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Abstract

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

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Foreword

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

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Executive summary

Context

The Italian economy is starting to show signs of recovery after the years of recession that followed the financial crisis in 2008 and the euro area sovereign debts crunch of 2011. For the first time in years, gross domestic product (GDP) is forecast to grow, by 0.8% in 2015 and 1.4% in 2016.¹ However, Italy's GDP is still far below pre-2008 levels, and industrial production in 2014 was 25% below the 2007 level.

The debt/GDP ratio is one of the highest in the euro area, at 132.3% (2014). The unemployment rate is 12.7%, with a very alarming 42.7% rate of unemployment among young people (less than 25 years old). Both labour utilisation and labour productivity are low. Productivity has trended down since the mid-1990s because of misallocation of resources and other challenges such as the unfavourable innovation and business environment (OECD, 2015).

Italy put in place a set of strong fiscal consolidation measures, but in doing so it did not preserve its public support for research and development (R&D). As a consequence, Italy did not implement a smart fiscal consolidation strategy.

The Ministry for Education, Research and Universities (MIUR) is the main player in research and innovation (R&I), in charge of coordinating national and international scientific activities, supervising the academic system, funding universities and research agencies, and supporting public and private research and technological development. The Ministry for Economic Development (MISE) manages industrial innovation.

The national research programme 'PNR 2014-2020', delayed since early 2014, has not yet been officially approved.

Italy's R&D intensity is 1.29%, still far from the Europe2020 national target of 1.53%, which will not be reached if the current trend persists. To reach the Europe2020 target the yearly R&D investments should increase – assuming a constant GDP – by €4b, a much greater amount than the resources made available by present policies.

Moreover, the share of gross domestic expenditure on R&D (GERD) performed by the business sector (54%) is low for industrialised economies (OECD, 2014) and much lower than the EU-28 average of 63.67%.

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

- Publication by the MIUR of the guidelines for the new research evaluation exercise, which will be performed by the evaluation agency (ANVUR) on the period 2011-2014. ANVUR's final report is expected by October 2016.
- Modifications to the law on innovative start-ups, which opens the benefits to EU businesses controlling at least one branch in Italy.
- Implementation of the new R&D tax credit scheme. Businesses can benefit from a tax credit of 25% on incremental R&D expenditures; this percentage increases to 50% for extramural research carried out in collaboration with higher education institutions (HEIs) and public research organisations (PROs) or other businesses.
- New legislation on 'patent boxes', providing a 30% deduction from the corporation tax base on the incomes from patents, trademarks, licences and software in 2015, 40% in 2016 and 50% in 2017.
- The launch of the new National Operational Programme 'Research and Competitiveness' (PONREC) 2014-2020, which will trigger €1.29b, part from the European Regional Development Fund (ERDF) and European Social Fund (ESF) (€930m) and the rest from national co-financing (€360m) to the five Less Developed regions in the south (Basilicata, Calabria, Campania, Puglia and Sicily) and the three Transition regions (Abruzzo, Molise and Sardinia).

¹ See: http://ec.europa.eu/economy_finance/eu/forecasts/2016_winter_forecast_en.htm

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

1. unfavourable framework conditions and low level of business R&I activities;
2. public sector funding of R&I;
3. governance and management of the R&I system and policies;
4. territorial inequalities.

R&I Challenges

Challenge 1: **Unfavourable framework conditions and low level of business R&I activities**

Description

The Italian economic fabric is characterised by a production specialisation model still focused on traditional labour-intensive sectors with limited intensity of research, development and innovation, and by the small size of Italian firms.² A small set of innovative firms coexists with a large majority of small and micro enterprises with low productivity (OECD, 2014). The low level of research and development (R&D) activity is both a consequence and a cause of Italy's relative specialisation in low- to medium-technology products.

The intensity of business expenditures for research and development (BERD) in Italy is 0.72%, much lower than in other large EU economies such as France (1.46%), Germany (1.93%) or the UK (1.11%). The BERD in absolute values was €10.9b in 2013, a slight decline from €11.1b in 2012.

It is worth noting that two firms alone – FIAT in the automotive and parts sector and Finmeccanica in the aerospace and defence sector – accounted for 60% of all R&D investment by Italian firms included in the EU top 1,000 Scoreboard ranking (edition 2013)³.

Other indicators point to the low innovativeness of Italian businesses. For example, in 2014 only 18% of large companies were selling online, just over half the EU average (35%). Small and medium-sized enterprises (SMEs) were even less active, with only 5.1% of them selling online – the worst performance in the EU, and far lower than the EU average of 15% (EC, 2015). In addition, Italy ranks 20th among the 34 countries analysed by the Innovation Union Scoreboard in terms of 'non-R&D innovation expenditures'. The rankings for 'Sales of new-to-market and new-to-firm innovations as % of turnover' (17th) and 'Knowledge-intensive services exports as % of total services exports' (21st) are also not outstanding.

The tight lending conditions and the small scale of the venture capital market – Italy ranks 18th in terms of venture capital as a percentage of GDP – are also hampering innovation activities, especially for new, small, innovative companies. Over 80% of firms' R&D spending is internally funded in all four large EU countries, according to the Bruegel Institute. However, in Italy the second biggest source of financing is bank loans (which fund slightly less than 10% of R&D spending), whereas in the UK this proportion is much lower (1%) and equity plays a more important role. Indeed, the role of venture capital funds or business angels, private investors operating on a smaller scale with respect to venture capital funds, is extremely limited in Italy (OECD, 2015).

Policy response

In March 2013,⁴ MISE reformed the system of firms' incentives, to target innovation for competitiveness and support investments in enabling technologies. Firms' incentives are

² "According to data from the National Institute of Statistics (ISTAT), only 3,470 out of more than 4.4 million registered businesses in Italy have more than 250 employees and qualify as large enterprises". See P. Moncada-Paternó-Castello and N. Grassano:

'Innovation, competitiveness and growth without R&D? Analysis of corporate R&D investment - A country approach: Italy' (2014): <http://iri.jrc.ec.europa.eu/documents/10180/12238/Innovation%20Competitiveness%20and%20Growth%20without%20R%26D>. It should be noted that FIAT (now FCA – Fiat Chrysler Automobiles) moved its headquarters to the Netherlands in 2014, so it is no longer registered as an Italian company.

³ Moncada-Paternó-Castello and Grassano (2014)

⁴ MISE D.M, 8 March 2013.

financed by the Fondo per la Crescita Sostenibile (FCS), which includes all the resources for technological innovation.

The MISE has also developed a support strategy based on three pillars: promoting investments, access to capital markets and innovative entrepreneurship.

A new tax credit scheme, available for 2015-2019, has been operational since summer 2015. It allows a 25% tax credit for incremental investments in R&D, up to a maximum annual amount of €5m for each beneficiary. The tax credit is increased to 50% in the case of R&D activities performed in collaboration with HEIs, PROs or other businesses. Incrementality is calculated upon the average of investments made in 2012-2014, and the annual expenditure should be at least €30,000. The forgone tax revenues have been estimated at about €2.5b for the 5 years of validity of the measures.

Italy also introduced a patent box for the first time in 2015, which allows the deduction of 50% of the revenues originated from direct/indirect use of intellectual property (IP) rights (patents, trademarks, industrial designs and models).

Moreover, a MISE-European Investment Bank (EIB) agreement, which allocates €100m of the MISE Guarantee Fund for SMEs to cover the risk of losses in R&D projects of SMEs and Mid-Caps, is expected to trigger a loan portfolio of at least €500m by the EIB.

In addition, liberalisation measures have been taken on the capital markets, allowing bond issuing by unlisted companies and lending to firms by securitisation (SPV) and insurance companies. It is worth noting that Italy was the first EU country to set up rules for the collection of risk capital through online crowdfunding platforms in 2013.

Italy also established the legal definitions of innovative start-ups (2013) and innovative SMEs (2015). These companies are defined on the basis of their R&D expenditure (15% of costs for innovative start-ups and 3% for innovative SMEs), qualified personnel (proportion of personnel holding a PhD and/or a master's degree) and IP ownership/licensing. Innovative start-ups and innovative SMEs benefit from reduced red tape, tailor-made labour law, tax relief, the possibility of raising investments through equity crowdfunding, etc.

Assessment

With the recent measures, Italian policy-makers have been trying to establish a consistent and stable framework to support R&I activities carried out by Italian businesses, whereas past support measures were characterised by their limited timespan and uncertainty in terms of budget availability.

There is also some anecdotal evidence that R&D activities by Italian businesses are under-reported; the new tax credit scheme might have a positive impact on the emergence of the non-reported R&D.⁵

Finally, the recent measures show a shift towards a support system dominated by indirect funding, which might not be entirely suitable for young companies. As recently recommended by the Organisation for Economic Co-operation and Development (OECD, 2015), Italy should try to implement an appropriate mix of direct and indirect funding to business R&I.

Challenge 2: **The public sector funding of R&I**

Description

The Italian public sector's R&D intensity is 0.53%, well below the EU average of 0.72%. The tight public budget conditions have led to cuts in the public sector support to the

⁵ The technical report annexed to the Budget Law 2015 mentions an estimated R&D expenditure by Italian businesses of around €15b in 2012 (http://www.bollettinoadapt.it/wp-content/uploads/2014/11/Legge-Stabilit%C3%A0-2015_Relazione.pdf, p. 7).

higher education system and R&D. Italy is actually amongst the Eurozone countries that have cut R&I budget more rapidly than other public expenditures.⁶

The government budget appropriations or outlays on R&D (GBAORD) recorded a continuing fall from €9.548b in 2010 to €9.161b in 2011, €8.822b in 2012, €8.444b in 2013 and €8.145b in 2014.

In 2013, the budget for universities was 20% lower than in 2008, and the low turnover rate for university full and associate professors caused a significant reduction in their number, which fell by 22% between 2006 and 2012 (IUC, 2014).

Funds for competitive calls have also been drastically reduced: resources for Progetti di interesse nazionale (PRIN) decreased from €100m in 2009 to €38.2m in 2012. Resources for the Fondo per gli investimenti nella ricerca di base (FIRB) amounted to €29.5m in the call launched at the end of 2012. In 2013 and 2014, MIUR did not launch any new FIRB or PRIN call. In January 2014, MIUR published the competitive funding call Scientific Independence of Young Researchers (SIR) with a budget of just €47m. Only in November 2015 was a new PRIN call launched, with a budget of €91.9m.⁷

A 2013 study by the Bank of Italy argues that 'Cuts to the ordinary funding of universities (about €750m in nominal terms between 2008 and 2013) do not appear, for instance, to be coherent with the Europe 2020 commitments for an expansion of the share of young graduates, nor do they seem to be based on a clear strategy in the field of research and innovation'.

For these reasons, the Country Report issued by the European Commission in the framework of the 2015 European Semester invited Italy to 'implement a growth-friendly fiscal adjustment based on the announced significant savings [...], while preserving growth-enhancing spending like R&D, innovation, education and essential infrastructure projects'.

Notwithstanding the limited budget resources, the performance of Italian public research has been improving in recent years, as shown by different recently published benchmarking analyses. Italy has a growing proportion of top publications (IUC, 2014), and ranks at the top in terms of university research productivity, measured by the number of articles per €1m spent on R&D and by the citations per €1m spent on R&D (SciVal-Elsevier, 2013).⁸

A second study on Italy's research output has been carried out by the Bank of Italy (Montanaro and Torrini, 2013). After a wide-ranging survey of available databases on scientific publications – including SCImago, Science Watch and the French OST – it concludes that, in terms of number of publications by public and private researchers, Italy ranks fourth among EU countries, after the UK, Germany and France, with about 3.4% of all scientific publications and citations, while outside Europe only the USA, China and Japan have larger scientific outputs than Italy. If scientific publications are divided by the number of researchers, Italy emerges as the leading country.

Preserving the quality of its research base is a big challenge for the Italian R&I system, in particular in a context of budget cuts and limited job opportunities for researchers in the public sector.

⁶ See R. Veugelers: 'Undercutting the future? European research spending in times of fiscal consolidation': "Most countries under high fiscal consolidation pressure cut their public R&I budgets, but some did so more forcefully than others." <http://www.bruegel.org/download/parent/829-undercutting-the-future-european-research-spending-in-times-of-fiscal-consolidation/file/1731-undercutting-the-future-european-research-spending-in-times-of-fiscal-consolidation>

⁷ <http://prin.miur.it/>

⁸ International Comparative Performance of the UK Research Base: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263729/bis-13-1297-international-comparative-performance-of-the-UK-research-base-2013.pdf

Policy response

On the policy level, Italian policy-makers have been taking steps towards a more open and competitive research system to get the highest value from the public research funds. In 2013, for the first time, 13.5% of institutional funding was distributed on the basis of the results of the Valutazione della qualità della ricerca (VQR), the research evaluation exercise carried out by ANVUR, the state agency responsible for the evaluation of universities and research. This proportion will progressively increase up to 20% in 2016.

The strategic document Horizon 2020 Italia (HIT2020) set the basis for a new 7-year national research programme in line with the European Framework Programme Horizon 2020, in terms of both main strategic areas and timeline. It also aims to increase the proportion of EU funding awarded to Italian researchers/organisations.

Unfortunately, the National Research Programme 2014-2020 (PNR 2014-2020), which is the national strategy for R&I, presented as a draft in early 2014, has not been approved yet.

Assessment

The public budget constraints faced by Italy have had a considerable impact on public R&I expenditure. The European institutions have recommended safeguarding the investments in R&I, but this has not yet been done. Despite the improved performance of the Italian research base, the country is facing a serious risk of brain drain, given the limited labour opportunities for researchers in the public sector and low absorptive capacity of the business sector (see Challenge 1). It is estimated that about 50,000 Italian researchers are already working abroad.

In addition, 'betting' on the availability of EU (Horizon 2020) funds as a substitute for the reduced national resources would mean that Italian applicants in H2020 should significantly improve the performance recorded during the Seventh Framework Programme (FP7) phase. In fact, Italy ranked fifth in terms of total FP7 funding in retained proposals (€11.257b), but the success rate of Italian applicants was only 18.3%, compared with 25.1% in France, 24.1% in Germany and 22.4% in the UK.⁹

The first results of Horizon2020 show that the success rate of Italian applicants is the fifth lowest in the EU.¹⁰

Challenge 3: Governance and management of the R&I system and policies

Description

The Italian R&I system has been characterised by a number of issues affecting the management of R&I policies: fragmentation of strategies, with a great many initiatives at both national and regional levels; delays in the implementation of measures; and instability and uncertainty regarding budget availability and allocations.

The R&I policy governance is the responsibility of MIUR together with MISE. Regions can also develop their own science, technology and industry initiatives on the basis of the concurrency principle.¹¹

⁹ FP7 Monitoring Report 2013 (2015):

https://ec.europa.eu/research/evaluations/pdf/archive/fp7_monitoring_reports/7th_fp7_monitoring_report.pdf#view=fit&pagemode=none

¹⁰ Horizon 2020 – First results (2015):

https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/horizon_2020_first_results_1.pdf

¹¹ Following the revision of Title V of the Italian Constitution, regions can legislate in all the fields that are not the exclusive competence of the central government, thus including R&I.

Other ministries (health, agriculture, defence, etc.) manage research funds and PROs in their specific fields. These PROs with specific missions fall outside MIUR's sphere of control and they are not concerned with the PRN.¹²

The R&I policies in the four Convergence regions (Calabria, Campania, Puglia and Sicily) were jointly managed by MIUR and MISE through the National Operational Programme for Research and Competitiveness (PONREC) 2007-2013. During the 2007-2013 programming period, southern regions also showed a dramatically low absorption capacity of their Structural Funds.¹³

Delays are also affecting the approval and/or implementation of recent measures developed by MIUR: the PRN 2014-2020, the main strategic pillar of the national R&I policy, is still under approval (see Challenge 2); the procedure for hiring university professors on the basis of the National Scientific Qualification (Abilitazione Scientifica Nazionale, ASN) was stopped in the second year of implementation (2014) by MIUR in view of its reform, which is still ongoing. Funds for the SIR and the National Technology Clusters calls were distributed to the awarded projects years after the launch of the calls.

Business R&D support has also been characterised by a high degree of uncertainty; for instance, tax credits for R&D, first introduced in Italy with the 2007 Budget, have gone through frequent changes in terms of budget availability, regulations and procedures.

Policy response

Actions have been taken by the Italian policy-makers to streamline and rationalise the system of PROs. For example, in January 2015, a new PRO, the National Council for Agricultural Research and Analysis of the Agricultural Economy (CREA), was created by merging two organisations, the Istituto Nazionale di Economia Agraria (INEA) and Consiglio per la Ricerca e la Sperimentazione in Agricoltura (CRA).

The first attempt at tackling the dramatic delays in the management of Structural Funds in the southern regions led to the launch of the Cohesion Action Plan in November 2011, in which PONREC funds were merged with Structural Funds. Building on this legacy, Italy announced in August 2013 the creation of the Agency for Territorial Cohesion, which is in charge of the efficient management of Structural Funds for the programming period 2014-2020.

The National Smart Specialisation Strategy identified 12 areas of specialisation¹⁴ across Italian regions (which are consistent with the ones addressed by the upcoming PRN) in order to stimulate cross-fertilisation and reduce fragmentations and duplications.

The measures launched by MISE in support of business R&I (detailed in Challenge 1) have provided a more stable framework for investments in R&I by Italian companies, which can count on, for example, the R&D tax credit for the 5-year period 2015-2019.

Assessment

Italy is still suffering from governance issues, which are affecting strategic pillars of its R&I system. For instance, the delay in the approval of the 2014-2020 PNR, which was planned to be aligned with the timespan of Horizon 2020,¹⁵ has left Italy without a national research strategy for nearly 2 years. In addition, the fact that the PROs outside MIUR governance are not concerned with the PNR is hampering the development of a comprehensive and consistent national research strategy.

¹² Draft RIO CR 2015.

¹³ The total absorption of Structural Funds 2007-2013 was just above 50% in January 2014; this figure then increased to 73.6% in May 2015. Source: <http://www.opencoesione.gov.it/spesa-certificata/>

¹⁴ Aerospace; agriculture and food; blue growth (sea); green chemicals; design, creativity and made in Italy; energy; intelligent factory; sustainable mobility; healthcare; smart, secure and inclusive communities; technologies for living environments; technologies for cultural heritage.

¹⁵ Previous PNRs were 3-year programmes.

On a more positive note, the reformed system for firms' incentives aims to provide a stable and consistent package addressing the different phases of the R&I cycle, from investments (R&D tax credits) to IP revenues (patent box). However, no ex-ante assessment exercise on the additionality of the new schemes was performed, with a risk of a negative impact on the state budget in terms of tax expenditures.

Challenge 4: **Addressing territorial inequalities**

Description

Italy has long suffered from large divergences between the north and the south with respect to key socio-economic factors such as unemployment, female participation, household incomes and many types of crime, especially violent crime. The recession's impact on both economic activity and employment has been more severe in the south than in the north (OECD, 2015).

The divergences between northern and southern regions also emerge when looking at R&I activities and indicators. For instance, there are very huge gaps in R&D intensities between leading regions such as Piedmont (1.51%), Emilia-Romagna (1.09%) and Lombardy (0.94%) and the four Convergence regions, Campania (0.54%), Calabria (0.01%), Puglia (0.19 %) and Sicily (0.23%).¹⁶

The indicator on the total number of innovative start-ups as a proportion of the total number of corporations¹⁷ shows again that the Convergence regions are lagging behind the northern ones. In Piedmont and Emilia-Romagna, innovative start-ups represent, respectively, 0.45% and 0.49% of corporations, compared with 0.19% in Campania, 0.24% in Puglia and 0.25% in Sicily (Calabria, on the other hand, shows a surprising relatively high value, at 0.34%).

Finally, recent cuts in public expenditure on universities and research had a stronger impact in southern regions: between 2008 and 2014 the Ordinary Fund for Higher Education (FFO) (the main block funding) was cut by 0.3% for universities in the north and by 10.7% for those in the south. A compound calculation of the turnover rates for professors and researchers assigned to each Italian university in 2012-2015 shows that universities in the south have lost 281 posts (*punti organico*), while the ones in the north have been assigned 341 additional posts.

Policy response

The PONREC has been the main strategy to boost the R&I-driven competitiveness of southern regions, with a total allocation of nearly €4.6b in five priority areas: (1) industrial research, (2) structural/infrastructural strengthening, (3) clusters and laboratories, (4) smart cities and communities and (5) social innovation.

The Agency of Territorial Cohesion was established following the PONREC experience to coordinate the management of EU Structural Funds and other cohesion policies, including R&I regional actions, for the 2014-2020 programming period (see Challenge 3).

Assessment

The territorial inequalities between the north and south of Italy have dramatically deepened during the recession, as highlighted by a number of recent analyses that warned about the risk of long-term underdevelopment.¹⁸

¹⁶ <http://www.opencoesione.gov.it/progetti/temi/ricerca-e-innovazione/>

¹⁷ http://startup.registroimprese.it/report/3_trimestre_2015.pdf

¹⁸ See the SVIMEZ report 2015 on the economy in the South of Italy: http://www.svimez.info/index.php?option=com_content&view=article&id=335&lang=it

R&I-related initiatives in recent years have had mixed effects on the R&I system of the southern regions. On one hand, the Cohesion Action Plan, launched in 2011, helped improve the very low trend in take-up of Structural Funds, and also involved civil society in the Smart Cities and Social Innovation calls. On the other hand, cuts in public funding and the recent allocation of teaching/research personnel both had negative repercussions on universities in the south, owing to their comparatively low performances in teaching and research and their less efficient financial management of resources. Nevertheless, MIUR introduced some corrective measures to mitigate the effects of the performance-based allocation, e.g. a more favourable calculation in the standard cost per student (+5%) for the universities in the south (the measure affects 25% of the core part of the FFO).

1. Overview of the R&I system

1.1 Introduction

Italy is a large EU country (60.8m inhabitants in 2014), accounting for 12% of the EU-28 population. The country's economic performance started to improve in 2015 after a long recession, but gross domestic product (GDP) has not yet returned to its 2008 values. In 2013 and 2014, GDP growth in real terms was negative (-1.7% and -0.4% respectively); in the first two quarters of 2015, GDP recorded some recovery. The National Institute of Statistics (ISTAT) forecast GDP growth of 0.9% in 2015, 1.4% in 2016 and 1.4% in 2017 (ISTAT, 2015a). The ISTAT estimates are broadly in line with EU-28 growth forecasts.

The long crisis experienced by Italy has changed the position of the country within the EU; in 2014 GDP per capita – traditionally higher than the EU-28 average – was €26 500, lower than the EU-28 average of €27,400. The unemployment rate doubled from about 6% in 2008 to 12.7% in 2014; youth unemployment reached 40%. In 2011-2014, the share of employment in high- and medium high-technology industries was about 5.9%, above the EU-28 average, which in the same period was stable around 5.6-5.7%. Employment in knowledge-intensive sectors, although below the EU-28 average, remained stable from 2011, with a slight increase in 2014 to 34.5% of total employment. From 2010 to 2012 in Italy, the total value added originated by the manufacturing sector was stable around 31%, in contrast to the lower and declining percentages in the EU-28. The value added of high-technology industries in the same years remained unchanged at 2.2-2.3% of the total.

The fall in GDP worsened the ratio of sovereign debt to GDP, which rose from 102.3% in 2008 to 132.3% in 2014, although the general government deficit/GDP ratio from 2012 complies with EU stability programme constraints. The implementation of austerity measures from 2009 to the present time has led to widespread public budget cuts, tight liquidity constraints and falls in the value of investments, affecting the dynamics of R&D expenditure and innovative activities. Many Ministry of Education, University and Research (MIUR) and Ministry of Economic Development (MISE) funds and research calls suffered postponements and periods of suspension because of the scarcity of public funds.¹⁹

Considering research and development (R&D) efforts, in 2013 gross domestic expenditure on R&D (GERD) recorded an increase over 2012 of 1.1% in real terms, although provisional data for 2014 show a fall of 1.8% in real terms since 2013 as a result of a decrease in the R&D performed by the university sector (-5.9%) and by the non-profit sector (-2.7%) (ISTAT, 2015b). In 2014, the business sector was the largest R&D performer, investing 0.72% of GDP, followed by universities, at 0.35%.

In 2013, Italy's total R&D personnel amounted to 246,764 full-time equivalents (FTEs), of whom 116,163 were researchers. The increase in R&D personnel of around 6,600 FTEs since 2012 is concentrated in the business sector. Expenditure for universities accounts for 1% of Italy's GDP, as opposed to the EU average of 1.5%.

Evidence on innovation in firms has been provided by the results of the latest Community Innovation Survey (CIS); according to the 2012 CIS survey, in the period 2010-2012, 51.9% of firms with more than nine employees introduced at least one innovation, a slight increase from previous years; total expenditure on innovation amounted to about €24b in 2012, 50% of which went to R&D expenditure. The economic impact of the innovations introduced was rather limited, accounting for 16.3% of total turnover in 2012. Private companies have introduced innovations with limited cooperation with other organisations: only 12.5% of innovating firms collaborated with

¹⁹ Nascia, L. and Pianta, M. (2015).

others; cooperation with the public sector and with higher education institutions (HEIs) is low and cooperation with foreign firms is marginal (ISTAT, 2014a).

The national R&D intensity target – R&D expenditure equal to 1.53% of GDP – is still far away, and the gap between Italy and the EU-28 average persists. In 2011, the R&D to GDP ratio was 1.21% compared with an EU-28 average of 1.97%. In 2014, the R&D to GDP ratio was 1.29%, compared with an EU-28 average of 2.03%. In 2014, GERD per capita also showed the persistent gap with the EU-28 average: €341.70 per capita as opposed to €558.40 per capita. If current policies continue, it seems unlikely that Italy will reach the national R&D intensity target in 2020 and the country may see an increasing gap with the EU-28 average R&D intensity.

