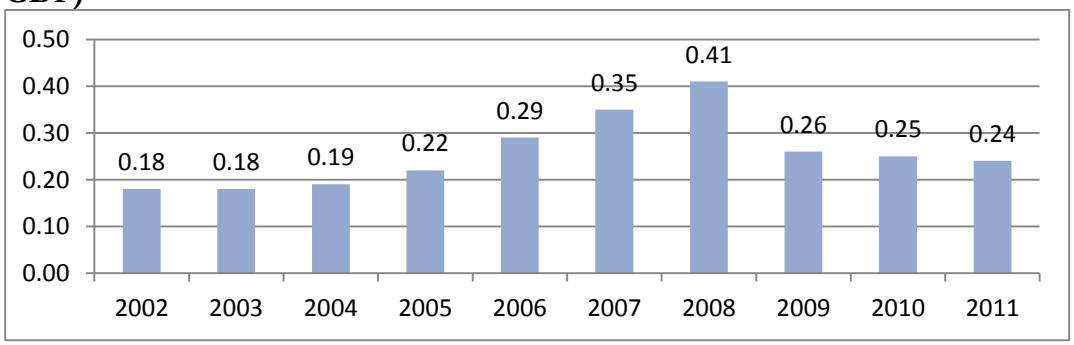
The broadband access of enterprises is comparatively low (63% in Romania and 90% EU average in 2012, Eurostat data), which is also reflected in the limited number of enterprises receiving orders online (5% in Romania, 14% EU average, Eurostat data).

At systemic level five interrelated challenges can be identified:

1. *The RDI system is chronically underfinanced*. The GBOARD is very low, but further does not comply with the official targets, creating instability and unpredictability in the system, both for organisations and individuals.

With the exception of 2007 and 2008, the Government financing for R&D stayed well below 0.3% of GDP (see graph below), a value less than half of the EU27 average, although the commitment to Barcelona objectives of 1% of GDP was also an explicit assumption in the elaboration, in 2006, of the National RDI Strategy 2007-2013. Faced with economic crisis, Romania was one of the few countries that drastically reduced the budget allocation for R&D, and as a result in 2009-2012 most of the projects financed by the National RDI Plan were continuations of those started in 2008-2009, with few new calls. The reduction in funding was also reflected in drastic renegotiations of undergoing projects with consequences both on the quality of results and the predictability of funding.

Figure 3: Total intramural R&D expenditure financed by Government (percentage of GDP)



Source: Eurostat

In response to the budget cuts, the 2009 "Plan to increase the efficiency and effectiveness of RDI expenditure" introduced a funding re-prioritisation, focusing on four main directions[29] and several reform measures to maximize the social and economic impact of RDI investment and allow the release of the EU's RDI financial assistance to Romania.

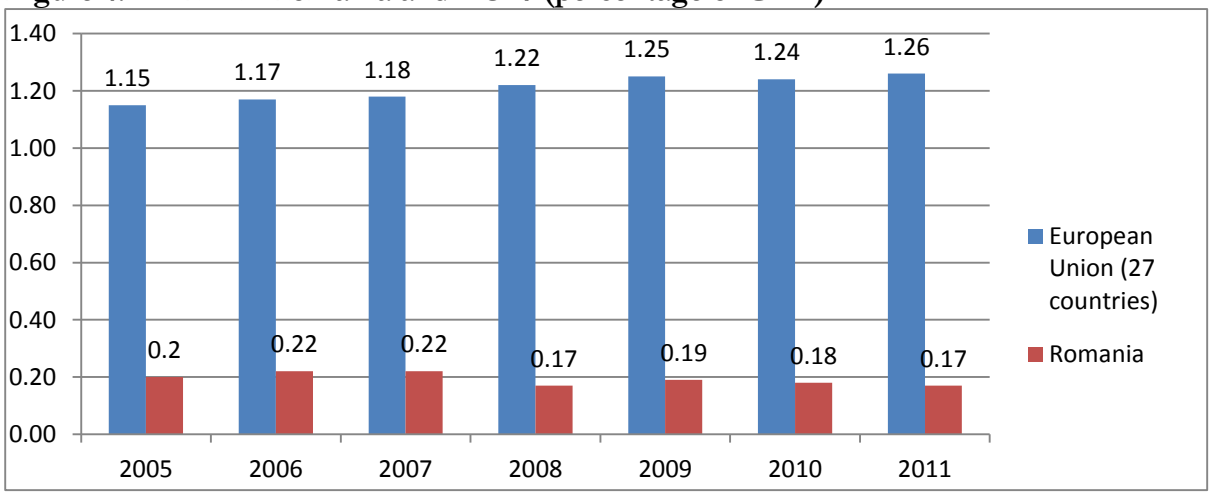
The financial situation of the human resources for research was affected also by the reduction in the wages of public university and research institute personnel by 25% in 2010, in line with all the other budgetary employees, a reduction which was eliminated gradually only in 2012.