Table 1: Main R&I indicators 2012-2014

Indicator	2012	2013	2014	EU average (2014)
GDP per capita (€)	26,800	26,500	26,500	27,400
GDP growth rate (%)	-2.8	-1.7	-0.4	+1.4
Budget deficit (% of public budget)	-3.0	-2.9	-3.0	-2.9
Government debt (% of GDP)	123.2	128.8	132.3	86.8
Unemployment rate as percentage of the labour force	10.7	12.1	12.7	10.2
GERD (€m)	20,502.5	20,983.1	20,770.3	283,009.388 (total for EU-28)
GERD (% of GDP)	1.27	1.3	1.29	2.03
GERD (€ per capita)	345.20	351.60	341.70	558.40
Employment in high- and medium high-technology manufacturing sectors (% of total employment)	5.9	5.9	6.0	5.7
Employment in knowledge-intensive service sectors (% of total employment)	33.9	34.2	34.5	39.8
Turnover from innovation (% of total turnover)	11.0	NA	NA	11.9
Value added of manufacturing (% of total value added)	30.8	31.3	NA	26.2 (2012)
Value added of high-tech manufacturing (% of total value added)	2.3	2.3	NA	2.5 (2012)

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

1.2.1 Main features of the research and innovation system

Italy's R&D system is based on a mixed public-private funding model; in 2012, 47.1% of resources for R&D were provided by the business sector and 43.5% by the public sector. Funds from abroad – including EU funds – accounted for 9.5% of R&D financing (ISTAT, 2014b, p. 2).

The business sector is the largest R&D performer. In 2013, the private business sector accounted for 54% of total GERD, followed by universities, with 28.2%, and public institutions, which are mainly public research organisations, with 14.9% of GERD. In 2013, large businesses with 500 employees and more accounted for around 62.5% of R&D performed by private businesses, and small firms with fewer than 50 employees accounted for 10.3% of private business R&D²⁰ (ISTAT, 2015b). In 2012, multinationals recorded around €2.6b of R&D investment, a slight decrease from 2011 (ISTAT, 2014c).

1.2.2 Governance

The governance of Italy's research and innovation (R&I) system gives the top role to the Council of Ministers, which defines priorities and outlines policies in the National Research Programme (PNR), the main government document for R&D planning, and allocates resources through the annual Budget. The Budget allocates resources for 1 year and plans their allocation for 3 years. The Budget, designed by the Prime Minister, is voted on and amended by Parliament. A key role is also played by MIUR and MISE.

Regions have limited participation in R&I policies, since the devolution of responsibilities to local institutions delegates R&I policies at regional level only under the concurrency principle. Regions can develop local initiatives in R&I and contribute to policy-making on R&I; in some cases, research organisations are funded and managed by regions. In particular, regions manage the innovation funds within the National Operational Programme 'Research and Competitiveness' (PONREC) framework, which concerns the R&I activities that are part of territorial cohesion policies. The PNR has no financial mandatory commitment and its implementation is realised under the constraints of Budgets. Political instability has often undermined the effective allocation of resources and guidelines in the long term. The new PNR 2014-2020, presented as a draft in February 2014, has been delayed because of the revisions introduced by the new minister and the still pending approval by the Inter-Ministerial Committee for Economic Planning (CIPE).

MIUR is the main player in R&I, in charge of coordinating national and international scientific activities, supervising the academic system, funding universities and research agencies, and supporting public and private research and technological development. MIUR coordinates the preparation of the PNR in consultation with other ministries, regions and other stakeholders such as business organisations.

The National Agency for the Evaluation of Research (ANVUR) is in charge of the monitoring and evaluation of the research system. ANVUR started its activities in 2011²¹ and since then it has expanded its role overseeing universities, setting the ground rules for the authorisation of university courses, doctoral courses and the national qualification, the system introduced in 2012 for recruiting professors in universities. In 2013, ANVUR published the first evaluation report on Italy's universities and public research organisations (PROs) (ANVUR 2013). In 2014, the report on the state of research in Italy was published (ANVUR, 2014). In 2015, ANVUR started the preliminary

²⁰ In 2013, businesses with 50-249 employees accounted for 16.4% of the R&D of private business; businesses with 250-449 employees accounted for 10.8%.

²¹ Formally created by Law 186/2006.

activities for the second evaluation on Italy's universities and PROs for 2011-2014 in accordance with the guidelines set up by MIUR.²²

CIPE has the role of coordinating science and technology policy – focusing on medium- and long-term actions – and releasing the PNR proposed by MIUR. CIPE also reviews the Economic and Financial Document (DEF), which includes the National Reform Programme (NRP), relevant for monitoring the policy agenda and its impact on the R&I system.

MISE manages industrial innovation. In particular, the Department for Competitiveness is in charge of technological innovation and responsible for industrial policy, industrial districts, energy policies, policies for small and medium-sized enterprises (SMEs), and instruments to support the production system. At the same time, the Department of Development and Social Cohesion (DPS) is in charge of the planning, coordination and management of EU Structural Funds and has outlined specific actions for research and innovation in the multiannual programme Quadro Strategico Nazionale (QSN) 2007-2013²³. The Agency for Territorial Cohesion has been created to coordinate the use of EU Structural Funds and cohesion efforts, including R&I regional actions; since 2013, it has been the responsibility of the DPS. MISE and MIUR coordinate Italian participation in Horizon2020 in the areas relevant to their activities, coherently with their own strategies and with the Smart Specialisation Strategy.

Other ministries (health, agriculture, defence, etc.) manage research funds in their specific fields. The list of PROs outside the remit of MIUR is very long and includes a wide range of typologies of PROs with different governance, regulations and research objectives. The Ministry of Health manages the Istituto Superiore di Sanità (ISS); the Ministry of Labour manages the Istituto per lo Sviluppo della Formazione Professionale dei Lavoratori (Isfol), a PRO focusing on labour studies; the Environment Ministry manages the Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), the Agriculture Ministry manages the Istituto Nazionale di Economia Agraria (INEA) and Consiglio per la Ricerca e la Sperimentazione in Agricoltura (CRA); finally the Presidency of the Council of Ministers manages the Istituto Nazionale di Statistica (ISTAT), the national statistical institute.²⁴ The governance and missions of these institutions are deeply connected with the reference ministry and a large proportion of MIUR measures are not addressed to these PROs. This means that labour conditions vary, the strategy is fragmented, work is duplicated and the research programme is not able to take advantage of all available resources.²⁵

Fragmentation is the key issue that is limiting the effectiveness of the current research policies, since PROs falling under the supervision of different institutions have different juridical frameworks, face many barriers to cooperation and are an obstacle to the management of common objectives for the governance of the research system. On top of this, the assessment of the quality of research largely excludes the output of PROs that are not under MIUR's supervision and, in some cases, that assessment is replaced by other evaluation systems aiming to ensure the compliance of the institutional mission more than the quality of research output.

The Digital Italy Agency (AgID), established in 2012,²⁶ is in charge of the Italian Digital Agenda (IDA) under the control of the Prime Minister's office.

²² MIUR DM 27/06/2015 Linee guida VQR11-14.

²³ A new QSN for the 2014-2020 programming period is not available yet

²⁴ See Montanaro and Torrini (2013) Table A8 for a complete list of the PROs under the supervision of other institutions than MIUR.

²⁵ See De Luca (2013). The article illustrates how the high number of PROs is relevant to research, how they follow different trajectories from the MIUR-controlled PROs and the consequent issues for the whole R&D system.

²⁶ Law 134/2012 amended the constitution of the previous agency for the Agenda Digitale, which has never been fully operational.

Invitalia, an agency owned by the Ministry of the Economy and Finance (MEF), implements entrepreneurial initiatives, including some of MISE's innovation programmes, such as Brevettiplus and Brevettiplus2, and the funding of innovative start-up firms.

Responsibility for R&I policies has remained in the hands of the national government. Regions, under the concurrency principle, develop local initiatives in R&I and contribute to policy-making on R&D; in some cases, research organisations are funded and managed by regions through local innovation agencies. In particular, regions manage the innovation funds within the PONREC framework, concerning the R&I activities that are part of territorial cohesion policies.

The university system does not play a major role in the decision-making process on R&I policy. The National University Council (CUN) is an elected body representing the Italian university system and acts as MIUR's independent consultative body on university policy, national research programmes, funding allocation and recruitment policies. The Conference of Italian University Rectors (CRUI) also plays a consultative role over higher education policies.

In 2013, the more relevant evaluations of Italy's R&I system included five documents: *Horizon 2020 Italia Ricerca e Innovazione* (HIT2020; MIUR, 2013); the ANVUR research quality assessment (*Valutazione della Qualità della Ricerca*, VQR; ANVUR, 2013); the report by CUN on universities (CUN, 2013); the ANVUR report on the university and research system (ANVUR, 2014); and a study by the Bank of Italy on the public research system (Montanaro and Torrini 2013). The ERAWATCH Country Report 2013 and the RIO Country Report 2014 already examined the findings of such studies.

The VQR was the first assessment of the quality of research of HEIs and PROs through the full use of output indicators and international benchmarking. The VQR does not provide an evaluation of each research programme and it affects the allocation of the institutional funds for HEIs and PROs (Ordinary Fund for Higher Education, FFO, and Ordinary Fund for Public Research Organisations, FOE). The next VQR is still in progress and will evaluate HEIs' and PROs' outputs for 2011-2014.

MEF implements econometric forecasting for GDP growth and public debt stabilisation. MEF forecasts are published in the yearly *Documento di economia e finanza* (Document of Economic and Financial Policy, DEF), which complies with the EU econometric model QUEST III (which includes R&D impact on growth). The Budget passed by Parliament is not usually supported by forecasts of GDP growth.

1.2.3 Research performers

Public research is based on HEIs and PROs. In 2015, 96 universities were active, of which 66 are public institutions and 11 provide only distance learning (online; *Università telematiche*).²⁷ The territorial distribution of HEIs ensures that university education and research activities are accessible throughout the whole country. The teaching function has been affected by a widespread reduction in personnel since 2008, as a result of recruitment constraints and retirements. The number of students has also been progressively decreasing since 2009, partly because of an increase in students' fees following the reduction of transfers from the government to the universities, but also as a result of a reduction in the number of university and doctoral courses (ANVUR, 2014). Austerity has also had a negative impact on competitive calls, which have been underfinanced and postponed. Concerning the 'third mission', the ANVUR report stressed the heterogeneity of activities to be evaluated but did not provide any conclusive assessment. Thus, budget cuts affected the tuition fees although they did not push many HEIs to merge to save costs.

²⁷ The full list can be downloaded from the MIUR portal: <http://cercauniversita.cineca.it>.

MIUR is in charge of supervising 12 national PROs. PROs have an important role in the whole research system, in contrast to the UK pattern, which is based on HEIs only. In the Italian system, PROs are specialised in applied research, HEIs in fundamental research and private businesses in industrial research.

The National Research Council (CNR) is the largest PRO. It is a network of multidisciplinary institutes throughout the country, with around 7,200 employees²⁸ and an average yearly budget of around €900m, 66% of which comes from the institutional block fund (FOE). The National Agency for New Technologies, Energy and Sustainable Development (ENEA), with around 2,500 employees²⁹ and a budget of around €250m, supervised by MISE, has the mission of carrying out R&D on energy and the environment. The ISS, with around 1,500 employees³⁰ and a yearly budget of €280m, supervised by the Health Ministry, is in charge of pharmaceutical and health research and of the Health Research Programme.

The private sector employs around 171,000 people in R&D activities, of whom 52,700 are researchers,³¹ mainly concentrated in large companies, with a significant proportion in multinationals. The territorial distribution shows a concentration of employment and business R&D expenditure in the northern regions and Lazio, rather than a homogeneous distribution of HEIs among regions.

The business sector in Italy shows a small number of large companies involved in R&D; therefore, their economic specialisation hugely affects the field of research and, in some cases, mergers and acquisitions as well as corporate strategies can have a profound effect on the objectives and the quantity of R&D performed in the country. Fiat (automotive), Finmeccanica (aerospace and military), Telecom Italia (telecommunications), Unicredit and Intesa San Paolo (banking) are the most relevant R&D players in the top 1,000 EU companies ranked by R&D.³² After 2010, Fiat – the main private player in R&D – downsized its economic activities in Italy and in 2014 became Fiat Chrysler Automobiles (FCA), moving its headquarters to the Netherlands. The corporate strategies of Fiat may in the future affect the allocation of the intragroup R&D investments, including relocation of laboratories.

At the beginning of 2000 the reallocation of activities within Telecom Italia, especially during the merger with Pirelli, affected the quality of research activities allocated in Italy.

The high importance of Finmeccanica, a company under the control of the government, is mainly due to the Defence Ministry budget, since Finmeccanica is largely focused on the military industry. However, since the JRC Scoreboard reports on R&D investments only by group of firms, detailed information about territorialisation of R&D investments and the actual field of R&D performance cannot be provided. National official data on business R&D for 2015 (ISTAT, 2015b) confirm the prevalence of automotive, banking and telecommunications, which account for around one-third of the total BERD, and to a lesser extent, of radio, television and communication equipment and apparatus, as well as machinery and equipment not elsewhere classified (n.e.c.) and pharmaceuticals.

²⁸ Data are for 2013 and do not include fixed-term personnel (www.cnr.it).

²⁹ Data are for 2015 (www.enea.it).

³⁰ Data are for 2015 (www.iss.it).

³¹ Data are for 2013 and are expressed in headcount (ISTAT 2015b).

³² 2014 EU Industrial R&D Scoreboard (<http://iri.jrc.ec.europa.eu/scoreboard14.html>).

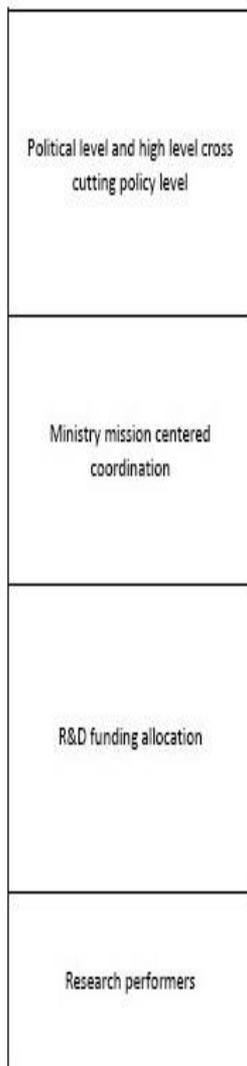


Table 1: The structure of the Italian R&D system

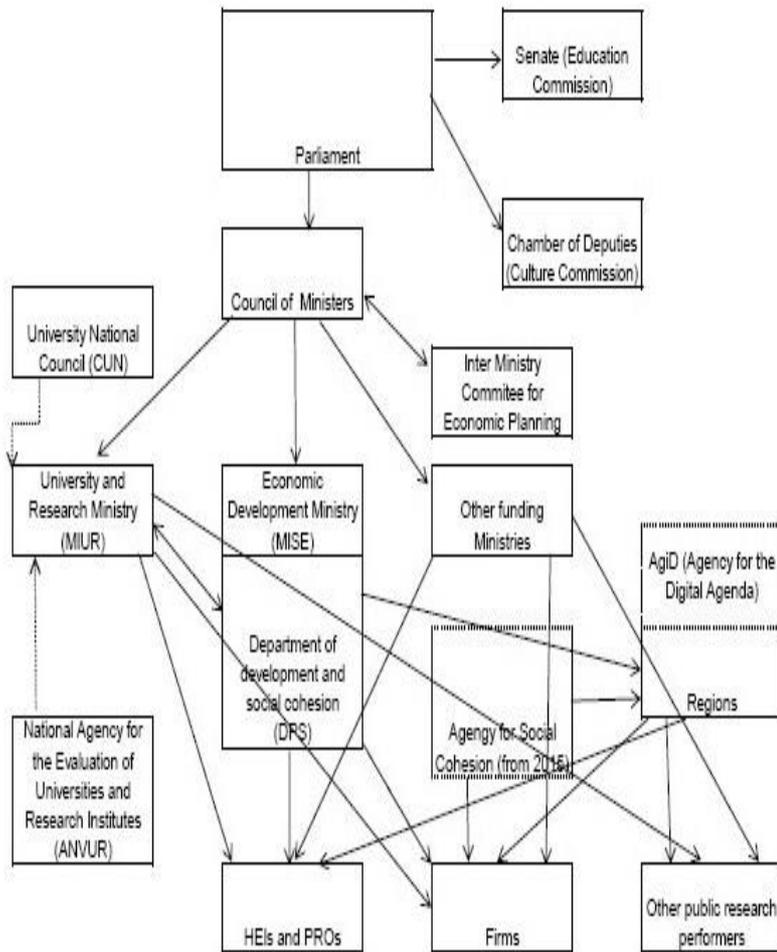


Figure 1: Structure of the Italian R&D system.

2. Recent developments in R&I policy and systems

2.1 National R&I strategy

The National Research Programme 2014-2020

The new PNR 2014-2020 should, since 2014, be the major document on which national R&I strategy is based. However, the change of government in 2014 and the amendments by the new minister, Stefania Giannini, have delayed the whole process, which is still pending, as approval by the CIPE has not yet been received.³³

The new PNR proposes an integrated approach to education, innovation and research with a special focus on public-private cooperation and industrial research (MIUR, 2014a). The strategy has been set up on a 7-year term to be in line with the EU Horizon 2020 programme and with the EU Structural Funds programming period, facilitating joint planning and implementation. It complements the strategic document HIT2020 released by MIUR in 2013, including the evidence coming from the strength and weakness analysis supplied by HIT2020. The PRN has been designed with the cooperation of relevant stakeholders such as regions, public institutions and firms organisations. It provides a roadmap for R&I for 2014-2020, aiming to advance frontier science and implement the Europe2020 targets.

The minister amended the original version of the PNR and grouped the identified grand challenges in four categories³⁴: the priority group for accessing resources (agrifood, aerospace, design creativity and Made in Italy, and smart farms); the high-potential group (Blue Med, green chemicals and cultural heritage); the transitional group (smart communities, technologies and life environment); and finally the consolidated group (energy, mobility, transport and health).³⁵ The new PNR also pays particular attention to research infrastructures, a traditional strength of the Italian R&I system.

The main goals include simplification, effectiveness and efficiency of investment in R&I; greater researcher mobility; and ability to attract larger shares of EU financing.

The PNR 2014-2020 has the explicit aim of integrating Structural Funds in R&I policies – as also stressed in the HIT2020 strategic document. This document envisages a stakeholder consultation intended to design a shared strategy taking into consideration the interests of society; an analysis of the strengths and weaknesses of the national R&I system is also proposed, leading to the Smart Specialisation Strategy, which could become a policy priority.

MIUR plans to allocate around €4.6b³⁶ by 2020, leveraging €11b from EU programmes, namely €8.8b from Horizon2020, with an increase of around 20% in the resources awarded to Italian participants, and €2.2b from Regional Operational Programmes (POR). As discussed above, although the minister presented the revised PNR in February 2015, a full version is not openly available yet and CIPE's approval is still awaited. Thus, the programmes, priorities and the overall strategy have not yet been implemented, leaving the system in a long period of uncertainty.

³³ The CIPE had not yet discussed the PNR at the end of October 2015.

³⁴ A full version of the new PNR is not available yet; Giannini presented only a summary of the PNR to the press: <http://www.scuola24.ilsole24ore.com/art/universita-e-ricerca/2015-01-29/pronto-pnr-2014-2020-ricerca-46-miliardi-7-anni-200233.php?uclid=ABldiJmC>.

³⁵ The former version of the new PNR included 11 Grand Challenges for the R&I system: scientific and cultural progress; health, demographic change and wellbeing; European bio-economy challenges; secure, clean and efficient energy; smart, green and integrated transport; climate action, resource efficiency and raw materials; Europe in a changing world – inclusive, innovative and reflective societies; space and astronomy; secure societies – protecting the freedom and security of Europe and its citizens; restoring, preserving, valuing and managing the European cultural heritage; creativity; and digital agenda.

³⁶ €2.9b from FFO, FOE, FISR and the Basic Research Investment Fund (FIRST) and €1.7b from the PONREC.

2.2 R&I policy initiatives

In the last 3 years, policy initiatives have focused on the revision of research system assessment, funding schemes, innovation in firms, tax credits, doctoral training and patents. The short durations of the last three governments caused delays and postponements of some measures.

The revision of ASN

The new recruiting system Abilitazione Scientifica Nazionale (ASN) – a qualification system for scholars who want to become candidates for positions as full and associate professors – was revised by the new Research Minister, Stefania Giannini, at the end of the first two exercises of 2014 and 2015, but only in the second half of 2015 did the government publish the new guidelines, which were to come into effect 1 year later. In accordance with the revised rules, the new qualification procedure would start in 2016.

The new research system assessment

In 2011, MIUR released the regulation to the first assessment of the quality of research in Italy for PROs and HEIs.

In June 2013, ANVUR, the institution in charge of the evaluation, published the final report on the assessment of the quality of research over 2004-2010 (VQR), and in March 2014 it published the first report on the research and university system in Italy.

The VQR assessed the performance of both universities and departments (95 HEIs, 12 PROs and 26 other research institutions such as inter-university consortia). It involved the participation of experts for each discipline (including foreign experts) in peer-review processes, lists of scientific journals for ranking research quality and other assessment tools. The indicators of the VQR measured the output in each scientific field, with a focus on the third mission to understand the connections with the economic and social context.

In 2015, MIUR published the guidelines for the 2011-2014 VQR. The new assessment will also include indicators of the capacity to gain national and international competitive projects and the quality of doctoral training. ANVUR's final report is envisaged for October 2016. The reaction of the scientific community to the MIUR guidelines has been very negative. On 12 November 2015, CUN officially asked the minister to stop the implementation of the VQR 2011-2014.³⁷ The request arose from the increasing turmoil in the universities. At the end of 2015,³⁸ 87 petitions in 37 HEIs asked that the new VQR be stopped, because of issues about the methodology and the increasing budget cuts, which were also scheduled in the most recent Budget.

The availability of the VQR allowed a growing proportion of the two institutional funds to be allocated in accordance with the VQR results. The assessment of HEIs and PROs has become a key factor in recruitment in HEIs and PROs, since permission to hire new recruits largely depends on the VQR scores.

The innovative start-up laws (2012 and 2015)

The innovative start-up law approved in 2012 is the major policy in Italy to trigger innovation in private business.

The policy started during the Monti government with the approval of Law 221/2012, which defined innovative start-up and certified incubators, simplified the administrative burden for innovative start-ups, implemented some exceptions to labour laws, streamlined access to the credit market and to innovative financial instruments such as equity crowdfunding, and introduced some easier ways to access international markets. Finally, the set-up of new rules aims to help develop a new enterprise if a first start-up fails financially.

³⁷ <https://www.cun.it/uploads/6079/RACCOMANDAZIONEVQR11NOVEMBRE2015.pdf?v=>

³⁸ <http://www.roars.it/online/sale-la-febbre-84-mozioni-in-37-atenei-e-ora-anche-il-cun-raccomanda-stop-vqr>

According to Law 211/2012, an innovative start-up is defined as a firm established within the last 48 months, with headquarters located in Italy and a turnover of less than €5m, that does not distribute profits and has technological innovation as its main activity. Moreover, innovative start-ups must comply at least with one of the following requirements:

1. R&D investments not lower than 15% of total costs or production value, whichever is higher;
2. at least 33% of the workforce holding a PhD or studying for a doctorate and at least 50% of the workforce having a tertiary education degree;
3. holding the IP of at least one patent, trademark or licence.

Innovative start-ups take advantage of free registration in the business register, specific labour law discipline, priority visas for extra-EU employees, tax credit for the employment of high-skilled employees, tax benefits for managers, employees, administrators and investors, web crowdfunding, access to the Fondo centrale di garanzia per le piccole e medie imprese and, finally, streamlined access to some internationalisation services.

A certified incubator is an Italian firm providing services to promote development and creation of innovative start-up firms. The certified incubator must offer also the necessary premises for the start-up activities, provide high-bandwidth internet access and be managed by experienced and skilled personnel. Certified incubators cooperate with universities, financial partners and research centres connected to the activities of their portfolio of start-ups.

For operational implementation, Law 211/2012 delegates to a large amount of secondary regulations that were released by MISE and CONSOB, the stock market regulatory agency, only during 2014. The increases in the number of innovative start-ups (5,106 in the third quarter of 2015) and certified incubators (37 in the third quarter of 2015³⁹) are encouraging signs of the success of the policy.

MISE publishes an annual report on the monitoring of innovative start-ups. The monitoring activity focuses on the access of innovative start-ups to the financial facilitations, with a bimonthly report that makes available information about the Fondo di garanzia. Invitalia is MISE's agency in charge of promoting the innovative start-up law. At the end of September 2015, Invitalia had financed 604 innovative start-ups, which took advantage of €159m of benefits and incentives.

Law 33/2015, the 'Investment compact', amended the 2012 innovative start-up law with the explicit aim of increasing the number of firms benefiting from the 2012 law. Law 33/2015 also assessed as eligible firms based in any EU country but controlling at least one foreign branch in Italy, and extended the start-up notion to firms established within the previous 60 months.

The new law also introduced the definition of an 'innovative SME', which can take now advantage of many fiscal and financial aids available to innovative start-ups. Innovative SMEs include firms based in any EU country but controlling at least one foreign branch in Italy of business, including incorporated companies, which must comply at least with one of the following requirements:

1. R&D investments not lower than 3% of total costs or production value, whichever is higher;
2. 30% of the workforce holding a PhD or studying for a doctorate and at least 50% of the workforce having a tertiary education degree;
3. holding the IP of at least one patent, trademark or licence.

³⁹ The register of innovative start-ups and of certified incubator is available at: <http://startup.registroimprese.it>.

Innovative SME status allows access to fiscal holidays for the administrators and employees, simplified bureaucratic procedures, tax benefits for the investors, innovative ways to access the capital market, such as crowdfunding, and, finally, streamlined access to funds to finance internationalisation activities. Innovative start-ups as well as innovative SMEs are recorded in a special section of the business register of the Chamber of Commerce.

FFO and FOE allocation criteria

At the beginning of June 2015, the new FFO for universities was published by MIUR, some months in advance of the traditional deadline at the end of the year.⁴⁰ The new FFO, unlike that in 2014, showed another reduction in financing: funding was €6.9b in 2015 compared with €7b in 2014, resulting in a total reduction of €87.4m following the spending review of 2014.⁴¹

As in 2014, the FFO adopted two innovative mechanisms for the distribution of funds among universities. First, 25% of the FFO is distributed among universities on the basis of a 'standard cost' per student.⁴² Second, 20% of the FFO will go to 'better-performing' universities, and will be distributed as follows:

- 65% on the basis of their performance in the ANVUR quality assessment review (ANVUR, 2013);
- 20% on the basis of their recruiting policies (scientific production assessed by ANVUR of the professors who are recruited or promoted);
- 8% on the basis of the international teaching activities, combining the presence of foreign students and the courses followed abroad by local students;
- 7% on the basis of teaching activities.

CRUI (2015a) highlighted the €800m of total cuts on public HEIs from 2009, the dramatic fall of personnel in HEIs and the lack of a policy for the recruitment of young Italian researchers.

ANVUR (2014) and CUN (2013) explained the dangers behind the drop in public financing of HEIs.

The 2015 Budget recorded some reductions to the institutional fund for PROs (FOE): €42.9m in 2015 and €43m in 2016, in addition to the reduction of €51.2m in 2013 coming from the first spending review act.⁴³ Although Art. 4 of Law 213/2009 required an increasing proportion of funding be based on performance, in 2014 only 7% of FOE, the institutional fund for PROs, was allocated according to the results of the scientific output assessment. Finally, MIUR in 2014 and 2015, published the allocation between PROs of the 2014⁴⁴ and 2015 FOE,⁴⁵ respectively €1.75b and €1.7b.

The tax credit reform

In recent years governments have often redesigned the tax credit schemes for R&D. Frequent changes of regulations and procedures affected which firms are eligible for those measures. Many changes and delays due to bureaucratic procedures, however, have created uncertainty for business investment decisions, especially considering the long-term strategies, which would require a stable system of incentives.

⁴⁰ MIUR, DM 8 June 2015 no 335. Decreto criteri di ripartizione del Fondo di finanziamento ordinario (FFO) delle università per l'anno 2015.

⁴¹ Unlike many other ministries, MIUR spending review working group reports have not been made available; see:

<http://revisionedellaspesa.gov.it/rapportigruppilavoro.html>.

⁴² The standard cost methodology is outlined in a joint MIUR-MEF regulation, Decreto Interministeriale 9 December 2014 n. 893.

⁴³ Law 135/2012.

⁴⁴ DM 24 November 2014, no. 851.

⁴⁵ DM 10 August 2015 no. 599.

In 2007, the government experimented with a first general policy based on tax credits allocated through the 'click day', a selection process that awarded funds to firms in the order that the electronic requests arrived for 2008 and 2009.⁴⁶ In 2010, tax credits were not available. They were reintroduced in 2011 by the Monti government, which launched tax credit schemes for businesses financing research projects in partnership with universities or public research entities and for firms employing highly skilled workers in innovation and research. The resources for businesses financing university research projects were €55m in 2011, €180.8m in 2012, €157.2m in 2013 and €91m per year from 2014 onwards.⁴⁷ R&D tax credits for firms employing highly skilled workers in innovation and research were financed to the amount of €25m in 2012 and €50m from 2013.⁴⁸ At the end of 2013 the government reintroduced a general tax credit scheme⁴⁹ based on incremental expenditures and allocating a total budget of €600m for 3 years. This scheme was amended before the necessary operational regulation entered into force. Finally, the 2015 stability law⁵⁰ amended the tax credit regulation.

The 2015 stability law reduced the tax credit benefit to 25% of incremental R&D expenditures, except for the employment of highly skilled personnel and for HEIs and PRO partnerships. The maximum amount of eligible R&D expenditures is now €5m, the reference period is 2015-2019, the firm's turnover limit for eligibility was removed, patent expenditures are not eligible any more, since they are included in the 'patent box' measure, and the financial resources come from the abolition of the former tax credit initiatives.

A joint MISE-MEF secondary regulation⁵¹ sets the operational rules for the implementation of the new incremental scheme, detailing eligible expenditures. The incremental scheme is based on the difference between the average R&D expenditure of the 3 years before the tax credit reference year and the one of the year for which the tax credit is claimed. MEF will monitor on a monthly basis the compliance of the available sources for tax credits with the requests from the firms. The expected maximum financing is €255.5m in 2015, €428.7m in 2016, €519.7m in 2017, €547m in both 2018 and 2019, and €164m in 2020.

The patent box

The Italian approach towards patents initially did not comply with EU regulations no 1257/2012 and no 1260/2012 on the European patenting policy. There was in protest against the unequal language policy, since patents, according to the abovementioned regulations, are translated into three languages only. Italy then joined the Unitary Patent in September 2015, thus becoming the 26th member of the enhanced cooperation on Unitary Patent protection.

Another novelty in the national approach is the optional tax regime of the patent box. The 2015 stability law, amended by the investment compact law,⁵² has introduced the so-called 'patent box' measure, a specific tax scheme for patents, trademarks, licences and software. The tax facilitation consists of a deduction from the firm tax base of 30% of the incomes generated from patents, trademarks, licences and software in 2015. The deduction will increase to 40% in 2016 and to 50% in 2017. The MISE operational regulation of 27/8/2015 defines the modalities of implementation of the patent box scheme, under the reference of the OECD recommendation 'Countering Harmful Tax Practices More Effectively, Taking into Account Transparency and Substance, Action 5:

⁴⁶ Cantabene and Nascia (2014) have assessed the effectiveness of R&D tax credits provided in the period 2007-2009, finding some additionality of public and private funds.

⁴⁷ Law 12 July 2011 no 106.

⁴⁸ Law Decree no 83/2012.

⁴⁹ Law Decree no 145/2013. The art. 3 allowed a tax credit for the 50% of incremental R&D investments for a maximum of €2.5b.

⁵⁰ Law 190/2014.

⁵¹ DM 27/05/2015.

⁵² Law 33/2015.

2014 Deliverable'. Patent box policies are widespread in Europe, although some economists argue that they have negative effects on tax revenues and inequalities that are not counterbalanced by positive effects on innovation (see Mazzucato, 2013).

The doctoral reform

Law 240/2010 delegated the reform of doctoral training to a MIUR regulation released only in February 2013 by minister Francesco Profumo. The new regulation of doctoral courses meets the European Research Council (ERC) principles of innovative doctoral training and aims to increase the quality and attractiveness of doctoral schools in Italy.

The 2013 regulation introduced the 'industrial doctorate' and gave the ministry the authority to accredit doctoral programmes on the basis of the quality evaluation conducted by ANVUR, which monitors and assesses the new courses. Allocation of funding to doctoral programmes by the ministry follows the criteria set by the abovementioned MIUR regulation and relates to the quality of research conducted by the doctoral board, internationalisation of the doctoral programme, attractiveness, services and infrastructures available to programmes and candidates.

In January 2014, the ministry released the operational regulation for the new doctoral courses, taking into account ANVUR proposals for doctoral assessment.

Some additional resources are included in the PNR 2014-2020, with a yearly budget of around €60m.

PONREC 2014-2020

With the approval by the European Commission (EC) in July 2015 of the new PONREC 2014-2020 the government triggered the national implementing procedures. Five Less Developed regions (Campania, Apulia, Basilicata, Calabria and Sicily) and three Transition regions (Abruzzo, Molise and Sardinia) will take advantage of the activities of the new PONREC, which is intended to include around €1.29b coming both from the European Regional Development Fund (ERDF) and the European Social Fund (ESF) (€930m) and from local co-financing (€360m). MIUR will be in charge of the programme. The new PONREC has been designed to avoid any fragmentation with other programmes within the partnership agreement.

Funds largely focus on three areas: technological clusters (€327m), enabling technologies (€339m) and research infrastructures (€286m).

The envisaged activities will finance human capital projects (€283m), namely industrial doctoral courses (€114m), attraction of senior researchers to the target regions (€86m) and mobility (€83m).

The thematic fields of the new PONREC match with the thematic fields of the new PNR, which looks at leveraging EU resources as a key point of its long-term R&I strategy.

Evaluations, consultations, foresight exercises

The evaluation exercise carried out by ANVUR on universities and research (ANVUR, 2014) provides evidence based on the ISI Web of Science database of Thomson-Reuters and on the SciVal Scopus database of Elsevier. Data show that Italy's share of world scientific publications is now 4.4% in the fields of 'hard sciences' (including health and engineering, defined by ANVUR as 'bibliometric fields' where quantitative data are more reliable and relevant) and 1.9% in social sciences and humanities, with an increasing trend in both cases. Italy appears to be specialised in mathematics and physics, earth sciences, health sciences in the former group, and in decision sciences, economics and finance and psychology in the latter (ANVUR, 2014, pp. 485-490). In social sciences and humanities the English-language bias of available databases and the greater importance of publications in national languages explain the lower share of Italian scientific output.

However, even in this area, Italian articles are cited less frequently than articles from the UK, although the number of citations is similar to that achieved by articles from

Germany and higher than that of French and Spanish articles. Considering 'high-quality' articles in 'hard sciences' – those included in the top 10% of the world's most cited articles published in 2008 and receiving citations in the following 5 years – Italy's share is 13.1% of all its publications, compared with 13.4% for France, 15.5% for Germany and 16.6% for the UK (ANVUR, 2014, p. 498).

The ANVUR report also assesses the productivity of Italian researchers by relating scientific output to the expenditure for R&D. Considering the SciVal-Scopus database for 2010, Italy shows 3.88 publications per USD 1m R&D expenditure (at 2005 prices), compared with 2.33 in France, 1.78 in Germany and 4.14 in the UK. When only public R&D is considered, the values are 9.15 for Italy, 6.55 for France, 5.42 for Germany and 11.31 for the UK. The latter indicator has increased substantially over the previous 5 years for Italy, while it has declined for Germany and remained stable for the other countries. It is remarkable that in a context of drastic reduction of public resources the productivity of Italian researchers continues to improve and the results are 40% higher than German productivity (ANVUR 2014, p. 516). Even more striking results are obtained when productivity is measured in relation to the number of researchers: in 2010, Italy produced 0.54 articles per researcher, compared with 0.31 in France, 0.27 in Germany and 0.38 in the UK.

When only public researchers are considered, the productivity indicator is 0.82 for Italy, 0.73 for France, 0.47 for Germany and 0.51 for the UK. Again, Italy is the only country to record a steady improvement in this indicator over time; the productivity growth of the shrinking pool of Italian researchers and the lead over major EU countries is indeed remarkable (ANVUR, 2014, p. 518).

A second study on Italy's research output has been carried out by the Bank of Italy (Montanaro and Torrini, 2013); after a wide-ranging survey of available databases on scientific publications – including SCImago, Science Watch and the French OST – it concludes that, in terms of quantity of publications by public and private researchers, Italy ranks fourth among EU countries after the UK, Germany and France, with about 3.4% of all scientific publications and citations; outside Europe, the USA, China and Japan have larger scientific outputs than Italy (Montanaro and Torrini, 2013, p. 27, table A13). If scientific publications are divided by the number of researchers, Italy emerges as the leading country. Montanaro and Torrini (2013, p. 29, fig. 10) show that, using SCImago and OECD data for 2010, Italy produces 726 articles per thousand researchers, compared with 550 in the UK and about 400 in France and Germany. Remarkably, the number of citations received (excluding self-citations) per FTE researcher is close to 2, by far the highest value and almost twice the number of citations received by researchers from France and Germany (Montanaro and Torrini, 2013, p. 29, fig. 10).

The study also reports SCImago data for the main universities and research institutes. First, the comparison is carried out among universities that in 2006-2010 published at least 1,500 articles. In Italy, 49 universities were considered, whose researchers authored 326 000 articles; the average – 6 700 publications per university – was greater than in Japan, France (5,000) and Spain but lower than in the USA, UK and Germany (7,600). The same ranking emerges in the 'high-quality' publications that appeared in the top quartile of journals in their field as ranked by SCImago: 3,700 per university in Italy; 2,900 in France; and 4 200 in Germany (Montanaro and Torrini, 2013, p. 57, table A18). Second, the analysis was carried out on major research organisations; in the period 2003-2010 Italy's CNR produced 63,000 publications, 64.2% of which appeared in the top quartile of journals in their field as ranked by SCImago. This share was higher than that of the French CNRS (58.8%) and lower than those of the German Max Planck Gesellschaft (70.7%) and of the Spanish CSIC (68.1%) (Montanaro and Torrini, 2013, p. 61, table A21).⁵³

⁵³ An additional study by the Bank of Italy tried to rank Italian universities on the basis of individual data on graduates' employment and earnings, considered as indicators of the 'quality' of tertiary education. The investigation accounts for

2.3 European Semester 2014 and 2015

Italy's interaction with EU authorities in the context of the European Semester has been intense and has mainly focused on macroeconomic objectives and budgetary constraints. Considerations related to R&I have mainly focused on the need to preserve R&D expenditure from budgetary reductions, as it is part of the pro-growth adjustment required by the EC, and on the need to reduce Italy's distance from the EU average in various areas of education, human capital development and research efforts.

Italy's National Reform Programme for 2014

The National Reform Programme (NRP) for 2014 outlines the progress made in university financing and recruitment, the streamlining of public funding, the new indirect incentives for R&D investing firms, the social innovation calls and alignment with the EU research priorities. Within the FFO institutional funding to HEIs, a growing share has been allocated on the basis of universities' performances in education and research, and on the basis of the results of the quality assessment review published by ANVUR in 2013 (ANVUR, 2013). NRP 2014 also outlines the streamlining of public funds (Fund for Applied Research (FAR), FCS and FIRS), and the SIR programme, which launched a first call to finance young researchers. NRP 2014 also highlights progress made in the management of PONREC 2007-2013, which is expanding its relevance and is the major instrument for innovation and research policies in Cohesion regions: Campania, Calabria, Puglia and Sicily.

Italy's National Reform Programme for 2015

Italy's NRP 2015 (MEF, 2015) mentions the role played by the PNR in the structural reform package aiming at 'increasing the productivity of the economic system through the valorisation of human capital (Jobs Act, 'Good School', National Research Programme)' (MEF 2015, p. iv). The government also stresses its actions for improving the investment climate through 'fiscal incentives for machinery, funding of R&D, patents and trademarks' (MEF, 2015, p. vii).

The PNR 2014-2020 was in preparation in 2014, aiming to integrate policies at the European, national and regional level through a closer alignment between Horizon 2020 objectives at the EU level and national initiatives (MEF, 2015, p. 87).

The main policy actions introduced in 2015 were the tax credit and the patent box (discussed in detail other sections of this report). The Italian government has announced that it will continue 'rebalancing the tax burden from labour and income towards wealth and consumption activities, in particular those that are damaging the environment. A strengthening of environmental taxation in fact may offer an opportunity for development as it liberates public resources for supporting research and investment for an economy that is greener and more efficient in its use of energy and natural resources' (MEF, 2015, p. 63).

The Italian government has declared that wants to 'put knowledge at the centre of reform policies [...] increasing the innovative level of our economy also expanding the number of researchers, numbers that position Italy at the lowest ranks in the EU' (MEF 2015, p. 81).

Government policy on universities has focused – as discussed in another section of this report – on rewarding quality and increasing performance-based funding for tertiary education and research organisations on the basis of the results of current and future evaluation activities. A greater internationalisation of activities in higher education is also planned.

field of specialisation and local labour markets, but acknowledges the shortcomings of the model used in reflecting the contribution of each university to the 'employability' of its graduates (Ciani and Mariani, 2014).

Closer private–private cooperation is also a key aim of the government; key tools for this include the 'National Technological Clusters, infrastructures of self-governance generating shared technological roadmaps, producing and aggregating in an effective way public–private partnerships'. Clusters have been developed so far in 8 of the 12 areas of national specialisation identified in the National Research Programme; the remaining 4 areas will be addressed in the near future (MEF, 2015, p. 88).

An emphasis is put on the human capital dimension and the pursuit of the Horizon 2020 objective of completing the European Research Area (ERA). Several measures are introduced and planned for attracting researchers from abroad, incorporating them in universities and research organisations, making greater use of European research funding and reorganising doctorates (see the analysis in other sections of this report).

Measures of this type respond to some extent to the R&I challenges the countries is facing, but their translation into specific actions and spending decisions is rather low. A major limitation for the implementation of this agenda is the lack of public funds, associated with the budgetary constraints the country is facing.

The European Semester country report

The European Semester country report (EC, 2015a) sets R&I issues in the broader context of macroeconomic and budgetary policy. The document stressed the weakness of R&D and innovation efforts, pointing out that 'R&D intensity in Italian firms was 0.67% in 2013, compared to a EU average of 1.29%' (EC, 2015a, p. 66). One of the reasons identified by the Commission is that 'Italy has reduced its public R&D budget more than its overall public budget (the share of public expenditure for R&D has decreased to 1.02% compared to 1.32% in 2007)' (EC, 2015a, p. 66). It also pointed out the modest level of public–private cooperation in R&I, where formal networks and structures are lacking. An important point made is that 'The scarce R&D activities are both a consequence and a factor in the country's relative specialisation in products with low-medium technological intensity and it weighs down on the economy's non price competitiveness' (EC, 2015a, p. 66).

The evaluation of recent policies is that 'In 2014 limited steps have been taken' with the introduction of R&D tax credits and with the regulations for implementing the innovative start-up law (EC, 2015a, p. 67). Doubts are raised on the temporary nature of the tax credit (covering 2015-2019), 'in continuity with past experiences when frequent changes in rules, the temporary nature and the scarce predictability of such measures have weakened their effectiveness' (EC, 2015a, p. 67). It is also pointed out that a growing proportion of public funds for R&I is now distributed on the basis of performance indicators, and steps for favouring access to credit by innovative firms have been taken (EC, 2015a, p. 67).

The same Commission document also addressed university issues, noting that 'between 2009 and 2013, total public funding for tertiary education has been reduced by 20% in real terms and as a percentage of GDP public expenditure for tertiary education is the lowest of the EU (0.4% in 2012) (see Graph. 3.3.2)' (EC, 2015a, p. 73). In 2014 performance-based funding increased – from 13.5% to 18% of universities' public funding – and the standard costing was introduced. However, the Commission argues that 'in the medium and long term in order to improve the results of Italy's tertiary education it is of crucial importance that funding be adequate' (EC 2015a, p. 73).

The recommendations of the Commission document include the following:

'Implement a budget adjustment favourable to growth [...] preserving the expenditure capable to stimulate growth, i.e. expenditure in R&D, innovation, education and essential infrastructures' (EC, 2015a, p. 85).

'Make sure that public funds favour in a more substantial way the quality of education and research' (EC, 2015a, p. 89).

As pointed out above, the state of implementation of the recommendations from the EC is constrained by the limited room for manoeuvre Italy has in terms of budgetary policy. In other fields – including quality of human capital, research and universities – policies have taken various steps in the direction indicated. On the business side, the persistence of the recession and the weak investment climate have led to no significant improvement in business R&D efforts and in the innovative performance of Italian firms.

2.4 National and regional R&I strategies on smart specialisation

In 2013, the agency Invitalia managed the project 'Support and definition of regional R&I policies (Smart Specialisation Strategy)' in accordance with the commitment of MISE and in cooperation with MIUR to define the smart specialisation strategy for Italian regions under the guidelines of the RIS3. The project ended on 31 December 2014. It supports regions by providing information, surveys and statistics, promoting knowledge transfer (KT) from best-performing regions, sharing methods and tools, and ensuring consistency at national level. The approach to designing smart specialisation strategies relies on an open and inclusive view. Relevant stakeholders at the regional level – both institutions and private businesses – have been involved to contribute to the identification of an effective smart specialisation strategy. The operational methodology included SWOT (strengths, weaknesses, opportunities and threats) and proximity analyses at the regional level, qualitative and quantitative studies, and harmonisation of local initiatives.

During 2014 Invitalia released the regional and sectoral specialisations⁵⁴ and the set of monitoring indicators, and supported the government in selecting the thematic areas included in the new partnership programme 2014-2020, the new PONREC and the new PNR.

Invitalia supports regions on RIS3 implementation, and the web portal ResearchItaly is the common access point for sharing experiences. The beginning of the activities of the new PONREC will include the RIS3 implementation and monitoring. Relevant stakeholders such as HEIs have been involved in the preliminary steps of the project.

The project is focused on the programming documents for the 2014-2020 EU funding cycle. The action plan identifies public-private partnerships as a modality to trigger private investments. The project structure is based on monitoring and evaluating methods for the whole period 2014-2020.

The financial commitment on the 12 thematic areas is scheduled in the new PONREC and the adoption of the same areas into the new PNR allows the shaping of the next policies in accordance with the smart specialisation strategy.

⁵⁴ The map can be downloaded from:

https://www.researchitaly.it/uploads/7553/Mappatura%20specializzazioni_IL%20quadro%20regionale_1.pdf?v=801f04a.

2.5 Main policy changes in the last five years

Main changes in 2011

ANVUR activities for the first R&I assessment

Main changes in 2012

National qualification system (new recruitment system of professors)

New doctoral reform

New regulations for the major Research funds

Innovative start-up law

Main changes in 2013

Publication of the ANVUR assessment report

Institution of the Agency for territorial cohesion (not yet operational)

Creation of AgID (Agency for Digital Italy)

Main changes in 2014

New PNR (not implemented yet)

Changes in the qualification system

Patent Box law

Main changes in 2015

Revision of the innovative start-up law and innovative SMEs law

Tax credit reform implementation

New PONREC 2014-2020

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

3.1 Introduction

Table 2: Basic indicators for R&D investments

Indicator	2011	2012	2013	2014	EU average (2014)
GERD (% of GDP)	1.21	1.27	1.30	1.29	2.03
GERD (€ per capita)	333.7	345.2	351.6	341.7	558.4
GBAORD (€m)	9,161.4	8,822.3	8,444.3	8,145.2	92,828.145 (total for EU-28)
R&D funded by business enterprises (% of GDP)	0.55	0.56	0.59	NA	1.12 (2013)
R&D funded by PNP (% of GDP)	0.04	0.04	0.04	NA	0.66 (2013)
R&D funded by HEIs and GOV (% of GDP)	0.52	0.55	0.55	NA	0.68 (2013)
R&D funded from abroad	0.11	0.12	0.13	NA	0.2 (2013)
R&D performed by HEIs (% of GERD)	0.35	0.36	0.37	0.35	0.47
R&D performed by government sector (% of GERD)	0.16	0.19	0.18	0.19	0.25
R&D performed by business sector (% of GERD)	0.66	0.69	0.71	0.72	1.30

Italy's Europe2020 target for R&D investment is 1.53% of GDP. Current policies have not been able to significantly improve this indicator, which in 2014 was equal to 1.29%, in spite of the continuing fall in Italy's GDP. It was 1.26% in 2012 and has remained broadly stable since (ISTAT, 2014a). In 2013 and 2014, Italy continued to reduce public expenditure while business R&I expenditure has been contained by the recession. Public sector's salary policies, whose increases have been stopped by law since 2009, and the restrictions on replacing retired members of staff contributed to contain any increase in public R&D expenditure.

The R&I system of Italy has been seriously affected by the economic recession that has hit the country since 2008. After the slump of 2009 (-5.5% in GDP), Italy's GDP stagnated in 2011 (+0.4%) and fell in 2012 (-2.3%), 2013 (-1.9%) and 2014 (-0.3%). This fall in GDP follows a decade when growth and economic performance were below the EU average.

According to ISTAT, total intramural expenditure on R&D (GERD) was €20.5b in 2012, a 1.9% increase in real terms over 2011. Preliminary data for 2013 report a 2.9% fall in real terms since 2012. A further fall of 1.9% in public R&D and a 1.4% increase in firms'

expenditure are expected by ISTAT for 2014 (ISTAT, 2014b, p. 1). Total R&D personnel in 2013 was 253,000 FTEs, a 5.2% increase over 2012. There were 118,000 researchers, 6.6% more than in 2012.

Italy's GERD per capita in 2013 was €338.50, lower than the EU-28 average (€539.20). In order to reach the Europe2020 target, the yearly R&D investments should increase – assuming a constant GDP – by €4b, an amount far from the resources made available by present policies.

Considering the development of GERD in real terms since the start of the economic crisis in 2008, we find a limited decline and an overall stability in its composition; in 2013, GERD was mainly performed by the private business sector (54%), followed by HEIs (28.2%) and the public sector (14.9%). In terms of GBAORD, expenditure recorded a continuous fall from €9.711b in 2009, to €8.825b in 2011, €8.822b in 2012, €8.444b in 2013 and €8.145b in 2014.

Research funding from abroad – both private and public, including EU funds – has become a significant source for Italy's R&I, reaching 0.12% of GDP in 2012. The funding flows from abroad originate from three important sources: foreign direct investment (FDI)-associated R&D, EU framework programmes and EU Structural Funds. Framework programmes (FP6 and FP7) have become a relevant channel of European funding for research in Italy. Participation in FP7 calls was widespread, with a 18.3% success rate for Italian applicants. Italy is the fourth highest-financed country in FP7 (more than €3.6b from 2007 to October 2014),⁵⁵ after the UK, France and Germany; business participation is strong, with six Italian firms among the top 50 recipients of signed grants for firms in 2007-2013, two universities in the top 50 and six research centres in the top 50.⁵⁶

Data on Italy's participation in FP6 and FP7 – based on elaborations by the JRC Research and Innovation Observatory of EC data – show for the former 3,244 projects approved with 6,836 participants and a EU financial contribution of €1.5b (20% of EU total). In FP7, 6,303 projects were approved with 12,101 participants and an EU financial contribution of €3.6b (17.6% of EU total). First data from H2020 indicate 1,146 projects with 2,150 participants (8% of total EU), well below the envisaged level in the new PNR.