2. *Business sector is not innovation ready.*

The underlying factors for this situation need to be seen in a larger time perspective: starting with the huge technological gaps Romania faced after the end of communism (which included unlike other communist countries a decade of restricted imports of technologies), the strong structural transformations afterwards (with the decay of heavy industry and textiles), the difficulties of recapitalisation when faced with reluctant FDIs (in the context of delayed market economy in the 90's), and the limited credit for investment. Currently, the economy is dominated by low tech industry and the interest for innovation still fades when compared with the opportunities of technology acquisitions. Activating private interest for RDI requires a policy mix for innovation (including IPR, clusters, taxation, education and skills, public procurement of innovation, pre-commercial public procurement etc) beyond the scope of the National RDI Plan or even the structural funds for innovation.

BERD as percentage of GDP in Romania is six times lower than the EU27 average (EUROSTAT, 2011). Moreover the crisis determined an even further reduction, which reveals that Romanian companies are in general not relying on innovation-based competitiveness. The business R&D investment is also not correlated with the governmental investment, as few connections are in place between these sectors.

Figure 4: BERD in Romania and EU27 (percentage of GDP)



Data source: Eurostat

[29] These were: (i) payment of international organisations membership fees (FP7, EURATOM, CERN, etc); (ii) maintaining the research capacity of National R&D institutes by providing a 30% increase of their institutional funding allocated through the Core R&D programmes; (iii) increasing the absorption of Structural Funds; and (iv) freezing new calls under the National RDI programmes.

The enterprise sector saw the most dramatic decline in terms of human resources, losing over 50% of its researchers (from 12,690 in 2000 to 6,127 in 2009). This situation is in stark contrast to the EU, where the number of researchers employed in the private sector increased by 3.5% between 2000 and 2008), United States (increase of 1.2 %) and Japan (increase of 2%) (European Commission, 2011). The situation in 2010 and 2011 marked an incredible further decrease to only 3,518 researchers, a drop by 42% in 2 years (see NIS 2012a).

Romania's 13.9% share of SMEs with new or significantly improved products new to the market as % of all SMEs with innovation activities (2006-2008) is the lowest among EU-27 countries, at about half of the EU-27 average of 27% (European Commission, 2011, p. 321).

3. *Academic orientation of the research supply.*

After a decade of almost complete autarchy in the RDI system, the National RDI Plan 2007-2013 aimed at focusing RDI towards clear outputs in terms of international publications and patents. While the increase in R&D intensity in 2007 and 2008 produced a remarkable change of behaviour in term of publication, the connection with the economic sector has not been achieved yet. The underlying factors are connected to: a) the predominant educational orientation of universities; b) the structural gaps between the national R&D institutes with the current economy; c) the undeveloped science for policy dialogue, which result in underuse of socio-economic research capabilities. The technological transfer infrastructure is not only underdeveloped, but also confronted with an undersupply of technologies to transfer. Under these conditions, the most successful connections are to the international scientific communities, as it is for instance the case of nuclear physics.