EU Structural Funds co-finance PONREC, which was funded with €4.4243b for 2007-2013.⁵⁷ PONREC is the major instrument for the implementation of measures for innovation and industrial R&D. Strategic documents consider PONREC a key driver for the improvement of the R&I system. PONREC's objective is to increase the competitiveness of the four Objective 1 regions through progress in R&I as a source of higher competitiveness for the entrepreneurial system. The integration of research and innovation as a pillar of such initiatives and the joint management by MIUR and MISE of PONREC has led to an increase in the R&I dimension in the local development and social cohesion policies. PONREC granted over €4.8b of funds to 3,315 projects in 2007-2014⁵⁸ in Italy's four Objective 1 regions (Calabria, Campania, Puglia and Sicily).

The recent release of the new PONREC scheduled the first calls by the end of 2015 and will take advantage of the previous monitoring and evaluation activities of the DPS.

⁵⁵ http://ec.europa.eu/research/fp7/index_en.cfm?pg=country-profile

⁵⁶ Seventh FP7 Monitoring Report 2013 11/03/2015.

⁵⁷ Available resources were reduced in October 2012 after the reprogramming round of MISE and MIUR. The funding from the ERDF is €3.102b. The budget available can be downloaded from <http://www.ponrec.it/programma/risorse-finanziarie>.

⁵⁸ <http://www.ponrec.it/open-data/progetti> Data updated on 30/04/2015.

3.2 Smart fiscal consolidation

3.2.1 Economic growth, fiscal context and public R&D

After a long contraction, Italy's real GDP is back to its early 2000s level.⁵⁹ Most of the difference is due to the poor performance of total factor productivity. As a consequence of the financial crisis, potential output also declined amidst an ageing population, weak labour market participation, fiscal consolidation and private sector deleveraging. The Italian economy is still struggling after years of recession. Growth was expected to turn positive in 2015 (0.8%), but it is predicted to remain well below the EU average. It is supported by increasing global demand, improved confidence, the weaker euro, falling oil prices and improving financial conditions. Growth is expected to accelerate somewhat in 2016 (1.4%) and 2017 (1.3%), driven by the same main factors.

The government's balance sheet sharply deteriorated during the crisis, from close to balanced in 2007 to a more than 5% headline deficit by 2009 (Figure 2, left). Because of the 2011 austerity measures the deficit declined to 2.8% in 2013 and 3.0% in 2014. It is expected to fall to 2.6% by 2015 thanks both to the primary balance (planned savings, extension of the public sector wage freeze, improved VAT collection, pick-up in the corporate income tax) and to declining interest expenditures. Despite the improving growth outlook, the deficit is expected to fall to 2.5% only in 2016 because of the flexibility required under the 2016 Stability Law. On a no-policy-change assumption, the deficit is projected to narrow down to 1.5% in 2017. The very high government debt (127-130% of GDP) remains a heavy burden for the Italian economy and a major source of vulnerability, especially due to weak growth. Recent reforms of the pension system are expected to be beneficial in the medium and long term, but only in a context of growth-friendly consolidation, sustained nominal growth and ambitious structural reforms.

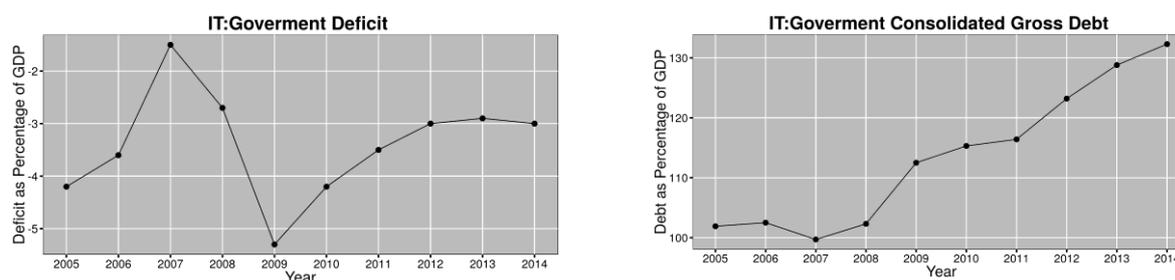


Figure 2: Government deficit and public debt.

Data source: Eurostat.

Total GERD in Italy was €20.983b in 2013. There were three main sources of R&D funding: the business sector (€9.483b), the government (€8.696b) and foreign funding (€2.026b). Direct funding from the government goes to R&D in the business enterprises (€735m), the government (€2.554b) and the higher education sector (€5.266b).

⁵⁹ In contrast the Eurozone GDP is 10% higher than at the beginning of the 2000s.

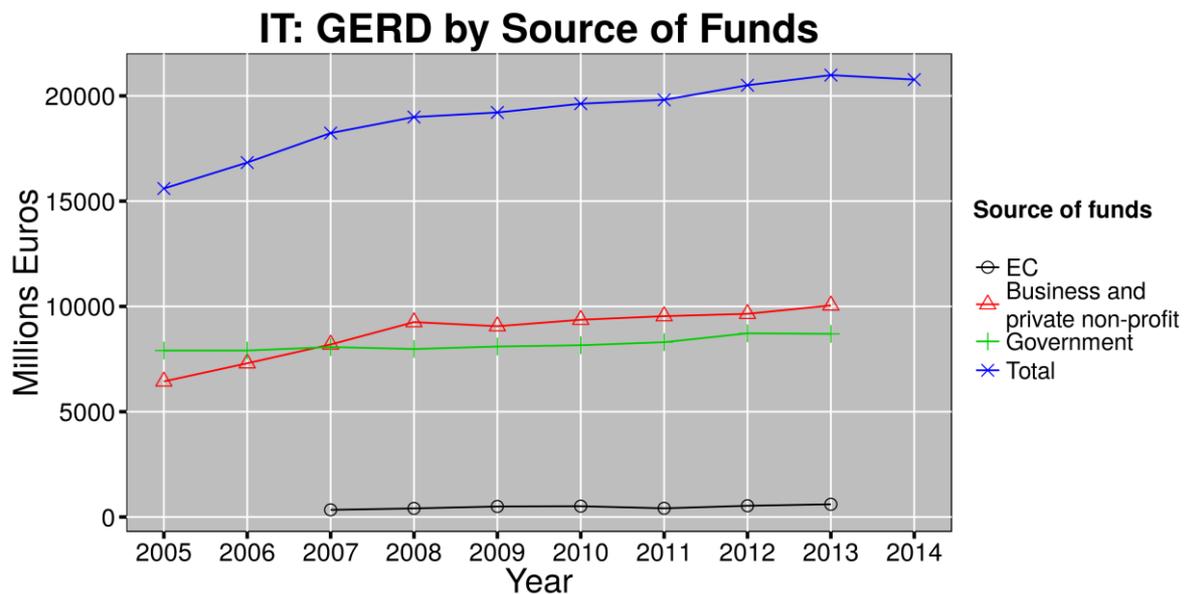
Table 3: Key Italian public R&D indicators

Indicator	2007	2009	2013
GBAORD (% of government expenditure)	1.30	1.19	1.05
GERD (% of GDP)	1.13	1.22	1.30
of which GERD to public (% of GDP)	0.50	0.53	0.55
Funding from government to:			
(% of GDP)			
Business	0.04	0.04	0.05
Public (government + higher education sector)	0.45	0.46	0.49
Total	0.50	0.51	0.54
EU funding (% of GDP)	0.02	0.03	0.04

Source: Eurostat.

3.2.2 Direct Funding of R&D activities

Figure 3 shows the historical development of GERD financing in Italy, in current prices.

**Figure 3:** Funding of GERD.

Data source: Eurostat.

The government's and private sector's (meaning the aggregated funding from business and private non-profit) contributions to the total GERD are the largest and similar in size, with the private sector outperforming the government as a source of funding for Italian R&I from 2007 onwards. The contributions from both the private sector and the government have grown modestly (less than 10%) in nominal terms from 2008 onwards. The consequence is of course a limited growth of the total GERD in the same period.

Despite increasing in nominal value over time, EC funding of Italian R&D expenditure plays a marginal role in the Italian GERD.

3.2.2.1 Direct public funding from the government

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

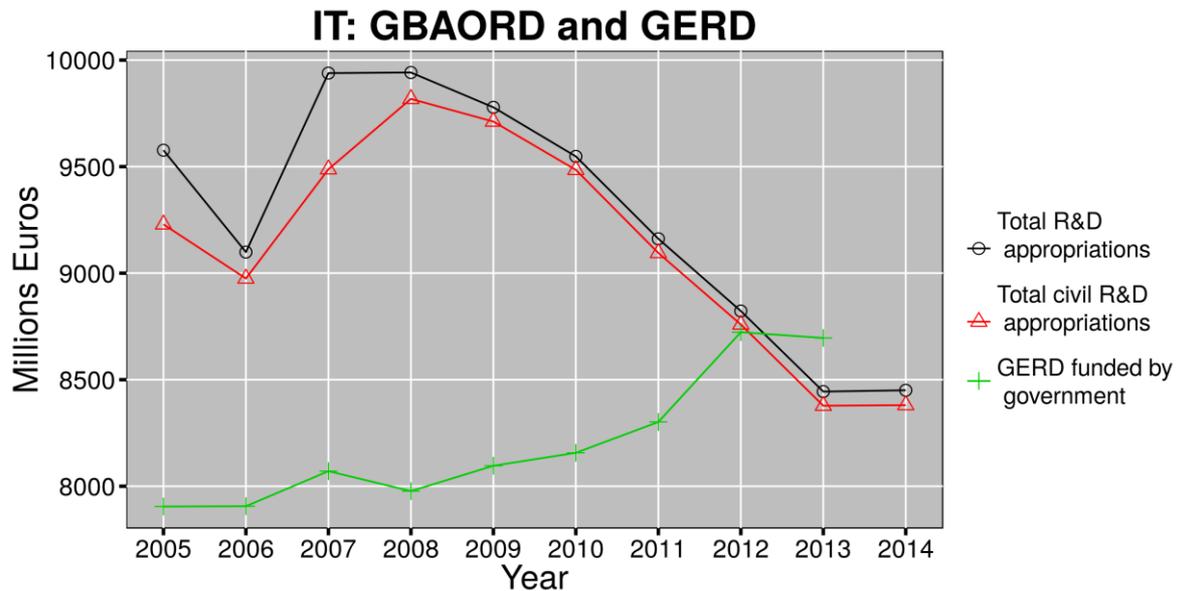


Figure 4: R&D appropriations and government-funded GERD (millions of euros).
Data source: Eurostat.

Starting from the onset of the financial crisis in 2008, the total (civil) appropriations (GBAORD) exhibit a declining trend. In 2014 the total (civil) appropriations were significantly lower than their pre-crisis levels. The latest data for 2014 indicate stasis in the decline of the R&D appropriations between 2013 and 2014.

The trend of growth in the GERD funded by the government from 2008 onwards appears to have come to a halt in 2013, but the lack of more recent data make it impossible to assess if this applies also to the last 2 years.

In fact, the last three Italian governments followed a policy aimed to reduce the 'unproductive' public expenditures, using the 'spending review' as a method to cut the budget and the stability laws as a legal act to summarise all the budget constraints for each year.

The current government also has not released any measure aimed to increase the overall public expenditure for R&D; some measures are targeted to trigger business investments, but the policy of tax reduction on firms is addressing another round of fiscal consolidation in the forthcoming stability law.

The Renzi government policy is focused on stimulating growth through tax reductions for firms and real estate owners, and the fiscal wedge on labour.

Budget savings undermined university activities, as argued by the CUN report in 2013, leading to fewer professors, fewer students and fewer courses. According to MIUR data, the number of enrolments in Italian universities fell by more than 50,000 between 2008 and 2014. The number of researchers and professors reduced by more than 10,000 (around 20%) from 2008 to 2014, more than in any other public institutions. In the same period universities increased students' fees to compensate for the lower amount of resources from the government and, as stressed by the OECD, the Italian universities are becoming more expensive for students than the EU average.

The reduction of available resources delayed PRIN and FIRB, the two traditional competitive calls in R&D intended to finance 'not targeted' research. Also, a new competitive research call, SIR, has not yet been launched again after the 2014 round. In 2013, FAR, the more relevant fund for industrial R&D, stopped its activities for lack of available funding.

The research career is much less attractive since opportunities for permanent employment have become scarce and wages are low. In 2015, CRUI, the body representing deans of universities, released a document commenting on the new FFO (CRUI, 2015a), and argued against the loss of more than €800m from FFO since 2009, from 0.49% of GDP to 0.42%, in contrast to 0.99% in France and 0.93% in Germany.

Military R&D allocations have played a marginal role in Italy in recent years, as can be seen from the small difference between the total and civil allocations. The gap between the appropriations and the funding from the government tends to close starting from 2009, and in 2012 the two almost overlap. A possible explanation is provided by ISTAT in its publication *La ricerca e sviluppo in Italia - 2012*, published in December 2014, which states that the public sector experienced a significant increase in the estimated expenditure, thanks to a more accurate accounting of expenditures by some important research institutes and, to a lesser extent, the emerging of new public entities that perform R&D activities (ISTAT, 2014b, p. 2).

3.2.2.2 Direct public funding from abroad

In Italy, the business sector is the most important (non-public) foreign source of R&D funding, as shown in Table 4.

Table 4 clearly shows that the EC is the most important foreign source of direct public funding, reaching more than 50% of the contribution from the business sector in 2013, whereas the contributions from foreign governments, higher education sector in other countries and international organisations are negligible.

Table 4: Public funding from abroad to Italian R&D

Source from abroad	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total (millions of euros)	1,241.7	1,389.2	1,736.5	1,509.8	1,810.2	1,927.2	1,794.5	1,938.5	2,025.5
Business enterprises (millions of euros)	NA	NA	1,243.3	948.2	1,106.2	1,182.0	1,103.5	1,186.0	1,101.4
EC (millions of euros)	NA	NA	339.7	408.7	499.9	512.8	413.5	533.4	604.0
Government (millions of euros)	NA	NA	110.9	100.7	149.4	177.5	182.5	134.3	139.2
Higher education sector (millions of euros)	NA	NA	0.8	14.7	18.8	19.6	21.3	7.4	54.3
International organisations (millions of euros)	NA	NA	19.2	19.9	16.5	16.8	52.6	52.2	54.9
Total (% of GERD)	7.96	8.25	9.52	7.95	9.42	9.82	9.06	9.45	9.65
EC (% of GOVERD)	NA	NA	4.21	5.12	6.17	6.29	4.98	6.11	6.95

Distribution of public funding

Figure 5 shows how the public funding to sectors of performance has developed over time.

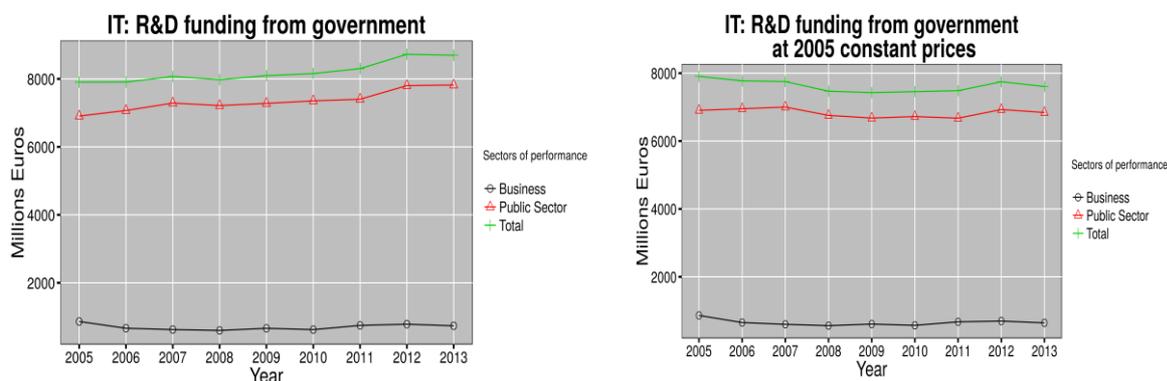


Figure 5: Government intramural expenditure by sectors of performance. Data source: Eurostat.

Not surprisingly, the public sector (government + higher education) is the main recipient of government-funded GERD. When reckoned in constant 2005 prices, the modest growth in total government funding (mirrored in the government funding to the public sector) is washed away.

3.2.3 Indirect funding: tax incentives and foregone tax revenues

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

The Italian framework for indirect support to business R&D has been characterised by a high degree of unpredictability and instability.

A first general R&D tax credit was introduced by the 2006 Budget (Legge 296/06 – art. 1 comma 280/283). The tax credits were allocated via the so-called 'click day', a selection process that awarded funds to firms on a first-come, first-served basis, according to order in which their online requests were submitted. As the Italian government set a cap for the tax incentives, the financial resources for the fiscal years 2007-2009 were already finished in May 2009. The 2010 Budget allocated some new resources for 2010-2011.

According to a study by the Italian Association for Industrial Research (AIRI), a total of €1.7299b was allocated for R&D tax incentives in the period 2006-2012.⁶⁰

In 2011, tax credits were reintroduced only for businesses financing university research projects or projects in partnership with public research entities and for firms employing highly skilled workers in innovation and research, with very limited allocations.

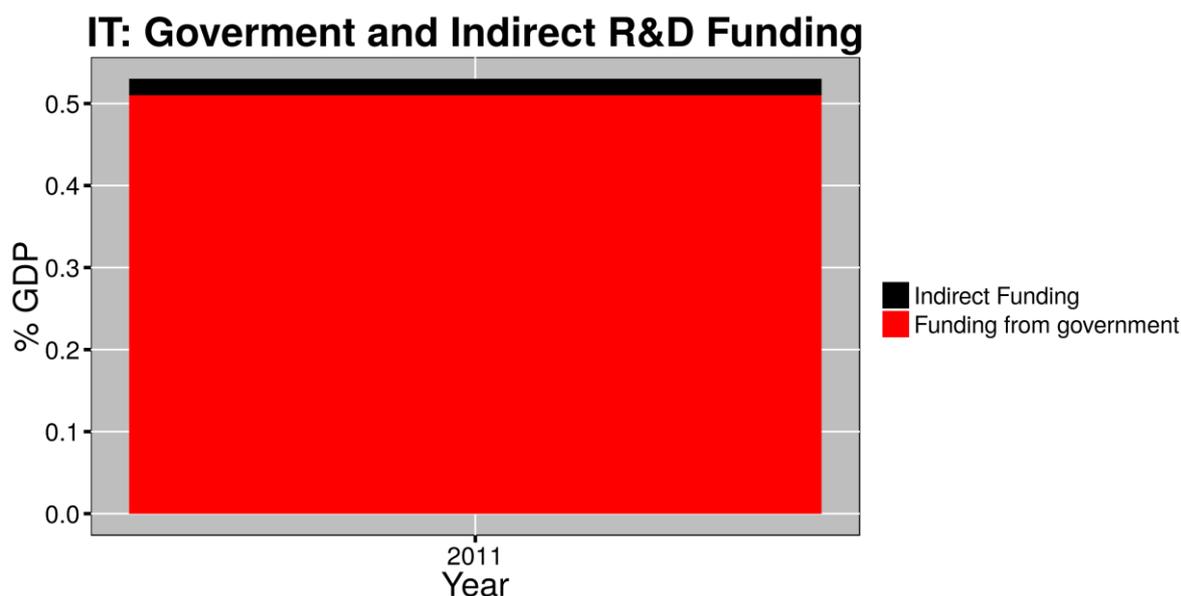
A new R&D tax credit scheme, available for the period 2015-2019, has been operational since the summer 2015. It allows a 25% tax credit for incremental investments in R&D, up to a maximum annual amount of €5m for each beneficiary. Incrementality is calculated upon the average of investments made in the 2012-2014 period, and the annual expenditure should be at least €30,000. For costs related to highly qualified personnel employed in R&D and the costs of the research performed in collaboration with universities, research organisations or other companies (including start-ups), the tax credit is increased to 50%.

⁶⁰ <http://www.airi.it/wp-content/uploads/2010/03/tab5.4.pdf>

The foregone tax revenues have been estimated at nearly €2.5b for the whole period 2015-2019, which is the highest amount allocated in the last 10 years.

Italy also introduced a patent box for the first time in 2015, allowing the deduction of 50% on the revenues from direct/indirect use of intellectual property (patents, trademarks, industrial design and models).

Figure 6: Government and indirect funding to R&D in Italy. Source: OECD.



Unfortunately, only very sparse quantitative data are available about indirect R&D funding in Italy. Figure 6 shows that indirect funding played a limited role in public sector support of business R&D in 2011.

3.2.4 Fiscal consolidation and R&D

Figure 7 shows the scatterplot of the structural balance versus GBAORD as a percentage of GDP (left), and structural balance versus GERD as a percentage of GDP (right)⁶¹:

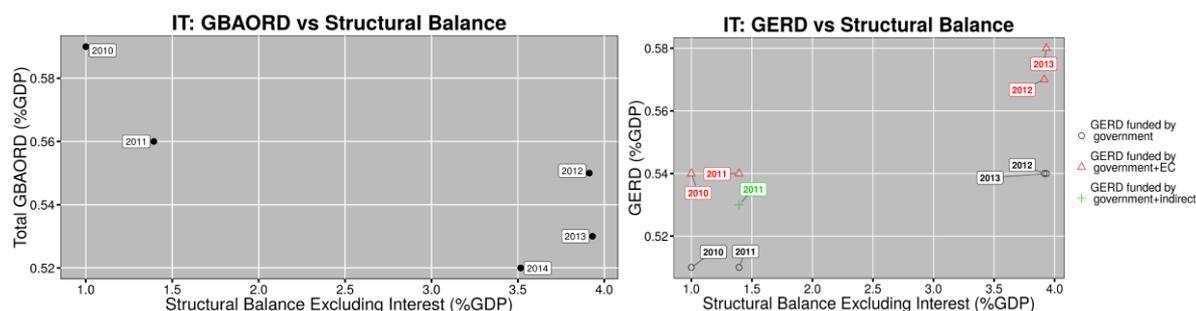


Figure 7: Fiscal consolidation and R&D.

Data sources: annual macro-economic database (AMECO), Eurostat, OECD

The Italian structural balance, as percentage of GDP, increased monotonically from 1% in 2010 to nearly 4% in 2013 and registered a minor setback in 2014. Meanwhile (see Figure 7, left), the total GBAORD expressed as a percentage of GDP decreased from

⁶¹ Structural balance data come from the annual macro-economic database (AMECO). The other indicators were taken from Eurostat.

about 0.59% in 2010 to 0.52% in 2014. As a consequence, it is possible to conclude that the fiscal consolidation came at the expense of the GBAORD.

In contrast, the GERD funded by the government (Figure 7, right) in 2012-2013 is clearly above the 2010-2011 levels. These figures can be explained by more accurate accounting of R&D expenditures by PROs and the emergence of new public R&D performers.

Based on section 3.2.3 and the above discussion, it can be argued that the fiscal adjustment process in Italy has come at the expense of public support for R&D.

The limited available data concerning indirect financing through R&D tax incentives strongly limit the possibility of taking it into account in this analysis.

3.3 Funding flows

3.3.1 Research funders

MIUR, for research, and MISE, for innovation, are the main players for the national R&I funding mix. However, other ministries are involved in financing R&D. The funding coming from other ministries usually finances the PROs they supervise.

MIUR and MISE jointly manage PONREC for the provision of R&I funds within the social cohesion policies, jointly coordinate Italy's participation in Horizon2020 according to the HIT2020 strategy, and coordinate the Smart Specialisation Strategy. The new PONREC 2014-2020 will be managed by MIUR only, with the assistance of the Agency for Territorial Cohesion.

The DPS within MISE is in charge of Structural Funds. On the other hand, the new Agency for Territorial Cohesion, created at the end of 2013, and fully operational since the end of 2015, will be the main player in the management of Structural Funds.

ANVUR is the institution in charge of the evaluation of HEIs and PROs and it regularly provides criteria for the institutional funds allocation using the results of the quality assessment review published in 2013 (ANVUR 2013).

AgID, established in 2012,⁶² is in charge of the IDA under the control of the Prime Minister's office and has responsibility for funding R&D in information and communication technology (ICT). Until 2015, AgID was not fully operational, since in 2012 and 2013 governments amended its role and mission, causing some delays to the beginning of activities.

The provision of resources for both institutional and project funds is regulated by the annual budget, which allocates resources for R&I policies for a 3-year period, but only the budget for the first year is mandatory, while the plans for the second and third years can be amended by the next budget.

The provision of resources from the institutional funds usually does not include any private agency.

Uncertainty in resource availability has been a further problem for both institutional and project funding of R&D efforts, and delays in the approval of PNR increased the degree of uncertainty in the scheduling of competitive calls.

In Italy, institutional funding continues to play a major role and public research and academic institutions are financed mainly through institutional funding with a variable share in accordance with institutional assessments rather than through project funding.

⁶² Law 134/2012 amended the constitution of the previous agency for the Agenda Digitale, which has never been fully operational.

The main R&D fund is FIRST (Fondo per gli investimenti nella ricerca scientifica e tecnologica), which supports the FAR (Fondo per le agevolazioni alla ricerca), as well as funds mainly directed towards universities and PROs such as PRIN (Progetti di interesse nazionale) and FIRB (Fondo per gli investimenti nella ricerca di base). The FAR is intended for co-financing PONREC projects with MISE.

Since 2013, the FCS, focused on technological innovation, has replaced the Fondo rotativo per sostegni alle imprese e gli investimenti in ricerca (FRI).

An increasing proportion of institutional funding is allocated in accordance with awarding rules, but the criteria adopted, except for the VQR assessment, are not stable and change every year, creating issues about transparency and their effectiveness in increasing the productivity of the system, as discussed in section 3.4.1. The ANVUR quality assessment is becoming more important. The major funds access regulations were streamlined in 2012 and 2013.

The major source of private not-for-profit funding is the Associazione Italiana Ricerca sul Cancro (AIRC), which in 2014 allocated €97.4m to R&D.

3.3.2 Funding sources and funding flows

As already discussed in Chapter 1 and in section 3.1, the budget for R&D is largely managed by the national public budget. The funding mix of MIUR and MISE is strongly dependent on the approval of the yearly budget, which can change the financial resources available for research. EU structural funds and FP funding are relevant but not yet comparable to the central budget. Regions do not invest large amount of resources in R&D; their involvement usually happens within the framework of PONREC. Strategic documents such as HIT2020 and the new PNR envisage an increasing share of R&D funding coming from EU research programmes, with an increase of 20% of the resources awarded to national players. The new PNR 2014-2020 envisages higher shares of private funding to the strategic projects too, with estimated co-financing of 50%.

The new PONREC release will make available additional resources for R&D: €1.29b coming from the ERDF and €930m from the ESF, which contribute to human capital, research infrastructures and KT as detailed in Chapter 2.

In 2015 the amendments to the innovative start-up law increased the eligibility of facilitations to local branches of EU firms. This could increase the inflow of R&D funds from multinationals but an assessment of the size of foreign R&D funds coming from the new innovative start-up policy and from the new tax credits is not available yet.

3.4 Public funding for public R&I

3.4.1 Project vs institutional allocation of public funding

In 2015, no relevant change happened in the legal framework for the allocation of R&D project and institutional funding. In 2013 and 2014, the major changes in public funding regarded the allocation of funding for HEIs and have been largely investigated in the 2013 ERAWATCH Country Report and in the 2014 RIO Country Report.

A continuing shift from the dominance of R&D institutional funding towards funding based on performance or on projects is clearly visible.

Since 2012, public funding has increased the proportion of the institutional block funding allocated in accordance with performance indicators with the aim of reaching the 30% allocated in accordance with 'merit' indicators.

Actually, the share of FOE based on performance criteria has been 7% for 3 years now, although its progressive increase has been scheduled by MIUR.

FFO allocation rules change each year. Thus, in the last 3 years the VQR-based share has increased, other performance indicators have changed every year and since 2014 the standard student cost has been in place.

Other 'merit' indicators are not stable. This makes the framework for HEIs less clear, since they are not involved in a negotiation round to determine in advance indicators, achievements and the size of the awarded resources. The inclusion of standard costs is an additional issue, since it shifts the competition from quality to costs. The reference period for the current VQR is quite long ago and its ability to indicate the real performance of universities is decreasing. The new VQR results are an emerging key point for an effective performance-based allocation of resources within HEIs.

3.4.2 Institutional funding

Since 2013, a growing proportion of institutional funding has been allocated on quality-related criteria, as discussed in the previous section. In the 2014 FFO, mechanisms for the variable share of funds recorded some changes from 2013, and in 2015 MIUR introduced new criteria. The 'standard cost' per student⁶³ is increasingly more relevant than output indicators. As discussed in the previous section, only the VQR is a stable and clear indicator of performance, although it refers to the 2004-2010.

First, 20% of the FFO is distributed among universities on the basis of a 'standard cost' per student, with a new (but not yet tested) mechanism of resource allocation. Second, 18% of the FFO will go to 'better-performing' universities, and is distributed in the following way:

- 70% on the basis of their performance in the ANVUR quality assessment review (ANVUR, 2013);
- 20% on the basis of their recruiting policies (scientific production, assessed by ANVUR, of the professors who have been recruited or promoted);
- 10% on the basis of the relevance of international teaching activities, combining the presence of foreign students and courses followed abroad by local students.

ANVUR based its assessment on the best research outcomes obtained by each organisation (universities and research institutes) in the 7 years from 2004 to 2010. Approximately 195,000 publications by 130 organisations were evaluated, partly by submitting them to international experts, who appraised their scientific quality, and partly by analysing the citations received from third parties and examining their impact in their field of research. Moreover, the ability of the evaluated organisation to attract funding and the number of international collaborations, patents registered, spinoffs, museums and archaeological sites, third-party activities, etc. were also considered.⁶⁴ A VQR for the period 2011-2014 is currently being prepared.⁶⁵

According to the EC (2015b), effective implementation of the performance-based funding regimes is made more difficult by the overall decrease in higher education funding and the restrictive rules that limit the yearly change in the amount of funds allocated to each university.

Other output indicators have changed every year, with a negative impact on the readability of the effective performance, since HEIs' output is assessed ex post without communicating the scheme, the indicators and shares in advance to HEIs. The mechanism of planning the performance-based share of FFO is managed by MIUR in a top-down process that does not include a round of negotiations with HEIs. In the 2015 FFO, the performance criteria included the evaluation of the recruitment policies according to the VQR results, the international share of foreign students, for example ERASMUS students, both inward and outward, the number of unit training credits from abroad, and the proportion of students with at least 20 credits. The current procedure is

⁶³ The standard cost methodology is outlined in a joint regulation of MIUR and MEF (Decreto Interministeriale 9 December 2014 no 893).

⁶⁴ <https://www.researchitaly.it/en/understanding/overview/assessment/>

⁶⁵ <http://www.anvur.org/attachments/article/867/FAQ%20VQR%2021092015.pdf>

not able to trigger the necessary adjustments to the internal policies and strategies of the universities.

Finally, the introduction of standard costs, for budget reasons, is an additional issue with the basic criteria for evaluating performance. Standard cost methodology, although publicly available, is very complex, with issues related to understating the awarding rules. The introduction of cost competition indicators could bring the whole university system towards an allocation of resources based on cost savings, with some issues about the quality of the output, far from the original intentions of the current national and EU legislative acts.

3.4.3 Project funding

The traditional programmes for non-targeted research (PRIN) and for young researchers' proposals (FIRB) have been experiencing progressive budget reductions through the years.

Resources for PRIN decreased from €100m in 2009 to €38.2m in 2012.⁶⁶ Resources for FIRB in the call launched at the end of 2012 were €29.5m⁶⁷. No funds were made available in 2013 and 2014.

The main novelty for 2015 was the re-funding of PRIN by MIUR: a new competitive call with an allocated budget of €91.9m was launched in November.⁶⁸

In January 2014, MIUR published the call SIR, addressed to young researchers.⁶⁹ The budget of €47m was intended to finance projects managed by researchers aged under 40 in any scientific domain of the ERC. However, in 2015 the SIR programme did not launch any new call. Selections have been implemented in accordance with the core principles of international standards and from 2015 MIUR has managed a register of independent national and foreign experts.

Postdoctoral grants are traditionally scarce in the Italian system and no relevant changes happened in 2015.

3.4.4 Other allocation mechanisms

Defence R&D is not usually included in the MIUR planning policies. Some R&D funding to the military industry is managed directly by the Ministry of Defence, with ad hoc procedures not always based on competition. The planning bodies within the Ministry of Defence schedule R&D investments and the modalities of funding. Information on military R&D is often not available to the public and MIUR rules about peer review, assessment and monitoring do not apply. Some financing of defence R&D is managed by MISE. According to the information available in the 2015 stability law, MISE expenses for high-technology military programmes amounted to €2.5b in 2014, €2.4b in 2015 and €2b in 2016 and 2017.

3.5 Public funding for private R&I

3.5.1 Direct funding for private R&I

In 2014 the government launched some relevant programmes and in 2015 shifted the support to private R&D to indirect incentives such as tax credits and the revision of the innovative start-up law.

The regulation of the major funds for allocating competitive R&D projects, FAR and FCS, was revised in 2012, 2013 and 2014 in order to streamline the access modalities.⁷⁰

⁶⁶ PRIN call D.M. 28 December 2012 n. 957/Ric.

⁶⁷ FIRB call 2012 D. M. 28 December 2012 no 956/ric.

⁶⁸ <http://prin.miur.it>

⁶⁹ SIR call 2014 D.D. 23 January 2014 n. 197. <http://www.sir.miur.it>

⁷⁰ In March 2013, MISE reformed the system of firms' incentives, concentrating them into the FCS, which will include all

The FCS financed two calls in December 2014: one call of around €150m called 'ICT-Agenda digitale', within the framework of the digital agenda on key enabling technologies in ICT to create a single digital market; the second, called 'Industria sostenibile', targeting projects on sustainable growth and green economy with funding of €250m.

In September 2014, MISE issued the FCS call for industrial R&D projects covering the fields of ICT, nanotechnology, advanced materials, biotechnology, advanced manufacturing, and technologies associated with the EU Horizon 2020 programme. Available funding amounted to €300m, 60% earmarked for SMEs. Funds were provided in the form of low-interest loans.⁷¹

The National Technology Clusters are aggregations of companies, universities and public or private research organisations active in the field of innovation. They focus on eight technology fields. The programme, launched in 2012, financed 48 projects to the amount of €266m.

The 2012 Smart Cities call targeted the four Cohesion regions: Sicily, Calabria, Puglia and Campania.⁷² It aimed to involve SMEs, large firms, universities and PROs in innovative projects on social innovation in nine strategic areas, in line with the Horizon 2020 Societal Grand Challenges. After the selection phase, eight projects were awarded total funding of €200m.

The above initiatives are generally targeted towards the same thematic areas of EU programmes, such as Horizon 2020, the seven European Grand Societal Challenges or the European Digital Agenda, with a strategy of integration between national and EU R&I priorities.

Further initiatives have included the MIUR Technological Cluster programme, which supports eight aggregations of private and public bodies with €266m to foster innovation in selected thematic fields. In addition, the 2014 Budget allocated €100m in 2014 and €50m in 2015 to SMEs in the form of collateral as loan guarantees, managed in the frame of the FCS fund, using European Investment Bank financing.

The R&D programmes are specialised in specific parts of the R&D process. In the case of private business, R&D calls are focused on market innovation and industrial research.

Benchmarking with foreign programmes does not have a long tradition in the Italian system. Since 2012, a monitoring system has been set up, except for the calls under the PONREC programmes.

Innovative public procurement is included in the R&D strategies, although MIUR is not in charge of the innovation in the public sector; the Public Function Ministry and AgID are the bodies in charge.

As discussed in the previous RIO Country Report, the government has already launched a number of tenders for the provision of innovative products and services.

On 28 April 2015, MIUR and AgID signed a partnership agreement for the planning and implementation of innovative public procurement services. AgID is the central commitment for local and central public administration; it is part of the European Consortium in charge of the pre-commercial procurement (PCP) Cloud for Europe. During the second half of 2015, the call Cloud for Europe made awards to projects in three lots: Federated Certified Service Brokerage; Secure, Legislation-Aware Storage; and

the resources for technological innovation, linked to Horizon 2020 guidelines and definitions. It replaces the previous Fondo rotativo per sostegni alle imprese e gli investimenti in ricerca (FRI). Law 147/2013 added €100m to the FCS for 2014 and €50m for 2015. The MISE DM of 25/07/2014 regulated the modalities of access to the FCS.

⁷¹ http://www.sviluppoeconomico.gov.it/index.php/it/?option=com_content&view=article&viewType=1&idarea1=593&idarea2=0&idarea3=a=0&idarea4=0&andor=AND§ionid=0&andorcat=AND&partebassaType=0&idareaCalendario1=0&MvediT=1&showMenu=1&showCat=1&showArchiveNewsBotton=0&idmenu=2263&id=2031108

⁷² D.D. 5th July 2012 n. 391/Ric.

Legislation Execution. Within the framework of the European Digital Agenda, AgID set up two strategic documents on digital growth and on ultra-width broadband regarding open access policies.⁷³ They detail the national strategies for the implementation of the European Digital Agenda.

3.5.2 Public procurement for innovative solutions

The total value of public procurement contracts above €40,000 was €101.4b in 2014, equal to approximately 6% of GDP. This figure represents a remarkable increase after the contraction recorded in 2012 and the trough of 2013, when the value was around €84b.

The breakdown of the different types of procurement was 26.2% works, 46.4% services and 27.4% goods.⁷⁴

PCP/PPI landscape

Pre-commercial procurement was explicitly mentioned in the Italian legislative framework in the so-called 'Decreto Crescita' (Decree for Growth), D.L. 18/10/2012, which was then converted, with amendments, into Law 122 of 17 December 2012.⁷⁵

Article 19 of the decree is entitled 'Grandi progetti di ricerca e innovazione e appalti precommerciali' (Large research and innovation projects and pre-commercial procurement).

The decree assigns to the newly established AgID the task of carrying out PCP initiatives in the context of large-scale innovation projects, assigning to the agency a dedicated budget of €170m. The decree also plans the adoption of guidelines by MISE and MIUR to promote the diffusion of PPI and PCP by the public sector.

The strategy HIT2020, issued by MIUR at the beginning of 2013, aligns the Italian R&I strategy framework to the Horizon 2020 priorities and timeline. It mentions public procurement as a tool to stimulate and incubate research and innovation, in particular for SMEs. The document highlights the need to consolidate the legal framework for PCP with the aim of promoting R&I, including in regional Smart Specialisation Strategies.⁷⁶

A significant step forward was made with the signature of a formal agreement between MIUR and AgID on 28 April 2015,⁷⁷ with a programme based on four main objectives:

1. promoting the use of PCP as a tool to foster R&D activities;
2. promoting the use of 'demand-driven' innovative procurement, including PCP, with the aim of fostering innovation in markets, and maintaining and enhancing the presence of significant industrial R&I capacities in the country;
3. promoting the modernisation of the public administration services through the adoption of innovative solutions;
4. in the frame of the previous objectives, implementing the activities started with the call 'Avviso Pubblico per la rilevazione di fabbisogni di innovazione all'interno del settore pubblico nelle regioni convergenza' ('Public call for the identification of the innovation needs of the public sector in the convergence regions') in March 2013 (see below).

⁷³ The strategic documents can be downloaded from:

http://www.agid.gov.it/sites/default/files/documentazione/strat_crescita_digit_3marzo_0.pdf;

http://www.agid.gov.it/sites/default/files/documenti_indirizzo/StrategiaBandaUltraLarga2014.pdf.

⁷⁴

http://www.autoritalavoripubblici.it/portal/rest/jcr/repository/collaboration/Digital%20Assets/anacdocs/Attivita/Pubblicazioni/RelazioniAnnu ali/2015/ANAC_Relazione_2014.02.07.15.pdf, p. 72.

⁷⁵ http://www.gazzettaufficiale.it/atto/serie_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2012-12-18&atto.codiceRedazionale=12A13277

⁷⁶ <https://www.researchitaly.it/uploads/50/HIT2020.pdf>

⁷⁷ http://www.agid.gov.it/sites/default/files/accordi_istituzionali/03_accordo_miur_-_agid.pdf

The agreement assigns to AgID the task of elaborating tools in support of the execution of PCP tenders, including templates for tendering documents, management models to define tender strategies, and guidelines for the realisation of PCP calls.

PCP/PPI initiatives

A series of relevant initiatives on PCP have been developed in Italy in the last 5 years, both at the national and regional/local levels.

The DPS launched in 2010 a joint project with AgID for the diffusion of the technologies for innovation, called 'Sostegno alle politiche di ricerca e innovazione delle Regioni' (Support to regional research and innovation policies⁷⁸).

One of the outcomes of the project was the publication in 2012 of the report *Gli appalti pre-commerciali per il finanziamento dell'innovazione nelle Regioni* (Pre-commercial procurement to finance regional innovation⁷⁹). The report was prepared by a working group that involved managers from the national and regional administrations, researchers and experts from innovation and technology transfer agencies. Its aim was to design some examples of PCP schemes that were consistent with the national legal framework, regional practices and the powers of the administrations. The design of the administrative documents went together with the launch of some pilot initiatives, namely in the Valle d'Aosta and Puglia regions.

Puglia

The Puglia region launched a PCP call⁸⁰ in August 2012 around the theme of independent living, in two macro-areas: *assistance and inclusion* and *health and safety*.

The total budget allocation was €2.3m, to fund a maximum of eight R&D services in the first phase, and a maximum of four projects during the second phase.

The initiative Open Labs was launched in April 2015 with a market consultation in three areas:

- A. adaptive water management platforms;
- B. treatment, reduction and reuse of sewage sludge in the processes of depuration of urban wastewaters;
- C. detection and monitoring of leakages in the water network distribution.⁸¹

Two calls for items B and C have been launched (deadline 31 March 2016), with an allocated budget of €625,000 each.⁸²

Lombardy

One of the most significant Italian pilot experiences is that of the Lombardy region, which launched a PCP initiative in April 2012 for the provision of industrial research and experimental development services to produce a new automated hospital bed-handling system⁸³ for the Niguarda Hospital in Milan. The project started in April 2012 with a technical dialogue among procurers, industry and research organisations to inform them about the new PCP procedure, and to identify possible gaps between the procurers' needs and the state of the art of industrial developments.

The call was then published in March 2013, with a total budget allocation of €750,000.

⁷⁸ <http://www.aginnovazione.gov.it/notizie/progetto-%E2%80%9C sostegno-alle-politiche-di-ricerca-e-innovazione-delle-regioni%E2%80%9D/>

⁷⁹ <http://www.aginnovazione.gov.it/wp-content/uploads/2012/05/QI08-QI09.pdf>

⁸⁰ http://www.sistema.puglia.it/portal/pls/portal/SISPUGLIA.RPT_DETAGLIO_DOC.show?p_arg_names=id&p_arg_values=26294&p_arg_nomes= PAGINATE&p_arg_values=NO

⁸¹ <http://www.empulia.it/pcp/SitePages/openlabs.aspx>

⁸² <http://www.empulia.it/bandi/SitePages/RegionePuglia.aspx?expired=0&type=Servizi>

⁸³ http://www.arca.regione.lombardia.it/cs/Satellite?c=Attivita&childpagename=DG_CRA%2FWrapperBandiLayout&cid=1213588632524&p=1213588632524&pagename=DG_CRAWrapper

The procedure sets out three different phases: feasibility study, technical design (five selected solutions), and prototyping, testing and experimentation (two selected solutions).⁸⁴

The procedure reached the final stage in early 2015 and two solutions were officially selected in September 2015. They were awarded €320,000 and €245,000. The tender envisages the signature of a contract for experimental development activities and for the management of IP rights.⁸⁵

Building on the successful experience of the Niguarda hospital project, Regional Law No 26 of 24 September 2015, 'Manifattura Diffusa Creativa e Tecnologica 4.0' ('Diffused and creative manufacturing 4.0'⁸⁶) mentions support to PCP and PPI as measures to stimulate the purchases of innovative technologies by the region.

The Regional Smart Specialisation Strategy⁸⁷ plans to extend in the coming years the experience of the first PCP project in the healthcare sector to new projects in the sectors of water, sustainable construction, energy and environment, transport, ICT, culture and healthcare.

Convergence regions

Some PCP/PPI initiatives were launched by MIUR and MISE between 2012 and 2013, targeted at the four Convergence regions (Calabria, Campania, Puglia and Sicily) and using PONREC funds.

In particular, in March 2013, the PCP call 'Avviso Pubblico per la rilevazione di fabbisogni di innovazione all'interno del settore pubblico nelle regioni convergenza' ('Public call for the identification of the innovation needs of the public sector in the convergence regions'⁸⁸) was published by the two ministries. The scheme, for which €150m was allocated (€100m by MIUR and €50m by MISE), is a 'call for ideas' to solve some innovation needs of the public sector.

A total of 30 expressions of interest/needs from the public administration were approved by MIUR.⁸⁹ The following step was the collaboration agreement signed in April 2015 between MIUR and AgID to plan and implement the activities for the development of innovative products and services aimed at satisfying the needs expressed by the public administrations.

The preliminary market consultation⁹⁰ for the development of R&D services intended to create innovative solutions, products, services or processes not yet available on the market in the areas of civil protection and emergency management was officially started on 22 October 2015. The consultation responded to the needs expressed by Sicily's Department of Civil Protection and the provincial fire departments of Lecce and Caserta.

⁸⁴ <http://cordis.europa.eu/fp7/ict/pcp/docs/pcp-lombardia-v4.pdf>

⁸⁵ http://www.arca.regione.lombardia.it/shared/ccurl/830/892/GUUE_publicata_agg_2_2013_PCP.pdf

⁸⁶ http://www.attivitaprodottive.regione.lombardia.it/cs/Satellite?c=Redazionale_P&childpagename=DG_Industria%2FDetail&cid=1213754836211&pagename=DG_INDWrapper

⁸⁷ http://www.attivitaprodottive.regione.lombardia.it/shared/ccurl/206/417/DGRX_3486_S3II.pdf. Page 67.

⁸⁸ <http://attiministeriali.miur.it/anno-2013/marzo/di-13032013.aspx>

⁸⁹ http://www.aqid.gov.it/sites/default/files/reqole_tecniche/elenco_30_manifestazioni_di_interesse.pdf

⁹⁰ https://www.researchitaly.it/uploads/13377/Agenda_30ottobre2015%20-%20concise.pdf?v=ed06d0f

3.5.3 Indirect financial support for private R&I

The shift towards indirect financial support for private R&I is a recurrent issue in Italian research policy. The traditional approach was focused on direct financing, usually tailored to large firms. Since 2012, governments have implemented three type of measures aimed to support firms indirectly: tax credits, innovative start-ups support and patent boxes (see Chapter 2 for additional details).

The 2012 and 2015 innovative start-up laws have introduced facilitations, tax exemptions, derogations to the general legislative system about work and failures, and some innovative methods for access to the finance and capital market. The current tax credit scheme was released in the 2015 stability law. It is an incremental scheme, financed with about €2.6b for 2015-2020. The 2015 stability law has also introduced the so called 'patent box' measure, a specific tax scheme for patents, trademarks, licences and software.

3.6 Business R&D

3.6.1 The development in business R&D intensity

The BERD intensity in Italy, although on the rise since 2006, remains relatively modest. It was around 0.7% of GDP in 2013-2014 (see Figure 8). This is the main barrier to increasing the R&D intensity to a level closer to other large EU countries such as France or Germany (where it is close to 1.5% and 2% respectively).

Manufacturing and services account for more than 95% of the BERD intensity. In particular, the contribution from manufacturing is more than double that from services and it has been on the rise since 2007. Unlike that, the BERD intensity of the service sector stagnated in 2007-2013.

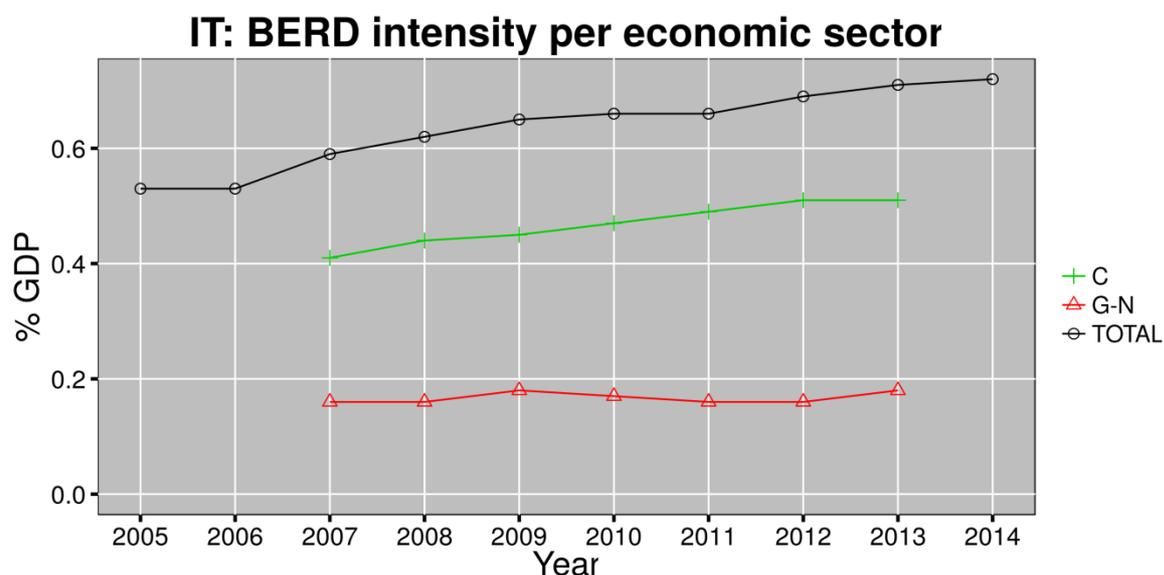


Figure 8: BERD intensity broken down by most important macro sectors. C, manufacture; G-N, services.

The business sector is the main funder of Italy's BERD (see Figure 9). The contribution from the government is rather small (in the range 0.04-0.06% of GDP in the period under scrutiny) and so is the funding from abroad, which has always been below 0.1% of GDP.

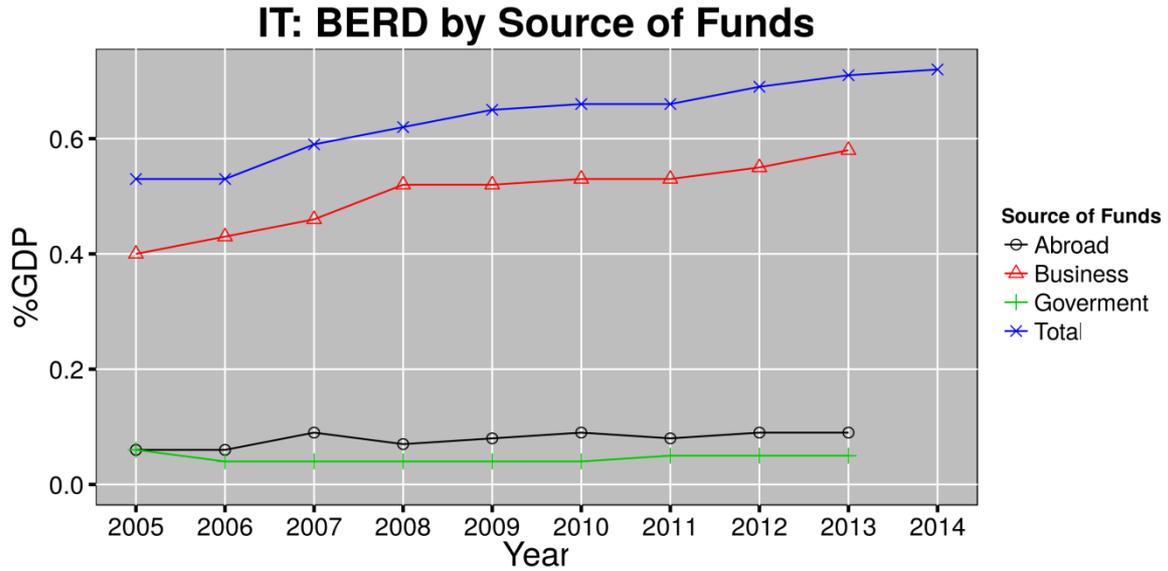


Figure 9: BERD by source of funds.