4. *The RDI system is fragmented.*

A large number of PROs (139 institutes, 55 universities, not considering the research centres) having mostly a subsistence strategy populate the Romanian RDI system, while at national level there are no strong anchors in terms of socio-economic objectives with proper political commitment for stimulating or imposing a restructuring with a thematic (or other type of) concentration. Hence, the efforts are rather administrative, aimed at better evaluation, while the incentives for concentration remain low. The results are reflected also in the incapacity of reaching critical mass.

5. *High brain-drain and not enough brain-circulation.*

Despite the relatively low weight of tertiary education graduates in total population, the supply of PhDs and post-docs is much higher than the capacity of absorption in the public and private R&D organisations or in public institutions (in view of public procurement for innovation) under current settings. The efforts made for mobilising the diaspora had only a reduced impact, given the uncertainties in funding, the high bureaucracy and the difficulties of access in PROs.

4 ASSESSMENT OF THE NATIONAL INNOVATION STRATEGY

4.1. National research and innovation priorities

The most important RDI policy document in Romania is the National RDI Strategy 2007-2013 and the associated National RDI Plan 2007-2013, both elaborated through a broad process of consultation with the main RDI stakeholders of the country, within the first national foresight exercise in S&T organized in 2005-2006 by NASR within its Sectoral R&D Plan.

While the National Strategy sets the objectives for the entire RDI system, the National Plan includes a series of programmes which were financed by the budget allocated to NASR (approximately 70% of the total public spending). The discrepancy in scope between the Strategy and the Plan is given by the limited authority of NASR in the RDI system.

The programmes of the Plan are similar to the EU FP7 (i.e. People, Capacities, Ideas, Partnerships in Priority domains, Innovation and Sustaining Institutional Performance), as a means to encourage the learning curve for the national RDI community to apply to European funds.

The largest programme, "Partnerships in Priority domains", is the only one with an associated list of priorities, Ideas is a programme addressing mostly exploratory research, and Innovation is oriented towards the specific needs of the companies. The other programmes are considered transversal ones.

The general set of priorities of the Partnerships programme are also similar to FP7 (i.e. ICT, energy, environment, health, agriculture and food, biotechnologies, innovative materials, processes and goods, space and security, and socio-economic and humanistic research), but the subcategories have many differences when compared to FP7, as resulting from the national consultations (Technopolis 2012). The rather large spectrum of priorities has been considered as a dissipation of the scarce resources (World Bank 2011). The concentration of resources is probably the key challenge for the next planning cycle and its success is at least partially dependent of the more broad capacity of commitment for socio-economic priorities at national and regional level.

The recent international collaborations are thematically focused. Hence, the Swiss-Romania cooperation programme 2011-2016 envisages: Cancer, cardiovascular diseases, diabetes and obesity; Impact of waste and pollutants on environment and climate; Sustainable energy; Economic growth and social disparities. The cooperation programme Romania - Norway, Iceland, Liechtenstein is focused on Climate change and renewable energy; Health and food safety; Environmental protection and management. Finally, the framework for research collaboration between Romania and France, supports joint research projects in the fields of Physics, Environment, Chemistry, Mathematics.

In what regards the structural funds, the 2011-2013 National Reform Programme refers to specific business sectors and strategic industries (e.g., ICT, energy, transport - the electrical vehicle, large R&D investments) where innovative clusters and public-private partnerships will be supported.

4.2 Evolution and analysis of the policy mixes

Following the dimensions of the policy mix identified by Guy (2009), the main evolutions in the last three years are related to:

1) **Human Resources**

- In Romanian higher education, the number of students in S&T fields increased between 2003-2008 at a rate of around 6%, higher than the EU-27 average, but slower than total number of students during the period (which has an average growth rate of 11%).[30]
- There is no consistent policy either for increasing the interest of the young generation in S&T, or for balancing the public higher education financing towards S&T fields.
- The mobility of researchers is very limited, both inside the sector and with the business sector. This is due to employment practices in the PROs.
- The entrepreneurial training is underdeveloped in both secondary and tertiary education, and innovation management is quasi-absent.
- Romania has one of the lowest levels of life-long learning in Europe, while state support for higher education is almost exclusively oriented towards the Bologna-type programmes (Andreescu et al 2011).
- The Operational Programme "Development of Human Resources" of the structural funds supported the training of doctoral and post-doctoral schools with a target of 12,000 PhDs and 2000 post-docs by 2013. With all its problems (e.g. biased access, delayed payments), the programme created a large base of human resources for the RDI system.
- Small progress has been made in connecting PhD training and applied research. The doctoral schools remain mostly education-oriented and the objectives of the PhD theses are theoretical. Some efforts have been made for stimulating the involvement of PhDs in the research projects financed by the National RDI Plan.
- The quality of the doctoral programmes remains problematic and the supporting legal framework is unstable: the accreditation (*abilitare*) for conducting PhD thesis introduced in 2010 was cancelled in 2012, alongside the limit of 8 PhD students per adviser.
- The high investment in PhDs and post-docs is at odds with the latter's employment opportunities, as the employment in all PROs and more generally in the public sector has been blocked since 2010, while the private sector dramatically reduced the number of researchers.
- With a low autonomy in the management of human resources, PROs have adopted a strategy of conservation, including of the non-efficient personnel (an informal evaluation shows that the managers consider 40% of personnel as inefficient. World Bank, 2011)
- After a period of enthusiasm manifested by the scientific diaspora (supported by the diaspora conferences[31] and the online networking[32] organised by UEFISCDI), their interest in collaboration has been dramatically affected by the severe R&D budget cuts.

[30] Eurostat, *Science, technology and innovation in Europe*, Luxembroug, 2011, p. 63.
[31] http://www.diaspora-stiintifica.ro/
[32] http://www.brainromania.ro/

2) Science base

- High investment has been made in research infrastructures, both from structural funds and the Capacities programme of the National RDI Plan. Ensuring widespread access to some of these infrastructures remains problematic, despite the long-term promise of a national registry for research infrastructure.
- Under severe budgetary cuts and interruptions in the public calls for RDI, the research institutes mostly rely on institutional funding and thus maintain a subsistence strategy.
- In the absence of a strong political will for restructuring, the evaluation of the institutes is quite formal (with fuzzy criteria and incomplete national databases for references).
- The importance of research for universities drastically increased with the new law of education, the number of ISI-indexed publications being a dominant indicator in the classification of universities and the ranking of academic programs. This criterion (which was introduced ex-post) created an important reputation mechanism in the system, but it is not balanced by similar pushes towards creating connections with the economy and society.
- The private institutes are almost absent (except for the few privatised ex-public ones) given the unstable competition-based funding.

3) Business R&D and innovation

- The tax deduction for R&D is not a functional instrument, as it is conditioned by 15% R&D investment in total turnover (which probably fits only the few privatised R&D institutes) and is connected with the company profits (which normally lag a few years).
- The technology transfer infrastructure has not received a significant investment in the last years, being currently not fit for purpose.
- The bureaucracy and delayed payments for structural funds projects have contributed to companies' reluctance to collaborate with the public sector.
- No policy for inter-sectoral mobility is in place.
- IPR law is delayed, creating an additional disincentive for the large companies to locate their R&D capacities in Romania.

4) Economic and market development

- The integration of an innovation dimension in different *sectoral strategies* is quite formal. Despite the structural problems of different sectors (e.g., the massive brain-drain in health; the big scandals of corruption in energy; the agriculture paradox of large work migration and local uncultivated land), the connection of *research to policy-making* is very low, and innovation is not high on the list of options.
- Romania has one of the lowest *absorption rates of structural funds*. To this situation contributed the high bureaucracy, delayed payments, and the non-functional credit and guarantee system.
- The *regional dimension* is still underdeveloped, but out of formalism Romania elaborates strategies for smart specialisation for regions relevant only statistically, without proper infrastructure for commitment and implementation.
- In terms of financial policies, Romania does not yet have a multiannual public budget, thus contributing to uncertainty and even to ad-hoc investments of public organisations at the end of the year.