3.6.2 The development in business R&D intensity by sector

The manufacture of motor vehicles, machinery and equipment, and computer, electronic and optical products are the leading R&D performing sectors in Italy (see Figure 10). We observe substantial growth of BERD in the manufacture of machinery (C28) and motor vehicles (C29) between 2010 and 2013.

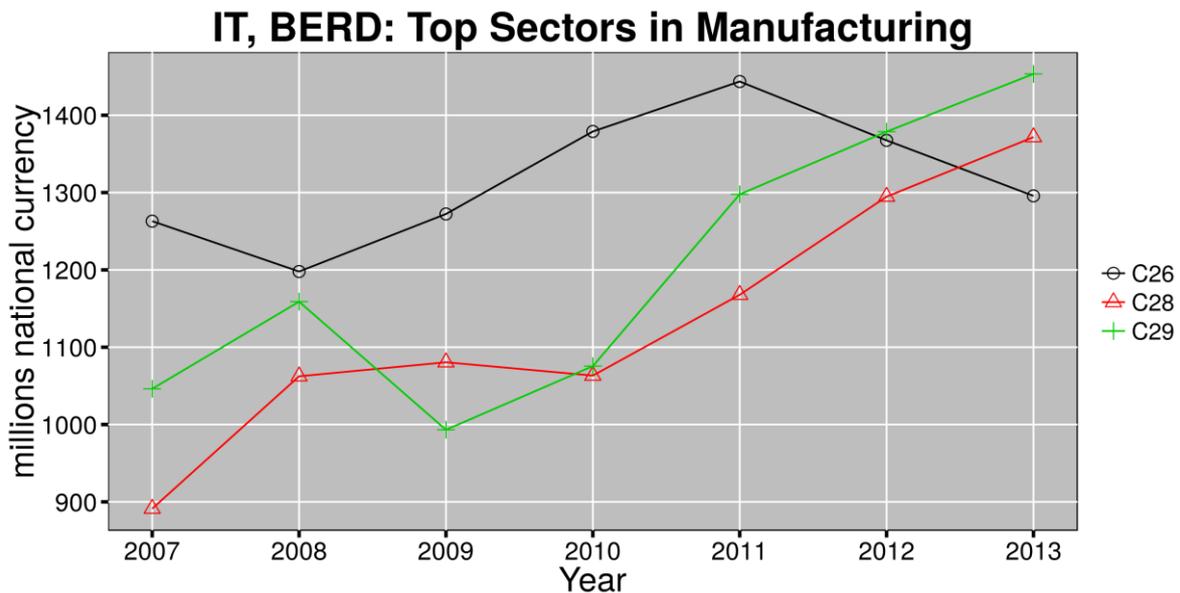


Figure 10: Top sectors in manufacturing.

C26, manufacture of computer, electronic and optical products; C28, manufacture of machinery and equipment n.e.c.; C29, manufacture of motor vehicles, trailers and semi-trailers.

Among services (see Figure 11), the information and communication field and professional, scientific and technical activities play a leading role. Each of them spends about 3-4 times as much on BERD as the wholesale and retail trade, the third service sector in terms of BERD expenditure.

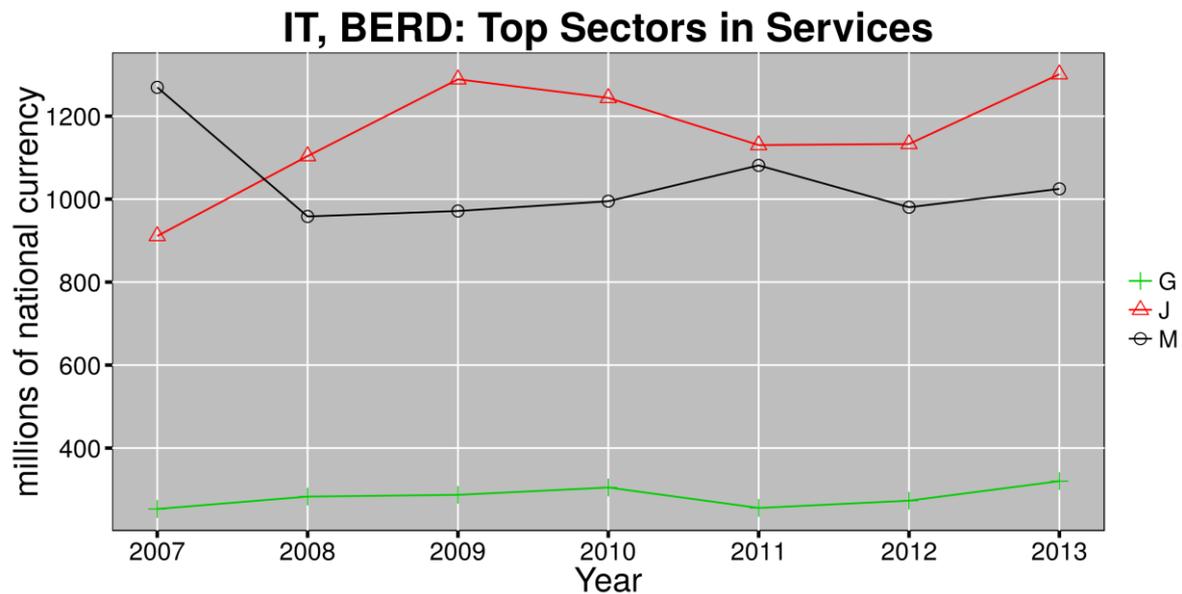


Figure 11: Top service sectors.

J, information and communication, G, wholesale and retail trade; repair of motor vehicles and motorcycles; M, professional, scientific and technical activities.

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

Manufacturing, professional, scientific and technical activities and wholesale and retail trade also play a leading role in the creation of gross value added (GVA) in Italy. Not surprisingly, considering that the structure of the economy still relies a lot on more 'traditional' sectors, among the most prominent sectors in terms of GVA are low R&D-intensive sectors such as real estate activities or compulsory social security, human health and social work activities (driven by the growing proportion of the population that is ageing and needing care) (see Figure 12). The manufacture of machinery, food, beverages and tobacco products, and clothes and textiles are also prominent manufacturing sectors in terms of GVA (see Figure 13).

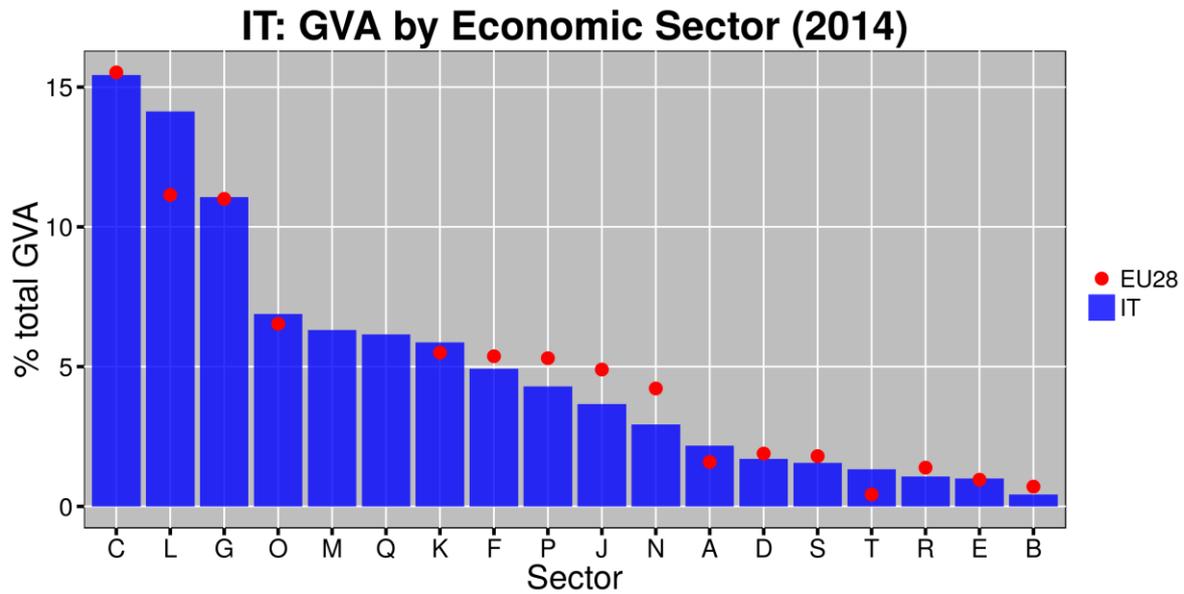


Figure 12: Economic sectors as percentage of total GVA.

Top six sectors in descending order: (1) manufacturing; (2) real estate activities; (3) wholesale and retail trade; repair of motor vehicles and motorcycles; (4) public administration and defence; compulsory social security; (5) professional, scientific and technical activities; (6) human health and social work activities.

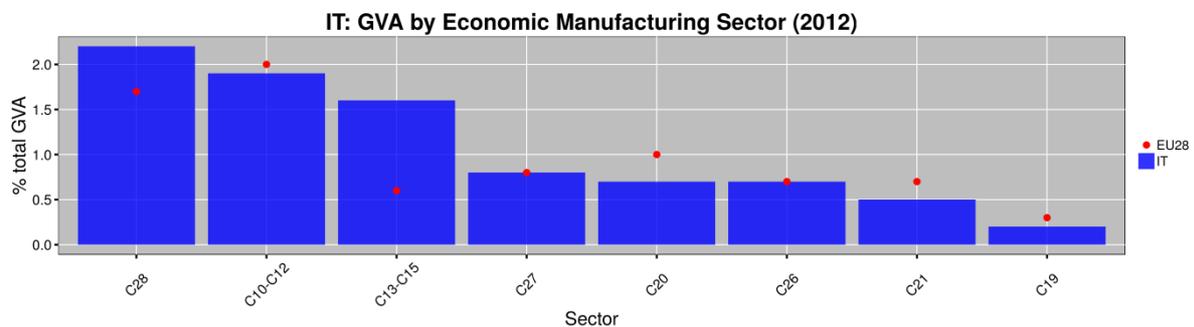


Figure 13: GVA in manufacturing.

Top six manufacturing sectors: (1) manufacture of machinery and equipment n.e.c.; (2) manufacture of food products; beverages and tobacco products; (3) manufacture of textiles, wearing apparel, leather and related products; (4) manufacture of electrical equipment; (5) manufacture of chemicals and chemical products; (6) manufacture of basic pharmaceutical products and pharmaceutical preparations.

When examining the GVA contribution of the top service and manufacturing sectors, it can be noted that wholesale and retail trade is set apart from the rest and generates the highest value added at factor cost (see Figure 14).

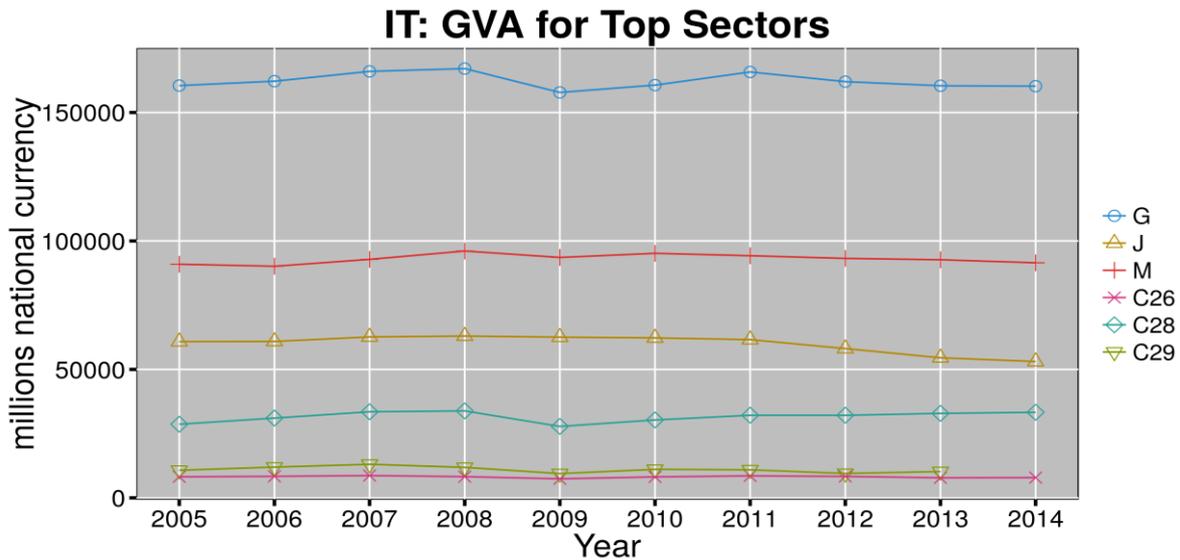


Figure 14: Value added at factor cost for the leading manufacture and service sectors in Figures 10 and 11.

3.7 Assessment

The policy mix for funding R&D has recorded some major changes from 2012, since the governments streamlined the access to the main direct funds, revised the performance scheme of the institutional funds, revised the indirect incentives for private businesses and introduced peer review as a regular feature of the evaluation procedure in competitive programmes.

However, delays, postponements and change of strategies, in addition to the smaller available budget, caused uncertainty for the operators and about the scheduling and the effective relevance of the major measures.

The traditional competitive programmes for untargeted research, after years of underfinancing, have not recorded any new calls for years, and only a few new programmes started in 2014 and 2015. Among them was a new PRIN call in November 2015 (see section 3.4.3 above).

The institutional funding is allocated according to performance-based schemes but the implementation modalities have been limited, since the indicators are released ex post and they are not stable. The inclusion of indicators such as standard costs may go against quality, since they could lead HEIs to compete on cheaper output.

The current policy mix encourages public-private partnerships, especially within PONREC, and it is intended to trigger R&D investments with more indirect incentives through tax credits, start-up laws and patent boxes.

An assessment of the additionality of the current indirect incentives is not yet available, although Cantabene and Nascia (2014) have assessed the effectiveness of R&D tax credits provided in 2007-2009, finding some additionality of public and private funds.

The current schemes are a novelty for the Italian system and the positive effects could be counterbalanced by the negative effect on the tax revenues especially for the patent box and innovative SMEs. The enlargement of the scope of the law on innovative start-ups to innovative SMEs, with very generous tax exemptions and quite flexible requirements to comply with, and the patent box scheme could lead to a reduction in the fiscal revenues for the public budget in exchange for little additional R&D investment.

However, the official data available do not show any increase in R&D investments and the country is still far from the Europe2020 headline target.

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

4.1 Quality of the science base

The research output of the R&D system recorded a very good performance, as discussed in the 2013 and 2014 Country Reports (Nascia and Pianta, 2014, 2015).

The VQR 2004-2010 stressed the fast growth of Italian scientific publications, including the 10 most cited publications in each field. Bibliometric indicators confirm the performance and the ranking of Italy's output productivity for both universities and PROs among the top countries.

The percentage of publications in the top 10% most cited publications increased from 10.17% in 2000, below the EU average of 10.55%, to 13.77% in 2010, higher than the EU average. Other bibliometric indicators for 2013 also outline Italy's excellent ranking in the EU.

In 2013, the number of publications per thousand of population in Italy was 1.47, compared with the EU-28 average of 1.43; the percentage of international co-publications was 42.1%, compared with the EU-28 average of 36.4% in; the number of international publications per thousand of population was 0.62, compared with the EU-28 average of 0.52.

ANVUR also reported on the ratio of articles to researchers, widely used as a productivity indicator: in Italy it was 0.54 articles per researcher, as opposed to 0.31 in France, 0.27 in Germany and 0.38 in the UK. One main weakness of the Italian R&D system, as also indicated by the findings of the CIS surveys, is the low level of public-private partnerships. The proportion of public-private co-publications is lower than the EU-28 average.

The reform of HEIs and PROs that started in 2009 has reduced the degree of fragmentation of the system, especially for PROs. However, the lower financing, as discussed and documented in this report,⁹¹ is undermining the future output of the R&D system, which in a context of falling public resources has still recorded productivity improvements.

In fact, fragmentation of the system still persists in the PROs that do not fall under the surveillance of MIUR. Some thousands of researchers who are actively involved in the scientific community are employed in PROs controlled by other ministries and they cannot benefit from the achievements of the recent years, such as mobility and the peer review methods.

Unification of oversight under MIUR could represent a big improvement of the R&D system towards more effective planning.

⁹¹ See also the ERAWATCH Country Report 2013, the RIO Country Report 2014, CUN (2013), and ANVUR (2014).

Table 5: Bibliometric indicators, measuring the quality of the science base.

Indicator	Year	EU average
Number of publications per 1,000 population	2013: 1.47	2013: 1.43
% of international co-publications	2013: 42.1	2013: 36.4
Number of international publications per 1,000 population	2013: 0.62	2013: 0.52
Percentage of publications in the top 10% most cited publications	2000: 10.17 2008: 12.66 2010: 13.77 2000-2013: 11.8	2000: 10.55 2008: 11.68 2010: 12.25 2000-2013: 11.29
Share of public-private co-publications	2011-2013: 1.7% 2011: 33.4	2011-2013: 1.8% 2011: 52.8

4.2 Optimal transnational co-operation and competition

4.2.1 Joint programming, research agendas and calls

MIUR is in charge of managing Italy's participation in international initiatives, such as European Framework Programmes, and any international activities regarding research. It also coordinates the participation of other ministries.

The Italian R&D policy is traditionally oriented to promote international cooperation, especially within the EU, as witnessed by the large amount of support for joint activities with other EU Member States.

A strategic document by MIUR for 2014 (MIUR 2014b) mentions internationalisation as a priority for the research system.

Since 2012 the domestic research policy has been set up in accordance with EU programmes. The EU agenda research priorities have been adopted into the national framework, embracing joint planning.

In 2015, Italy was also involved at the EU level in participating in and co-funding 12 European Research Area Network (ERANET) initiatives, with many institutions falling under MIUR coordination,⁹² and the six new Joint Technology Initiatives released by the European Council meetings of May and June 2014.

Italy is in charge of coordinating the joint programming initiative (JPI) Cultural Heritage, which financed in 2014, within the JPI Cultural Heritage framework, a competitive joint project call for €4.75m. Italy also coordinates the following, all financed in 2015: the JPI Facce 2, with €1m funding; the JNPD Neurodegenerative Diseases, with €1m funding; the JPI Oceans – Healthy and Productive Seas and Ocean, with €1.2m funding; and the JPI A Healthy Diet for Healthy Life (HDHL), with €0.4m funding.

In 2013-2014, MIUR financed calls within the framework of three Article 185 initiatives too.

Italy has also been participating in the international network EUROSTARS 2, within the framework of EUREKA, with a budget of €2.5m to finance R&D projects in SMEs from 2015 on.

⁹² Source: MIUR website (<http://www.ricercainternazionale.miur.it/era/eranet-e-sa.aspx>). The figure also includes indirect participation in some institutions controlled by MIUR.

A general ex post evaluation on Italy's international initiatives has not been implemented yet.

Since 2012, MIUR competitive funding calls have adopted standardised forms,⁹³ the ERC definitions of scientific sectors and full cost accountancy system for research projects.

In March 2013, MIUR amended the procedures for financing Italian projects selected by international research programmes that recognise international evaluations.

As illustrated in the previous Country Report, since 2012 the introduction of some policy novelties⁹⁴ has removed some legal and bureaucratic barriers hampering the effectiveness of international cooperation. Namely, Law 35/2012 and Law 134/2012 have simplified the rules of research projects by adopting definitions and eligibility of costs based on the EU legislation, created the legal basis for the domestic recognition of evaluation of international scientific projects selected by EU programmes, and stated that the national ex ante evaluation of the scientific suitability of a project can be replaced by international evaluation of selected projects in EU programmes regardless of the evaluation methods adopted by the international programmes.

4.2.2 RI roadmaps and ESFRI

The FOE is the main source of funds of Italian research infrastructures (RIs) and Italy contributes €90m each year to the construction of new pan-European RIs. In 2010, Italy released the last national roadmap, compliant with the ESFRI requirements.

According to HIT2020, Italy is increasing the extent of integration with EU for RIs but with a pattern oriented to consolidating the competitiveness and effectiveness of a smaller number of RIs instead of developing a growing number of RIs, as outlined in Horizon 2020 (from the current 550 RIs to 1,000 in 2020).

HIT2020 points out the guidelines for selecting strategic RIs under the requirements of the European Strategy Forum on Research Infrastructures (ESFRI) criteria and envisages the definition of a national plan for RIs with the target of strengthening cooperation with private business in order to increase KT.

HIT2020 envisages €185m yearly financing for the construction of new RIs, the upgrading of the existing RIs and the introduction of measures to streamline the access of Italian researchers to RIs. Although the HIT2020 strategy envisages setting up a fund to finance RIs, there is not yet a specific fund available for RIs in Italy and the funding of RIs is not direct yet. The PRO in charge can use a share of its institutional fund for the maintenance of each RI that is usually below the envisaged amount. Without a specific fund, eventual budget cuts to the institutional funds can stop the activities of national RIs. The new Gran Sasso Science Institute, a doctoral school based on the Gran Sasso RI, already in the first years of its life encountered some issues related to the lack of financing and only extraordinary financing was able to keep it open for the next 3 years.⁹⁵

4.3 International cooperation with third countries

International cooperation with third countries is coordinated by the Ministry of Foreign Affairs (MAE) supported by MIUR.

The most common instrument is signing bilateral agreements with third countries to establish a channel of scientific cooperation supported by the network of Italian embassies.

⁹³ PRIN and FIRB calls have adopted standardised forms for project evaluation since 2012.

⁹⁴ Law 35/2012 and Law 134/2012.

⁹⁵ http://www.ilmessaggero.it/abruzzo/gran_sasso_science_institute_vicina_la_conferma_un_triennio-1443195.html

At the end of October 2015, Italy was involved in 15 bilateral agreements, focused on researchers' mobility, and around 80 joint highly-important scientific projects managed directly by HEIs and PROs.

In 2014, MAE allocated around €1.6b for the high-relevance programmes. The SFIC and the Multi-Annual Roadmaps for international cooperation are not high on the agenda of the MAE. The new web portal Innovitalia⁹⁶ improves the integration of foreign policy with R&D.

4.4 An open labour market for researchers

4.4.1 Introduction

Italy has an institutional system for R&I that is complex and uneven, with areas that are well organised and show high performance and other areas that are less structured and effective. Public activities are highly structured and regulated by law, including the employment of researchers. Over the last 10 years, universities and PROs have been moving towards greater autonomy, combined, however, with strict standards set by ANVUR on staffing requirements and with a serious fall in resources for employing researchers, resulting in a fall in the overall number of researchers and university staff.

The majority of HEIs and PROs are public institutions and fall under national laws and national collective agreements for recruitment, pay, mobility, training and careers. In HEIs, permanent researchers' contracts are regulated by law; in PROs, in part by law and in part by collective agreements. According to ISTAT, in 2012 the total number of researchers was around 110,000 FTEs, mainly in HEIs (45,000), private business (41,000) and PROs (20,500).⁹⁷

4.4.2 Open, transparent and merit-based recruitment of researchers

The policies introduced in recent years have pursued the objective of open, transparent and merit-based recruitment of researchers; the most important development in this regard has been the introduction of the National Scientific Qualification (ASN) for candidates to university professorships.

In most research fields, this process has made international research standards and scientific merit more relevant to hiring and career progression. In some academic fields, however, progress is slower (see the detailed analysis in the previous RIO Country Report and the more specific studies cited there).

Law 1/2009 and Law 240/2010 regulate the recruitment of researchers and they have introduced major changes into the research system.

Since 2012, HEIs recruitment is based on the national qualification process,⁹⁸ which is designed to follow the criteria of transparent, open and merit-based recruitment. Foreign candidates and non-residents can access universities and research institutes through public selections on an equal footing with Italian citizens. Moreover, national regulations allow the direct recruitment of a limited number of foreign researchers (high-level scholars) to permanent positions.

According to Laws 1/2009 and 240/2010 young researchers, in HEIs and PROs, can apply only for temporary positions with a tenure-track path.⁹⁹ Law 240/2010 has introduced evaluation as a key element for researchers' and professors' salary improvements but, since 2011, Budgets have stopped any wage increase in the public sector, including universities and PROs. The Budgets of recent years have reduced the

⁹⁶ <https://www.researchitaly.it/innovitalia>

⁹⁷ Private non-profit institutions employed 3,900 researchers.

⁹⁸ See Chapter 2 for details on the 'habilitation' system. Before the reform, the recruitment system relied on internal selection panels, which created an advantage for internal competitors.

⁹⁹ Art. 39 of the 2015 stability law limited tenure-track positions in favour of temporary contracts.

career opportunities for young researchers, although some changes¹⁰⁰ were included in the 2014 Budget.¹⁰¹ Thus, the labour market for researchers is moving towards a situation in which there is little inflow of young scholars and career advancement for insiders is slowing down.

Laws 1/2009 and 240/2010 do not concern PROs that are not supervised by MIUR. They do not have the same recruitment framework and can adopt more traditional recruitment procedures in accordance with the public sector collective agreements.

The downsizing of HEIs' personnel, analysed in the previous RIO Country Report, has reduced the quantity and quality of teaching activities. The scarcity of permanent positions can lead many young researchers to move to foreign research institutions.