- Romania has a large shadow economy (30% of GDP in 2011, compared to an EU average of 19.5%, according to Atkearney 2011), due not only to the large number of taxes, but mostly to the low level of control. Under these conditions, innovation-based competition is not encouraged.

4.3 Assessment of the policy mix

Both the mid-term evaluation of the Romanian National RDI Strategy and Plan and the World Bank's Functional Review provide several recommendations for improvement. For example, the former document suggests the development of a systematic link between RDI policy and selected sectoral policies, as well as between the 2014-2020 Structural Funds and national RDI policy, a stronger focus on institutions and their empowerment, reducing complexity, improving the functions and the division of labour between the funding and advisory agencies of NASR, improving the implementation of the National RDI Plan, increasing the international exposure of Romania's research, the absorption of European funds and the business involvement in RDI. The latter document proposes to strengthen the governance of the RDI system through better understanding of the systemic nature of the national RDI set-up, increase the visibility of the RDI sector in the government for enhanced integration and functioning, strengthen the performance of public R&D activities, accelerate the translation of R&D into innovation in the private sector, and increase the level of private sector R&D (Ranga 2011)

Table 6: Synthetic view of challenges and policies addressing them

Challenges	**Policy measures/actions addressing the challenge** [33]	**Assessment in terms of appropriateness, efficiency and effectiveness**
The RDI system is chronically underfinanced	The complementary use of structural funds	The investment in infrastructure and human capital risks to pay little benefits in the context of limited financing for projects. The weight of structural funds allocated for R&D is almost half of EU average.
Private sector is not "innovation ready".	Tax deduction of 150% for R&D expenditures	The tax applies only to companies with over 15% R&D investment, making this instrument almost non-applicable in practice.
Academic orientation of the research supply	The differentiation of universities and the classification of programme studies include aspects related to research and innovation.	While the research dimension is very much emphasised, the connection with the business sector and commercialisation of results remain marginal. Most likely, the current procedure will only increase the pressure for publication

[33] Changes in the legislation and other initiatives not necessarily related with funding are also included.

Challenges	Policy measures/actions addressing the challenge [33]	Assessment in terms of appropriateness, efficiency and effectiveness
	Structural funds project for institutional development of ReNITT New financing lines from the Innovation programme.	Considerably higher investment is necessary to develop the technological transfer infrastructure. The very low base of innovation in the business sector requires a much broader policy mix (including IPR, public procurement for innovation, clusters etc.)
The RDI system is fragmented	The option for the public institutes for merging with universities. The evaluation of the institutes.	The incentives for merging are not clear. The process is not efficiently performed with few consequences for the institutes.
High-brain drain and not enough brain-circulation	The awards for including PhD students in the projects financed by the National Plan 2007-2013 Diaspora conferences organised starting 2008.	The number of actual projects financed decreased dramatically and the uncertainty of a scientific career is very high. The scientific diaspora is reluctant to collaborate after the interruption of project funding. Also, the actual access in the PROs is very much restricted.

5 NATIONAL POLICY AND THE EUROPEAN PERSPECTIVE

For 2013 the announced public budget will not create a change in resources, so the system will have probably one more year of austerity. However, this year, which is at the end of planning cycle, is critical for establishing the configuration of the next cycle. The initiative to close the loop with the first foresight exercise carried in 2006 has been taken and the consultations for the elaboration of the whole package (RTDI strategy, RTDI plan and the axis for innovation of the structural funds) started in January 2013. The project aims to: a) develop a vision for 2020 in the form of a shared set of principles for action; b) identify a limited set of priorities, correlated at national and regional level, based on strong evidence and opportunity argumentation made by the relevant stakeholders; c) develop an integrated investment model, with a complementarity between national and structural funds; d) develop a new governance model, able to ensure proper implementation. The on-going identification of priorities for structural funds for the next cycle and the missing coordination between national and regional policy decision challenge the ambitions of this exercise to create the critical mass along a limited set of priorities.

In 2009, the transition from a subsistence RTDI system towards a "driver of the knowledge society development in Romania"[34] was interrupted. Still, the country maintains its generic political commitment to Europe 2020 and rescheduled its gradual increase in public R&D expenditure up to 1% by 2020, with an intermediary target of 0.6% in 2016.

Hence, the generic challenge for the following years is to develop a new transition strategy from an under-dimensioned RDI system (four times below EU average in terms of human and financial resources) towards one positioned as an engine for growth. While theoretically financial resources will be available both from public and structural funds, a successful transition needs:

a) Path sustainability

A transformation towards a system capable of delivering for society requires *predictability of both resources and rules*. Hence, the multiannual allocation of the R&D expenditures (from national and structural funds) needs strong political support. At the same time, the PROs should have clear excellence criteria to be achieved on medium term. Setting ambitions even higher than the current best performers at national level, simultaneously with high premiums (in terms of institutional financing), would encourage leadership, collaboration and competition for best researchers.

For a system expected to double its resources in 3-4 years, it is critical to a maintain a *dynamic structural balance*, e.g., between human resources creation and access to the system, between infrastructure investment and access to and use of such infrastructures, between exploratory and oriented research, between institutional and competitive funding, etc. While increasing resources is not always reflected in output, it is important for the system to have a *productivity* control variable, which in terms of cost/output (be that publications, patents, products etc.) should, given the lower national labour costs, stay below the EU average.

b) A learning curve on the demand side

While the previous planning cycle managed to increase the capacity for publication, the new one aims for increasing the socio-economic impact. Seen from a *learning perspective*, the critical step is the development of an active demand both from business and the public sector.

[34] Vision for Research, Development and Innovation 2020, as included in the National RDI Strategy 2007-2014.

For the business sector, the first step is to create incentives for making *visible the existing R&D* activities, as reporting R&D expenditure and human resources requires an effort which now has no real return for companies. Understanding what type of companies are these, which are their innovation related practices, finding the relevant PROs they can collaborate are prerequisites of a realistic dialogue between public and private sector. A spectrum of even small collaborative projects should be deployed in order to facilitate the *co-evolution of the PROs and the companies*.

For a massive activation of the business sector, the policies should have a much *broader target group*. Thus, the tax deduction condition of 15% R&D expenditures in turnover should be lowered at least to the level where it makes eligible the existing R&D champions.

The current focus of the structural funds on technological transfer from local research organisations is also quite narrow in a country still facing technological gaps. For many companies the shift towards innovation will most likely be associated with the adoption and adaptation of existing technologies. For this stage, access to qualified human capital is very important and therefore the *inter-sectoral mobility* of researchers and the formation and employment of relevant PhDs should be encouraged.

Equally important to increasing the socio-economic relevance of RDI is the role of the public sector, which should develop and implement systems of *public procurement for innovation* and *pre-commercial procurement*. Also, the role of *science for policy* should be strengthened by capacity building in relevant agencies, thus escaping the current supply-driven orientation of most of policy oriented research.

c) Ecosystem approach

Concentration of RDI resources is seen as a must both at the existing level of expenditures and given the prospect of smart specialisation. However, the specialisations and concentrations should be understood as complex *ecosystems under formation*, able to create a gravitational force at local level, and to penetrate in the global value chains. The success of the new ecosystems will very much depend on the capacity of developing proper governance frameworks, able on one hand to coordinate along different policy domains and, on the other, to create a climate of trust among the relevant actors of the RDI system.

Summary of the progress towards the five ERA **dimensions**

1) More effective national research systems

Competitive R&D funding is dominant in Romania, being estimated at 70% in 2012. Out of the total public R&D budget, almost 80% has been allocated to the National Authority of Scientific Research (NASR, now part of Ministry of national Education), three quarters financing the calls under the National RDI Plan 2007-2017 and one quarter allocated as institutional funding (under NUCLEU programme) for the national R&D institutes. The non-NASR budget is allocated to: the Romanian Academy (decreasing from 13.8% of R&D public budget in 2010 to only 8.3% in 2013), which finances its institutes under its specific programmes; the Institute for Atomic Physics, which organizes competitions; and several ministries. The universities do not receive any institutional funding for R&D and they can only compete for projects. The NUCLEU programme is in a transition phase from a project oriented programme towards one based on institutional assessment. International evaluation has become a standard for the calls under the National RDI Plan.