One direct consequence has been the growing 'brain drain' of Italian researchers moving to foreign universities and research institutions. As already pointed out in previous reports (RIO Country Report 2014), this demonstrates the overall effectiveness of Italy's universities and training systems in producing world-class researchers. At the same time, the large-scale emigration of researchers seriously weakens Italy's science, technology and research base and represents a major challenge for the continuing effective operation of Italy's R&I system.

Conversely, a very modest number of foreign researchers finds employment in Italy. Much more significant is the growing number of foreign students who come to Italy to attend Masters' and PhD courses, taking advantage of the effectiveness of Italy's training system and of the relatively low fees that foreign students are asked to pay.

For young researchers who succeed in having research opportunities in the country, a major problem has been the insecurity of employment, with a variety of temporary arrangements that have created a large number of young scholars with highly uncertain future prospects. Institutional changes have directly affected the growth of insecurity, while the lack of public funds pointed out in other sections of this report has prevented universities and PROs from offering more stable forms of employment to their researchers.

Finally, it should be highlighted that, for temporary researchers, wages are dramatically below the EU average. For permanent university staff, a wage freeze has been in place for several years now, leading to lower real remunerations and preventing in most cases any possibility of a wage increase.

4.4.3 Access to and portability of grants

Italy's system does not give foreign researchers much access to research grants. Even when this is not formally impossible, very few resources go to foreign scholars. Portability is limited by the institutional rules of universities and PROs.

Access of non-residents to national grants is still limited. Only a few calls allow the participation of researchers from foreign institutions. The programme Rita Levi Montalcini, targeted to attract young researchers from abroad regardless of their nationality, was the first opportunity earmarked for researchers from foreign institutions.¹⁰²

In 2014, the SIR call allowed the participation of foreign institutions but only in partnership with resident institutions, and less than 50% of the grant could be allocated to the foreign institution. In general, access to national funding calls is closed to foreign researchers or limited to their cooperation with resident researchers, as in the case of

¹⁰⁰ Additional sources for recruitment and some derogations from the permanent prohibition on recruiting new personnel to the public sector. See Chapter 2 for details.

¹⁰¹ Resources for recruitment are budgeted into the block funds that finance universities (FFO) and research institutes (FOE). The 2014 Budget softened some recruitment constraints, as discussed in Chapter 2.

¹⁰² In fact, the programme is intended to attract Italian researchers living abroad in an attempt to reverse the brain drain.

FIRB calls. However, the qualification for professors has been open to foreign citizens and allows an English-language procedure.

Until 2012 the portability of research grants into other national institutions was limited, while transfer to foreign institutions was not allowed. In 2012, Law 35/2012 removed legal barriers to grant portability. Law 35/2012 allows researchers participating in international projects to leave their employer for the whole duration of the project (if they work at the employer's office) or for a maximum period of 5 years, if they change the location of their activities. The aim of the law is to streamline the procedures for grant portability at national and international levels.

4.4.4 Doctoral training

According to MIUR figures,¹⁰³ in 2014 doctoral courses were attended by more than 33,000 students. In the academic year 2013-2014 (28th cycle), 11,317 students passed the selection process for doctoral courses but only 1 434 were foreign citizens.

Doctoral courses fall under national regulations, especially for means of access; according to Law 240/2010, HEIs have a large degree of autonomy in managing and organising doctoral courses. Law 240/2010 introduced a major change to doctoral training. The reform introduced a new type of doctoral courses, called 'industrial doctorates', to build a bridge between the labour market and students.

ANVUR is the institution in charge of the approval, monitoring and assessment of the reformed doctoral courses. ANVUR released the criteria for the assessment of the doctoral schools in March 2015. The allocation of ministerial funds will be implemented in accordance with the ANVUR assessment.

The new regulation of doctoral courses meets the ERC principles of innovative doctoral training and aims to increase the quality and attractiveness of doctoral schools in Italy, especially for foreign students; partnerships with foreign universities are also encouraged. Multidisciplinary doctorates are allowed and PhD courses can include interdisciplinary training through common modules, with a special focus on the development of so-called 'soft skills'. Cooperation with firms is encouraged, including opportunities such as high-level apprenticeships within the business world.

MIUR released the operational regulation for the new doctoral courses in January 2014. The PNR 2014-2020, not yet approved, would bring more resources for new doctoral courses across the country.

The PNR envisages the promotion of innovative doctoral courses (i.e. industrial doctorates), with the programme 'Mille e più dottorati innovativi', which will promote innovative solutions for at least 1 800 doctoral students each year with a yearly budget of around €60m.

4.4.5 Gender equality and gender mainstreaming in research

While there is a growing awareness of the importance of gender equality in R&I, actions to this end are still limited in Italy's R&I system. The Department of Equal Opportunities (DPO) of the Labour Ministry and the National Parity Counsellor (CNP) are the major governmental institutions for gender issues. In HIT2020 and in the 2014 release of PNR 2014-2020, MIUR stresses the importance of gender issues for research, plans the set-up of indicators measuring the impact of gender policies and envisages research programmes on gender mainstreaming. However, until 2015 there were not any specific measures for a gender balance in the major research programmes.

Law 215/2012 reformed selection panels and boards of public firms according to gender balance, although according to research in 2012 the number of women in the top management of PROs was minimal.¹⁰⁴

¹⁰³ <http://statistica.miur.it/scripts/postlaurea/vpostlaurea.asp>

The academic system is also showing interest in research on gender issues. Some universities manage gender-oriented academic courses, and four universities organise doctorates and courses on gender studies (namely the universities of Bologna, Roma3, Roma La Sapienza and Napoli Federico II). The University of Bologna is involved in the international master's degree in women and gender studies (GEMMA). A partnership between MIUR and DPO, signed in 2013, is an additional tool to implement policies on gender issues in research.

Permanent employees in HEIs and PROs, after maternity or paternity leave, have the right to return to the same position and the same physical office, but atypical workers and fixed-term employees are excluded to some extent from the policies on gender equalities and suffer huge discrimination for lack of an effective gender and equal opportunity policy. In the private research sector, researchers are often employed on different terms according to each collective agreement.

4.5 Optimal circulation and open access to scientific knowledge

4.5.1 e-Infrastructures and researchers' electronic identities

The Italian Research & Education Network (Gestione Ampliamento Rete Ricerca, GARR) consortium implements the national strategy for access to digital research services, and the IDEM federation implements a framework to allow researchers accessing online resources,¹⁰⁵ although the kick-off of AgID has allowed the definition of a broader national strategy.

In 2012, the open data law (Law 221/2012, Art. 9bis) laid down the guidelines for the acquisition of software (open source software too) and the development of cloud services for public administration. AgID is now in charge of these activities, which cover the whole public sector and are not specifically targeted at research and universities.

In March 2015, AgID released the national strategy for ultra-fast broadband services after a stakeholder consultation. The strategy defines the target for the modernisation of e-services in Italy within the Digital Agenda framework. The strategy has a financial commitment, and envisages both direct public interventions and public-private partnerships.

AgID activities cover all policies about e-infrastructures in Italy. AgID also participates in some EU research projects. AgID is in charge of implementing measures and laying down guidelines about personal data security, the scope of personal data use, and identity validation and tracking.

However, GARR and IDEM are still the major institutions for e-infrastructures for research.

GARR is also in charge of the management of personal data security and identity certification, cloud computing and scientific software targeted for the research community. The GARR network, controlled by MIUR, is the e-infrastructure of the scientific community in Italy. It is a consortium of universities and research institutions that provides networking and computing services to the research community.

The IDEM federation is a service of the GARR network and it is the major initiative in the field of electronic identity for researchers. IDEM started its activities in 2009 and includes the majority of universities and research institutions in Italy (around 60). IDEM provides access to some digital research services such as scientific data, scientific journals and cloud computing resources. The IDEM approach relies on the provision of digital services to researchers with their own user account. Researchers can access IDEM digital services according to the agreements and the subscriptions of their institutions.

¹⁰⁴ <http://www.rete-armida.it/attachments/article/139/IArmida2012donneverticisetstorepubblicodef.pdf>

¹⁰⁵ GARR: <http://www.garr.it>; IDEM federation: <https://www.idem.garr.it>

IDEM is part of the international Edugain federation to provide an access to digital research services in other organisations.

4.5.2 Open access to publications and data

Only in 2013, with Law 112/2013, did open access (OA) become compulsory for research outputs funded at least 50% by the public budget. That law indicates the gold road and the green road as OA modalities. The green road defined by Law 112/2013 is based on an embargo period of 18-24 months, which is longer than the international recommendations. However, the law does not specify an open science policy.

In 2014, AgID published national guidelines for the exploitation of public information, a set of operational recommendations for publishing open data. In 2013, MIUR released a call for RI that earmarked €10m to develop systems based on OA for long-term preservation of research results. In 2014, the SIR call and in 2015 the PRIN call incorporated OA as mandatory for the publication of the output of the awarded projects.

CRUI pioneered the implementation of OA in the Italian scientific community and is still active in promoting it. For this, it works in close cooperation with CUN, MIUR's consultative body.

CRUI supported the participation of Italian HEIs in the Berlin Declaration and the introduction of OA into the university statutory regulations. At the end of 2015, 71 universities had signed the Berlin Declaration and 35 universities had included OA in their statutes.

The OA reference website in Italy, called Pleiadi, is managed by two university consortia: the Interuniversity Consortium for Computational Applications (CINECA) and the Inter-University Consortium for the Application of Super-Computing for Universities and Research (CASPUR). It indexes 56 institutional repositories and 14 journals and currently lists around 1 million publications. Italy participates in three major European OA projects: OpenAIRE¹⁰⁶ (CNR, CINECA), PASTEUR4OA¹⁰⁷ (Politecnico di Torino) and RECODE¹⁰⁸ (CNR).

In 2014, IRIS,¹⁰⁹ the Institutional Research Information System managed by CINECA, started to collect research data from more than 60 HEIs. It is compliant with the Common European Research Information Format (CERIF) and it is based on open-source technologies according to OpenAIRE guidelines.

In 2012, a partnership between CNR and AgID started the Science and Technology Digital Library to provide access to scientific data.

The Open Knowledge Foundation Italia has launched the portal openscience.it to promote OA.

The Telethon foundation is a non-profit organisation active in fundraising to promote the dissemination of OA peer-reviewed publications.

A growing number of Italian journals and repositories are indexed by the two major international web portals: OpenDoar.org indexes 75 academic Italian repositories while doaj.org indexes 319 Italian journals (2015).

¹⁰⁶ <http://www.openaire.eu>

¹⁰⁷ <http://pasteur4oa.eu/>

¹⁰⁸ <http://www.recode.eu>

¹⁰⁹ <http://www.cineca.it/en/content/iris-institutional-research-information-system>

5. Framework conditions for R&I and science–business cooperation

5.1 General policy environment for business

According to the World Bank's Ease of Doing Business index, the business environment in Italy is relatively weak and far from many international competitors. Italy lost position between 2014 and 2015, falling from 52nd to 56th in the general ranking. The main weaknesses are paying taxes, enforcing contracts, construction permits and getting electricity. The long time needed for the above mentioned procedures, the high tax rates and the administrative costs of these vulnerabilities are assessed as issues discouraging entrepreneurship.

On the other hand, resolving insolvency, minority investors' protection, cross-border trade, starting a business and property registration are the best elements of doing business in Italy. Insolvency regulations are not involved in the financial reorganisation of firms. However, many firms are not incorporated, so there are big barriers to any financial assistance scheme.

Laws on innovative start-ups and innovative SMEs provide some derogations from the ordinary bankruptcy law, offering entrepreneurs another chance. Innovative start-up entrepreneurs can take advantage of a 'fail fast' track and start again with a new firm. However, every improvement on that subject is deeply connected to problems with the justice system, whose lengthy procedures are traditionally a major weakness jeopardising the success of any new measures in support of businesses.

5.2 Young innovative companies and start-ups

Since 2014, Law 9/2014 has launched IT vouchers for SMEs, a benefit for the acquisition of IT materials for a maximum value of €10,000 for each firm. Since 2015, MISE has introduced the internationalisation voucher for SMEs, another €10,000 of direct funding for firms approaching international markets.

The policy for SMEs encourages cooperation through the Reti d'impresa, a new network contract that has been available to increase collaborative interactions between SMEs since 2008. Moreover, it creates a more favourable business environment from the early development phase. Certified incubators are intended to provide assistance to new innovative start-ups and encourage cooperation.

The MIUR Technological Cluster programme supports SMEs policies and encourages public–private partnerships with €266m for eight aggregations that are to foster innovation in selected thematic fields.

In 2015, MISE released the operational rules for Reti di impresa per l'artigianato digitale, funded with €9.1b, which aim to encourage cooperation between SMEs and HEIs in the IT field.

5.3 Entrepreneurship skills and STEM policy

Highly skilled human capital in Italy is weakening and the gap between Italy and European standards is growing.

Data from the 2014 Innovation Union Scoreboard (IUS) show that in 2012 21.7% of the population aged 30-34 had tertiary education, well below the EU-28 average of 35.8%. Conversely, 77.6% of people aged 20-24 had completed upper secondary education, not so far from the EU average of 80.2%. The number of first-time graduates – excluding those from masters' courses (*Lauree magistrali*) – was 160 000 in 2000 and 290,000 in 2005 but fell back to 210,000 in 2011-2012 (ANVUR, 2014, p. 17). The total number of university students in all courses was 1,674.000 in 1999-2000, before the reform of university courses, reached a maximum of 1,824.000 in 2005-2006 and then declined to 1,751.000 in 2011-2012 (ANVUR, 2014, p. 41).

The European Centre for the Development of Vocational Training (Cedefop)¹¹⁰ forecasts that by 2025 there will be an increase in demand for jobs in business and services and a stable number of jobs in manufacturing, with the proportion of professionals increasing to 22% in 2025. On the supply side, the proportion of the labour force with high-level qualifications is expected to rise to 31% from the 21% registered in 2013.

However, the downsizing of the university system and the budget cuts that led to a steep rise of universities fees¹¹¹ are a serious threat to the level of Italian human capital in the future. The risk is a reduction in the quantity of the human resource base.

According to an ISTAT survey (ISTAT, 2015c), doctorate holders are still recording a competitive advantage in the labour market: in 2014, 91.5% of people who had gained a doctoral degree in 2010 were employed and only around 7% were still looking for a job. However, the survey records that the proportion of doctorate holders living abroad had increased by around 6 percentage points from 2009 (12.9% in 2014).

As argued by ANVUR in the 2014 assessment report, the low employment prospects and the low wage differential between workers with secondary and tertiary education may discourage the pursuit of a university degree. The same issue is contributing to an increasing outflow of graduates, as discussed in the previous Country Report.¹¹²

This negative trends represents a serious loss for Italy's R&I system, a threat to its sustainability in terms of scientific research and teaching, and a major hindrance to catching up with the rest of Europe in terms of innovation and economic performance.

The PhD reform includes compulsory modules to train students in soft skills, a kind of teaching not traditionally available. In addition, the current measures – R&D tax credit and the innovative start-up law – are intended to provide indirect incentives to firms employing a highly qualified labour force; they do not give any specific benefit for the path from university to the labour market.

Thus, current policies do not address PhD students and their eventual benefits. In 2015, the Jobs Act (D.lgs 22/2015), the new reform of labour, did not include doctoral students and scholars awarded a grant from HEIs¹¹³ in the social unemployment scheme.

The 2015 Osservatorio Università-imprese (OU-I) report by CRUI (2015b)¹¹⁴ sheds light on some good practices of cooperation between firms and HEIs and formulated some guidelines to prevent any skill shortage in future.

5.4 Access to finance

In Italy, the policy for early-stage investments is based on crowdfunding within the framework of the innovative start-ups law. Business angel networks do not provide any direct support; however, in 2014 the annual survey by IBAN,¹¹⁵ the association of business angels in Italy, recorded a large increase in the volume of business angels' investments, up 45% (i.e. €46m) compared with 2013 but concentrated in a smaller number of operations.

In Italy, taxation for private funds is low and since 2012 the MEF has introduced a tax exemption for venture capital funds (DM 21/12/2012). AIFI, the organisation of venture capital firms, recorded that in 2014 venture capitalists in Italy invested €3.5b in 311 operations concentrated in the IT sector.¹¹⁶

¹¹⁰ <http://www.cedefop.europa.eu/en/publications-and-resources/country-reports/italy-skills-forecasts-2025>

¹¹¹ According to the Organisation for Economic Co-operation and Development (OECD), university fees increased by 75% between 2009 and 2014 (OECD, 2013).

¹¹² ISTAT data estimate an outflow of around 19,000 graduates in 2013.

¹¹³ INPS estimated around 52,000 people falling into this category in 2013.

¹¹⁴ The report enlists 12 good practices of some relevance to the R&I system.

¹¹⁵ <http://www.iban.it/it/3124>

¹¹⁶ <http://www.aifi.it/category/dati-di-mercato/>

The provision of guarantees to relieve the financial distress of SMEs is a traditional instrument in the national framework. Since 2000, the Fondo di Garanzia per le PMI provides guarantees to SMEs (around 77,000 applications in the first half of 2015), with streamlined access to innovative start-ups and innovative SMEs.

Innovative start-up laws provide some fiscal incentives to investors to scale companies up; on the other hand, the 'reti d'impresa' definition is another measure for supporting the growth in size of single micro firms and SMEs. Nevertheless, current programmes do not include any specific incentives for the growth of micro firms and SMEs after the first stages.

5.5 R&D-related FDI

The attractiveness of Italy for FDI is a long-term issue, as foreign investments have decreased dramatically since the 1990s. The major policies intended to attract R&D-intensive FDI are the tax credit law and the 2015 enlargement of the innovative start-up law benefits to branches of EU companies, already discussed at length in Chapter 2.

5.6 Knowledge markets

The last reform of intellectual property rights (IPRs) was introduced in 2010 (DL no 131, 13 August 2010). It promotes creativity and invention by researchers and universities and streamlines access to patenting procedures.

Italy has only recently joined the European Patent Office (EPO) Unitary Patent (September 2015).

Since 2011, MISE, the ministry in charge of IPRs, has provided support to national initiatives such as prize competitions for patenting firms, and benefits for firms that bring innovations to market. Since 2012, IPRs have been associated with the innovative start-up framework. The 2013 initiatives for innovative start-ups also include patenting and IPR issues.¹¹⁷

Developments in knowledge markets in the last 2 years have included different initiatives. In 2014, the Union of Italian Chambers of Commerce (Unioncamere), CNR and the COTEC foundation developed an online patent database to encourage firms to use patents held by Italy's PROs. Since 2013, a funding facility within the Fondo Nazionale per l'Innovazione (FNI) has been available for innovative projects based on patents. The financial fund IPGEST plans to invest €40.9m in SMEs active in patents.

Since 2011, government policies have encouraged patenting – and the use of other IPRs – by Italian firms, in particular SMEs. Initiatives include the programme Brevettiplus, managed by MISE through the agency Invitalia. The 'Award for patenting' scheme is intended to stimulate patent applications to the national and international patent offices. The line 'Incentives for the economic exploitation of patents' has the main purpose of increasing the economic value of patents of Italian firms. The programme is financed by MISE to the total amount of €30.5m (OECD 2014). The programmes Brevettiplus (since 2010) and Brevettiplus2 (since 2015) are aimed at micro firms and SMEs with at least one patent registered after 1 January 2013 and at university spin-offs with at least one patent registered after 1 January 2012. Brevettiplus2 makes available a subsidy up to €140,000. The programmes are managed by Invitalia with a budget of €30.5m. CNR and the Italiacamp Foundation signed an agreement in July 2015 to promote KT and patenting.

The national approach showed a new direction with the optional tax regime of the patent box, discussed in section 2.2.

¹¹⁷ See the MISE report to Parliament for a list of the innovative start-up initiatives.

5.7 Public-private cooperation and knowledge transfer

5.7.1 Indicators

Funding: business enterprise-funded/publicly performed R&D

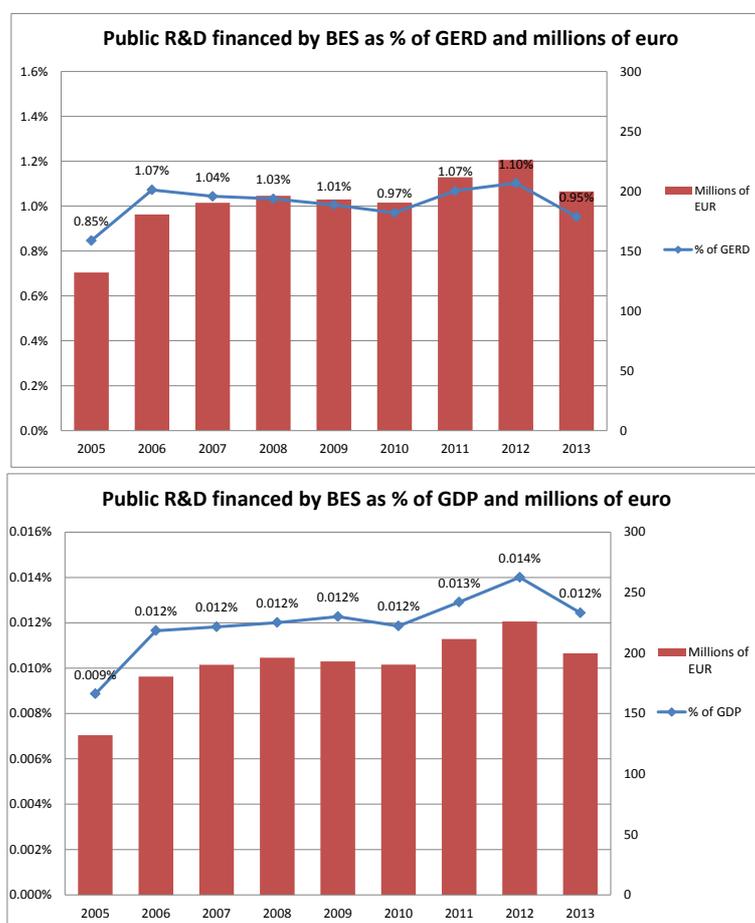


Figure 15: BES-funded public R&D in ITALY as percentage of GERD (€m) and percentage of GDP.

The level of the Italian business enterprise (BES)-funded public R&D expenditure as a percentage of GERD increased from 2005 to 2006, and then decreased constantly between 2006 (1.07%) and 2010 (0.97%), after which it returned to a growing path in 2011 and 2012. In both years the BES funding went over the €200m threshold. The indicator declined again in 2013, going below 1% of GERD, at 0.95% (see Figure 15).

The indicator expressed as a percentage of GDP fluctuates around the very low value of 0.01% of GDP, with the highest value, 0.014%, recorded in 2012, followed by a decline to 0.012% in 2013.

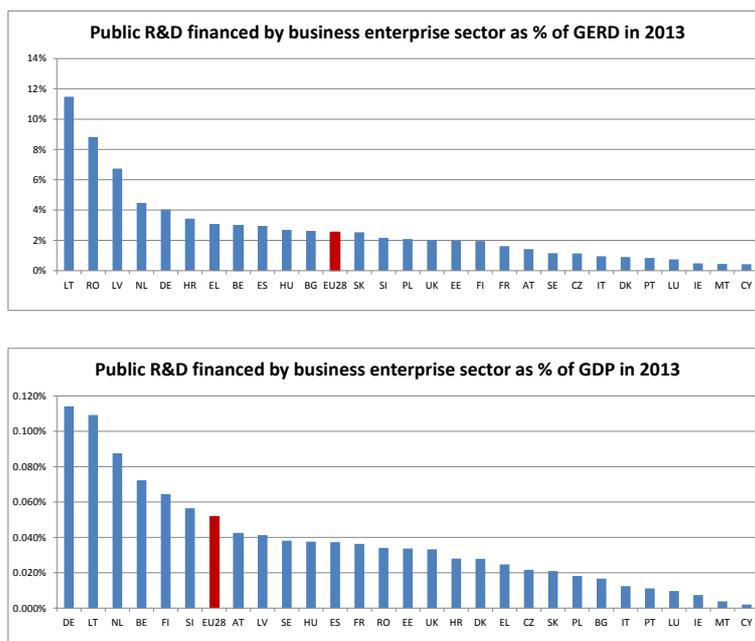


Figure 16: BES-funded public R&D as percentage of GERD and as percentage of GDP in 2013 in Member States.¹¹⁸

The two charts in Figure 16 show the values of BES-funded public R&D in all EU-28 Member States as percentages of GERD and GDP. Italy's levels are far below those of the best performers and the EU-28 average for both indicators, being ranked 22nd and 23rd respectively.

The low level of the BES-funded public R&D indicator can be explained by the R&D funding flows in Italy: the country is characterised by a system in which both the public and the private sectors have traditionally directed the largest share of their funding in a single direction, i.e. public funding towards public R&D performers and vice versa.

In fact, data about the expenditures by Italian businesses for R&D performed extramurally show that PROs and HEIs received only 1.19% and 5.52% of this funding respectively in 2011¹¹⁹.

Moreover, the Italian private sector is dominated by micro and small companies in the less R&D-intensive medium-tech and medium-low-tech manufacturing sectors, whereas the big research spenders, which account for a large proportion of Italian BERD, rely on their internal R&D capacities.^{120,121}

Funding: structural Funds devoted to knowledge transfer

¹¹⁸ 2013 was chosen as the latest data series providing a full comparison within the EU-28.

¹¹⁹ AIRI (Italian Association for Industrial Research): 'Spese per R&S, extra-muros, imprese, Italia - per strutture cui è affidata la ricerca (milioni di euro e valori percentuali)'.
<http://www.airi.it/wp-content/uploads/2010/03/tab4.9.pdf>

¹²⁰ See for reference: P. Moncada-Paternó-Castello and N. Grassano: 'Innovation, competitiveness and growth without R&D? Analysis of corporate R&D investment - A country approach: Italy' (2014).

<http://iri.jrc.ec.europa.eu/documents/10180/12238/Innovation%20Competitiveness%20and%20Growth%20without%20R%26D>

¹²¹ 'Two firms alone - FIAT in the Automotive & Parts sector, and Finmeccanica in the Aerospace & Defence sector - represent 60% of all R&D investment of the Italian firms included in the EU top 1000 Scoreboard ranking (edition 2013)' (Moncada-Paternó-Castello and Grassano 2014, p. 3).