2) Optimal levels of transnational co-operation and competition

Romania is part of 5 JPIs, 9 ESFRI projects and three bilateral agreements, but, given the limited national resources, most of collaborations/participations remain formal. Still, there are notable exceptions as the ELI-NP, for which construction already started.

3) A more open labour market for researchers

Romania is a net looser of brains with one of the largest scientific diaspora in Europe. Efforts have been made for attracting not only persons from diaspora, but more generically foreign researchers, by providing them opportunities for coordinating large projects based on contracts with Romanian research organisations. The cuts and uncertainties regarding the funding reduced the impact of the policy. The number of foreigners working in Romanian R&D remains very limited, not only because of relative low salaries, but also because of the general underdeveloped competition on the market for researchers at national level.

4) Gender equality and gender mainstreaming in research

The employment in R&D sectors is relatively balanced by sex (46% women in 2011, NIS data) The proportion of female PhD (ISCED 6) graduates in 2010 has been 48% in Romania, compared to 46% EU27 average, while the proportion of female academic staff grade A of 36% in Romania is substantially above the 20% EU27 average (*She knows 2012*). Hence, the gender mainstreaming in research is not a special concern at national level. Still, non-R&D specific policies are in place, Romania having one of the longest child care leave in Europe. According to the law 111/2010 amended by Governmental Ordinance 124/2011, the child leave is granted to one of the parents under two options: 1 year with a level of 85% of net average income in the 12 month with a minimum value of €140 and a maximum of €800; or 2 years with the same provisions except the maximum limit of only €280. The parent is also encouraged to return to job: if the person returns to the job before the end of 12 month, she/he will receives a stimulus of €140 per month up to the end of the year two.

5) Optimal circulation and transfer of scientific knowledge, including through digital ERA

Technological transfer while present in most declarative documents has an underdeveloped infrastructure and requires major investment especially in the human resources development. The public research funding strongly encourages publication of results, but not necessary under an open access regime. However, an important financial effort have been made for providing free of charge online access to a large spectrum of scientific literature[35] (especially Scopus) for PROs.

[35] www.anelis.ro

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ANNEX 1. PUBLICATION SUBJECT AREAS FOR WHICH ROMANIA HAS A COMPARATIVE ADVANTAGE 2007-2011

Subject Area	Impact Relative to Country/Territory	% Documents in Subject Area	% Documents in Country/Territory
AUTOMATION & CONTROL SYSTEMS	0.44	**1.33**	**1.43**
BIOTECHNOLOGY & APPLIED MICROBIOLOGY	0.47	0.48	**1.88**
CHEMISTRY, ANALYTICAL	**1.62**	0.67	**2.10**
CHEMISTRY, INORGANIC & NUCLEAR	**1.91**	0.54	**1.17**
CHEMISTRY, MULTIDISCIPLINARY	0.72	**1.52**	**10.26**
CHEMISTRY, PHYSICAL	**1.85**	0.52	**3.87**
DEVELOPMENTAL BIOLOGY	0.30	**1.76**	**1.29**
ECONOMICS	0.23	0.94	**2.15**
ENGINEERING, CHEMICAL	0.74	**1.72**	**6.02**
ENGINEERING, ELECTRICAL & ELECTRONIC	0.58	0.45	**2.99**
ENGINEERING, MECHANICAL	0.98	0.53	**1.10**
ENVIRONMENTAL SCIENCES	0.86	0.95	**4.49**
INSTRUMENTS & INSTRUMENTATION	**1.31**	0.73	**1.39**
MATERIALS SCIENCE, MULTIDISCIPLINARY	0.82	**1.23**	**11.36**
MATHEMATICS	0.68	**1.90**	**6.77**
MATHEMATICS, APPLIED	0.84	**1.84**	**6.51**
MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	**1.01**	**1.48**	**1.66**
MECHANICS	**1.23**	0.77	**1.87**
NANOSCIENCE & NANOTECHNOLOGY	**1.30**	0.40	**1.28**
NUCLEAR SCIENCE & TECHNOLOGY	0.94	0.87	**1.29**
OPTICS	0.63	**1.72**	**6.13**
PHARMACOLOGY & PHARMACY	**1.21**	0.29	**1.58**
PHYSICS, APPLIED	0.83	**1.05**	**7.92**
PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	**1.62**	0.46	**1.18**
PHYSICS, CONDENSED MATTER	**1.35**	0.68	**3.22**
PHYSICS, MATHEMATICAL	**1.14**	0.85	**1.53**
PHYSICS, MULTIDISCIPLINARY	0.91	**1.42**	**5.61**
PHYSICS, NUCLEAR	**1.72**	**1.46**	**1.50**
PHYSICS, PARTICLES & FIELDS	**1.50**	0.75	**1.32**
POLYMER SCIENCE	**1.26**	0.73	**1.91**
SURGERY	0.55	0.34	**1.72**

Source: InCites.

ANNEX 2. COMPETENCES OF ROMANIA BASED ON SCOPUS ARTICLES PUBLISHED IN 2006-2010

Competence	Description
Fluids; Heat transfer; Porous materials	Heat Transfer (89.3%); Fluid Mechanics (4.8%); Materials Processing (3.1%)
Manifold; Metric; Submanifolds	Topology (67.5%); Chaos Fractals & Complexity (19.1%); High Energy Physics (9%)
Membranes; Formal languages; Models	Data Mining (88.7%); Computer Systems Theory (11.3%)
Glass; Ions; Paramagnetic resonance	Solar & Wind Power (79%); Ceramics (14.1%); Surface Science (7%)
Nuclei; Fission; Barriers	Nuclear Physics (71.5%); Optics & Lasers (21.2%); Surface Science (7.3%)
Polymers; Azobenzene; Polyimides	Macromolecules & Polymers (100%)
Lasers; Pulsed lasers; Kinetics	Thermal Analysis (61%); Semiconducting Materials (34.6%); Applied Optics (4.4%)

Data source: Scival Spothlight

European Commission
EUR 26276 – Joint Research Centre – Institute for Prospective Technological Studies

Title: ERAWATCH Country Reports 2012: Romania

Authors: Radu Gheorghiu

Luxembourg: Publications Office of the European Union

2014- 38 pp. – 21.0 x 29.7 cm

EUR – Scientific and Technical Research series – ISSN 1831-9424 (online)

ISBN 978-92-79-34518-0 (pdf)

doi:10.2791/3977

Abstract
This analytical country report is one of a series of annual ERAWATCH reports produced for EU Member States and Countries Associated to the Seventh Framework Programme for Research of the European Union (FP7). The main objective of the ERAWATCH Annual Country Reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries.
The Country Report 2012 builds on and updates the 2011 edition. The report identifies the structural challenges of the national research and innovation system and assesses the match between the national priorities and the structural challenges, highlighting the latest developments, their dynamics and impact in the overall national context. They further analyse and assess the ability of the policy mix in place to consistently and efficiently tackle these challenges. These reports were originally produced in December 2012, focusing on policy developments over the previous twelve months.
The reports were produced by independent experts under direct contract with IPTS. The analytical framework and the structure of the reports have been developed by the Institute for Prospective Technological Studies of the Joint Research Centre (JRC-IPTS) and Directorate General for Research and Innovation with contributions from external experts.

LF-NA-26276-EN-N

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new standards, methods and tools, and sharing and transferring its know-how to the Member States and international community.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.

Publications Office

ISBN 978-92-79-34518-0
doi:10.2791/3977