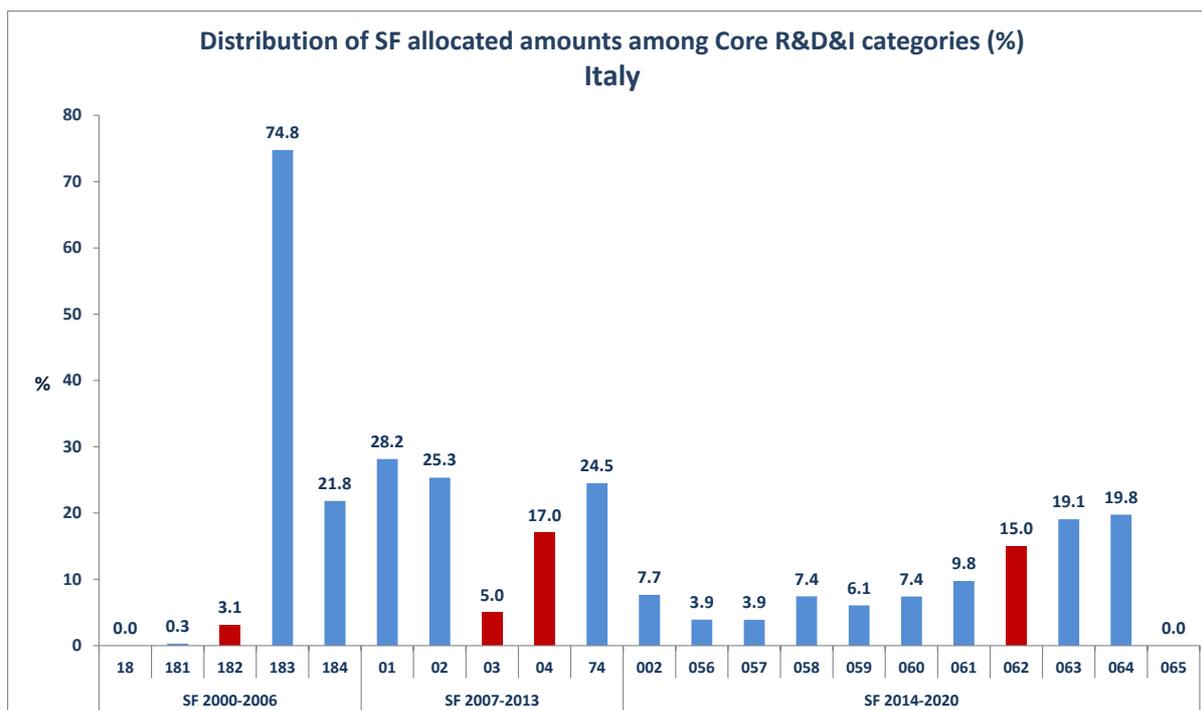


Figure 17: Structural Funds for core R&D activities 2000-2006, 2007-2013 and 2014-2020¹²². We use categories 182 (2000-2006), 03 and 04 (2007-2013) and 062 (2014-2020) as proxies for KT activities.

Italy has allocated 15% of its structural funds for core R&D activities to 'Technology transfer and university–enterprise cooperation primarily benefiting SMEs' (compared with 3.1% in 2000-2006 and 22% in the 2007-2013 programming period). It is only slightly lower than the EU average of 15.7% (the EU average was 26.1% for 2000-2006 and 30.1% for 2007-2013).

¹²² Figure 17 shows the Structural Funds allocated to Italy for each of the above R&D categories. The red bars show the categories used as proxies for KT. Please note that the figures refer to EU funds and they do not include the part co-funded by the Member State. The categories for 2000-2006 include: 18. Research, technological development and innovation (RTDI); 181. Research projects based in universities and research institutes; 182. Innovation and technology transfers, establishment of networks and partnerships between business and/or research institutes; 183. RTDI infrastructures; 184. Training for researchers.

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

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

Cooperation: proportion of innovative companies cooperating with academia

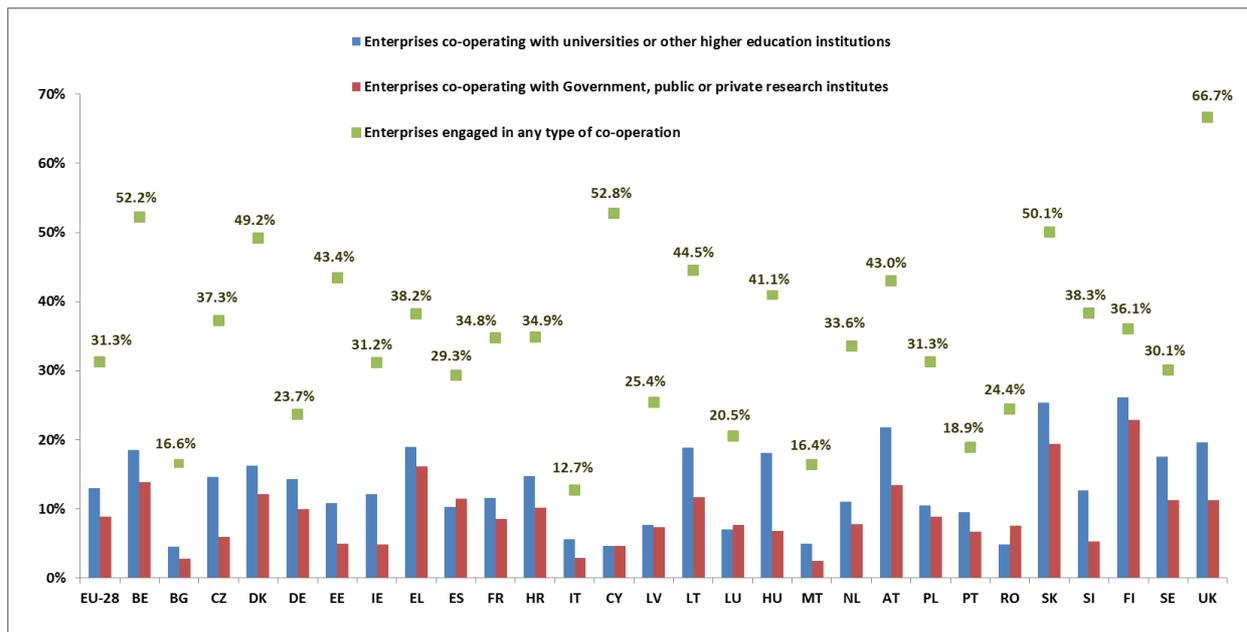


Figure 18: CIS 2012: proportion of innovative enterprises cooperating with academia

Figure 18 depicts the level of cooperation activities of innovative companies in the EU-28, according to the CIS 2012. The percentage of 'enterprises engaged in any type of co-operation' (green square) in Italy is the lowest in the EU-28 (only 12.5%), far below the EU-28 average of 31.3%. The percentage of enterprises involved in cooperation with universities or other HEIs (blue bar) is 5.6%, whereas collaboration with government, public or private research institutes (red bar) is 2.9%. Both indicators are also well below the EU-28 averages, which are 13.0% and 8.9% respectively. Moreover, Italy is in the bottom five for both indicators, together with countries usually ranked as 'modest' or 'moderate'¹²³ innovators by the IUS.

Cooperation: technology transfer offices (TTOs), incubators and technological parks

NETVAL is an association, funded in 2007, which groups 54 Italian universities, the CNR and other major PROs. It represents 66.3% of all Italian universities (and their TTOs), 90.0% of university professors (92.4% in the STEM areas) and 83.6% of all public research spin-offs¹²⁴.

The first TTOs were constituted in the 1990s but the majority of universities created ad hoc offices only between 2001 and 2008. Currently almost all HEIs and PROs have formal technology transfer structures¹²⁵. The Italian TTOs employ 204.3 FTEs, with an average of 3.7 each.

In Italy there are 32 certified business incubators registered at the ad hoc office of the Chambers of Commerce.¹²⁶

A recent study by Banca d'Italia, *Gli incubatori d'impresa in Italia*¹²⁷, surveys 58 entities that were performing 'significant incubating activities'.

¹²³ The latest IUS, for 2015, ranks Italy as a moderate innovator.

¹²⁴ <http://netval.it/netval-network/chi-siamo>. Last update 31/12/2013.

¹²⁵ XI Netval report on the valorisation of Italian public research. Page 22-23. Available at: http://issuu.com/netval/docs/rapporto_netval_2014_1/1?e=13058955/10524934

¹²⁶ <http://startup.registroimprese.it/report/listalncubatori.pdf>

¹²⁷ http://www.bancaditalia.it/pubblicazioni/econo/quest_ecofin_2/gef216/QEF_216.pdf

The Italian Association of Science and Technology Parks (APSTI) is a network that currently represents 25 science and technology parks.¹²⁸ They have been constituted since the 1990s, using funding from MIUR as well as EU Structural Funds.¹²⁹

Cooperation: proportion of public–private co-publications

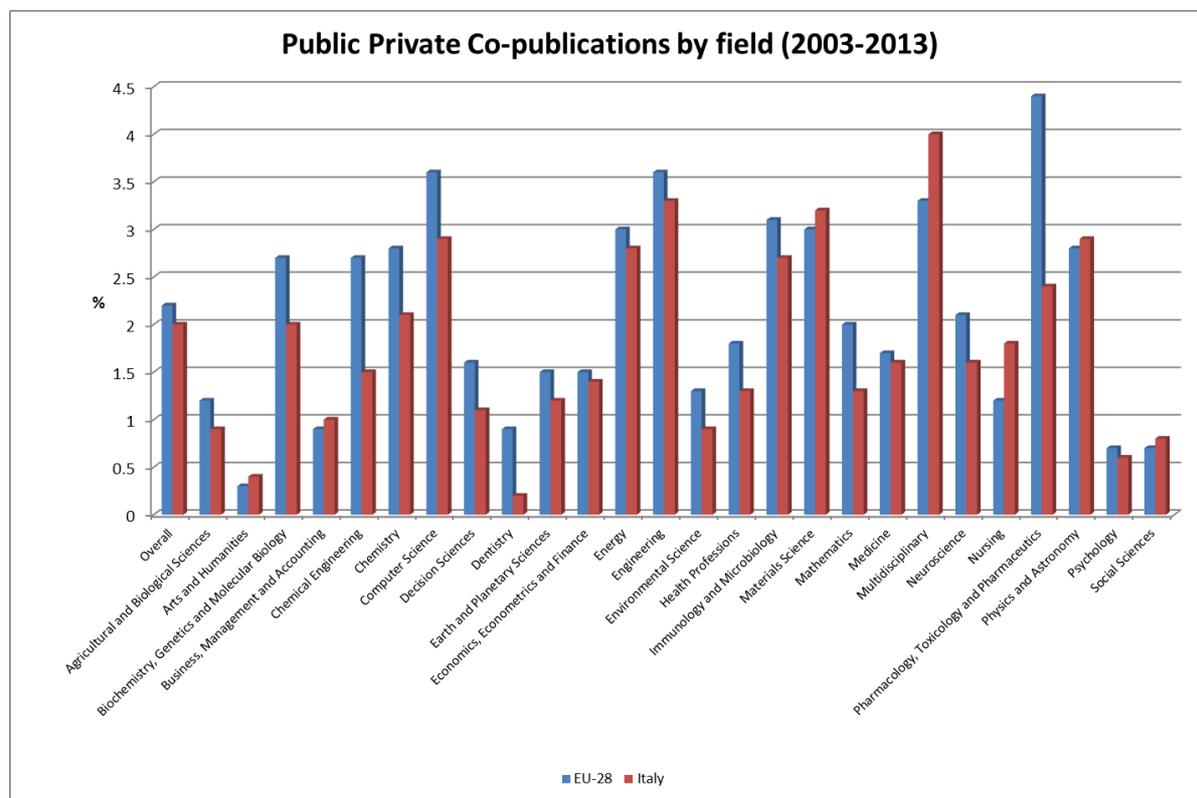


Figure 19: Co-publications by field in Italy, 2003-2013.

Source: Scopus database.

Figure 19 shows the average percentage of academia–industry co-publications by field in Italy in 2003-2013 compared with the European average. The total proportion of co-publications, displayed by the red 'overall' bar on the left of the chart, is 2.0%, just below the EU-28 average of 2.2%. Excluding multidisciplinary publications, the domains recording the highest share of co-publications are engineering, materials science, physics and astronomy (in which Italy's proportion of co-publications is slightly higher than the EU-28 average, at 2.9% vs 2.8%), computer science, and energy.

With 29.4 co-publications per million population, Italy is perfectly in line with the EU-28 average of 29.0, but very far from the Innovation Leader countries (Denmark stands at 182.1, Finland at 155.0, Germany at 57.8 and Sweden at 113.3).

Cooperation: patenting activity of PROs and universities together with licensing income

The Knowledge Transfer Study¹³⁰ allows Italy's performance to be benchmarked against the other countries surveyed as well as the EU average.

Italy is well placed in terms of patent grants, ranking sixth, with 4.7 patents per 1,000 researchers, higher than the EU average of 4.5.

¹²⁸ <http://www.apsti.it/index.php?id=53&L=1%27%20and%20char%28124%29%20user%20char%28124%29%3D0%20and%20%27%27%3D%27>

¹²⁹ There is no legal definition of science and technology parks in the Italian legislative framework.

¹³⁰ https://ec.europa.eu/research/innovation-union/pdf/knowledge_transfer_2010-2012_report.pdf

On the other hand, the number of licence agreements per 1,000 researchers is only 2.0, the eighth lowest score, far below the EU average of 6.5.

Licensing income is also quite low, at €61,000 per 1,000 researchers, compared with the EU average of €399,000.

Finally, Italy ranks third in terms of number of research agreements, immediately after the Netherlands and Finland, with 127.1 agreements per 1,000 researchers, while the EU average is 82.8.

Cooperation: companies

The NETVAL report¹³¹ presents a detailed overview of the spin-off companies stemming from public research since 1979.

At the end of 2014 a total of 1 144 spin-offs from public research were active in Italy, of which 146 were created in 2012 and 110 in 2013. In terms of sectoral breakdown, 295 companies were active in ICT, 225 in services for innovation, 183 in energy and the environment and 178 in the life sciences.

The special registry created within the network of Italian Chambers of Commerce lists 4 824 innovative start-ups¹³² currently active in Italy.

According to the Knowledge Transfer Study, there are 1.6 start-ups per 1,000 researchers in Italy, slightly below the EU average of 1.7.

5.7.2 Policy measures

Decree 179 18/10/2012, converted into Law 221 18/12/2012, introduced the legal definition of innovative start-ups, defining their features and providing a series of fiscal and financial support schemes¹³³.

Innovative start-ups must also meet at least one of the following additional 'alternative' requirements:

1. have 'costs in research and development greater than or equal to 15% of the highest value between cost and total production value of the innovative start-up';
2. hire 'as employees or in any capacity',
 - a) 'a percentage equal to or higher than one third of the overall workforce, [...] personnel in possession of a PhD or doing a PhD at an Italian or foreign university, or having a master degree and developing, for at least three years, a certified research activity at a public or private research Institute, in Italy or abroad';
 - b) 'or, in a percentage equal to or higher than two thirds of the overall workforce, [...] staff holding a master's degree according to article 3 of the Regulation referred to in Decree of the Minister of Education, University and Research no 270 of 22 October 2004';
- 3) be the 'owner, depositary or licensee of at least one industrial patent related to an industrial or biotechnological invention, or to a topography of a semiconductor

¹³¹ http://www.netval.it/static/media/uploads/files/Survey_2015_dati_2013.pdf, p.106.

¹³² <http://startup.registroimprese.it/report/startup.pdf> (accessed November 2015).

¹³³ They must have been established and have conducted their business activities for no longer than 48 months; must have as their sole or core business 'the development, production and marketing of innovative goods or services with high technological value'; from the second year of activity, must have a total value of annual revenue – stated in item A of the income statement according to Article 2425 of the Italian Civil Code – not exceeding €5m, as per the latest financial statements approved within 6 months from the end of the financial year; must not have distributed profits from the year of their incorporation and must not distribute them throughout the duration of the favourable treatment; must establish their main centre of business and affairs in Italy; and must not originate from a merger or demerger, or the divestment of a company or company branch

(http://www.agenziaentrate.gov.it/wps/file/Nsilib/Nsi/Documentazione/Start+up+innovative/Circolare+ENG_startup/Circolare+Start-up_ENG+06.11.2014.pdf).

product or of a new plant variety, or [...] the owner of rights relating to an original computer program recorded at the Special Public Register for Computer Programs, provided that such patents are directly related to the core business and activity of the company’.

Innovative start-ups can benefit from a series of fiscal advantages, including:

- reduced registration costs;
- favourable income taxation regime for capital gains deriving from the start-up shares;
- simplified procedure for the tax credit for hiring highly qualified personnel (see below on financial measures);
- tax deductions for the investments in the company.

Two examples of voluntary cooperation framework between the worlds of industry and research have been implemented in recent years.

The first is the agreement between Confindustria (the main Italian industrial organisation) and CRUI¹³⁴, signed in 2011, which is based upon eight measurable actions, including increase the number of STEM students and graduates; transfer knowledge; and increase the number of doctorate courses linked to industry needs.

The second is the memorandum of understanding between the CNR (the biggest Italian PRO) and Confindustria¹³⁵ signed in 2013. The agreement (called ‘Patto per la ricerca e innovazione fra CNR e Confindustria’) aims to foster cooperation to implement industrial research and experimental development and innovation programmes and to respond to the technological and economic needs of businesses, in particular SMEs.

The ‘Vetrina dei brevetti’ (‘Patents Showcase’)¹³⁶ of public research is a tool intended for valorising the results of the scientific research and technological development achieved by research organisations and universities on the market. The initiative has been promoted in 2014 by Unioncamere, CNR and COTEC, with the objective of facilitating Italian businesses’ access to patents originated by public research, through an online database.

With the tax credit for hiring ‘highly qualified personnel’¹³⁷, companies can deduct 35% of the costs of the new personnel, up to €200 000 per company and per year, when hiring highly qualified personnel on permanent contracts, in particular PhD graduates. The benefits of the decree have been extended (D. L. 179-2012) to innovative start-ups, with simplified administrative procedures. The budget allocated is €25m for 2012, and €50m per year from 2013 onwards.

A special fund provides tax credits for businesses and networks of companies (Reti d’impresa)¹³⁸, assigning tax credits to R&D projects to universities and research organisations. As it is intended to be funded through savings on current capital account transfers to private businesses, no allocation has been made available yet.

The FCS¹³⁹ provides funding at a special rate to companies for performing R&D projects in the technological sectors identified by H2020. The R&D projects must plan total eligible expenses between €800,000 and €3m and can be presented by individual

¹³⁴ <http://cruir.it/HomePage.aspx?ref=2023>

¹³⁵ http://www.confindustria.it/wps/wcm/connect/www.confindustria.it/5266/339662ce-4b1c-4913-b1ca-e737a64a6632/EstrattoAccordo+CNR-Confindustria20022013.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=339662ce-4b1c-4913-b1ca-e737a64a6632

¹³⁶ <http://www.innovazione.dintec.it/servizi/impresebrevetti/elenco.php?t=P>

¹³⁷ <http://www.camera.it/leq17/465?area=20&tema=790&Crediti+d%27imposta+per+la+ricerca+e+lo+sviluppo>

¹³⁸ Ibid.

¹³⁹ http://www.sviluppoeconomico.gov.it/index.php?option=com_content&view=article&viewType=1&idarea1=593&idarea2=0&idarea3=0&idarea4=0&andor=AND§ionid=0&andorcat=AND&partebassaType=0&idareaCalendario1=0&MvediT=1&showMenu=1&showCat=1&showArchiveNewsBotton=0&idmenu=2263&id=2031108;
http://www.sviluppoeconomico.gov.it/images/stories/normativa/Decreto_apertura_sportello_DEF.pdf

companies or by consortia, including in cooperation with research organisations. The special rate funding covers a proportion of the eligible expenses that varies according to the company size: 70% for small, 60% for medium-sized and 50% for large companies. The budget allocation is €300m, 60% assigned to SMEs and micro companies.

Two big calls have been funded in the framework of PONREC. This is the instrument with which Italy contributes to the development of the Cohesion Policy in the four Convergence regions (Sicily, Calabria, Puglia and Campania) and has a total budget of over €6b.

With the €1.1b call 'Industrial research projects to develop innovative products and services for businesses of the Convergence regions'¹⁴⁰, the MIUR selected (Decree 1 – 18/01/2010) a number of projects with a strong scientific and technological content for business innovation in products, processes and services in the four Convergence regions. The objective was to increase the competitiveness of the four regions, favouring sustainable development, together with diversifying product specialisation by consolidating excellence sectors. Companies have been invited to present industrial research projects, with the possibility of participating jointly with universities, PROs and other research institutions. The participation of SMEs has been promoted.

The 'Smart cities and communities' call,¹⁴¹ published in 2012, invited SMEs and large companies, universities and PROs to integrate their competencies and develop highly innovative solutions, which should use the most advanced technologies, to contribute to the regional development, respond to the concrete needs of the community and improve citizens' quality of living.

The ministry identified the following strategic areas:

- smart mobility;
- smart health;
- smart education;
- cloud computing technologies for smart government;
- smart culture and tourism;
- renewable energy and smart grids;
- energy efficiency and low-carbon technologies;
- smart mobility and last-mile logistics;
- sustainable natural resources (waste, water, urban biodiversity).

The budget allocation was €200.7m, with actual funding of €194.4m.

The establishment of the National Technology Clusters is one of the major efforts recently implemented by Italian policy-makers to foster high-level cooperation between academia and businesses. These clusters are organised aggregations of companies, universities, public or private research organisations, and other institutions active in the field of innovation, which focus their activities on a specific technology field. In this context, MIUR issued a call in 2012 that envisaged the development of clusters in the following areas¹⁴²:

- green chemicals;
- agrifood;
- technologies for living spaces;
- life sciences;
- technologies for smart communities;
- systems and means for terrestrial and maritime transports;
- aerospace;
- energy;

¹⁴⁰ <http://www.ponrec.it/programma/interventi/ricerca-industriale>

¹⁴¹ <http://www.ponrec.it/programma/interventi/smartcities>

¹⁴² <http://attiministeriali.miur.it/anno-2012/maggio/dd-30052012.aspx>

- intelligent factories.

As a result of the call, €266m was granted to 30 projects.

Italian regions are also quite active in supporting the R&I activities of businesses, especially SMEs. A recently issued report by Banca d'Italia, entitled *Le iniziative regionali per favorire l'innovazione delle imprese* (Regional initiatives fostering business innovation) provides an overview of regional innovation-supporting measures, including KT, targeting private businesses, with summary tables breaking down the measures by region.¹⁴³

The new R&D tax credit scheme introduced in 2015 (see previous chapters of the report) has been operational since July 2015¹⁴⁴. The scheme increases the 25% tax credit to 50% for R&D performed in collaboration with other companies or HEIs and PROs.

Another novelty introduced by the 2015 Budget is the legislation on patent boxes¹⁴⁵, which sets out special taxation for revenues resulting from licences or the direct utilisation of intangibles (patents as well as trademarks and other intangible goods). The tax credit is 30% for 2015, 40% for 2016 and 50% for 2017-2019.

The call 'Smart&Start Italia'¹⁴⁶, targeting innovative start-ups, was launched in February 2015. The call had a budget of about €200m, targeting innovative companies and small start-ups established within 4 years and registered in the special section of the Chambers of Commerce anywhere in Italy. Each enterprise could receive a maximum amount of €1.5m as interest-free loans, up to 70% of the value of their total investment plans.

In April 2015, the Vodafone Foundation, in cooperation with Polihub, a spin-off of the Milan Polytechnic, published a call for a total amount of €1m intended to award innovative projects in the social development of student spin-offs and NGOs.

The call 'PhD ITalents' (October 2015), a partnership between MIUR, CRUI Foundation and Confindustria¹⁴⁷, allows businesses performing R&D activities to benefit from co-funding of the labour costs for a period of 3 years when hiring PhD graduates. The contribution will cover 80% of the costs for the first year, 60% for the second and 50% for the third. The total budget allocated is €16,236m, of which €11m comes from MIUR. The initiative covers six thematic areas: energy, agrifood, cultural heritage, sustainable mobility, healthcare and life sciences, and ICT.

Italy is characterised by a modest level of public-private cooperation in R&D, as shown by the low level of private investments in publicly performed R&D, as well as by the percentage of innovative companies collaborating with HEIs and PROs.

The structure of the economy, largely relying on micro and small companies in less R&D-intensive sectors, the lack of strategic thinking by TTOs and their limited investment capacities for research commercialisation activities are some of the main weakness of the Italian KT system.

Still, public research commercialisation indicators have been improving slightly during the last 10 years, although largely influenced by the performances of the top five universities.

In recent years policy-makers have launched a number of framework and financial measures aimed at fostering KT and cooperation between HEIs/PROs and business. Nevertheless, some of them have suffered from limited financial resources (e.g. the cap set on the allocation for the tax credit scheme introduced in 2007, with all the resources

¹⁴³ <http://www.bancaditalia.it/studiricerche/convegni/atti/innovation-in-Italy/Lotti-Stefani.pdf>

¹⁴⁴ http://www.finanze.gov.it/export/download/novita2015/DM_RxS_27.5.2015_Credito_dximposta_per_attivitx_di_ricerca_e_sviluppo.pdf

¹⁴⁵ http://www.governo.it/GovernoInforma/documenti/legge_stabilita_2015/allegati/RELAZIONE_ILLUSTRATIVA.pdf

¹⁴⁶ <http://www.mise.gov.it/index.php/it/incentivi/impresa/smart-start>

¹⁴⁷ <http://www.phd-italents.it/media/>

already spent in the first half of 2009); others, such as the industrial doctorate, have suffered from heavy bureaucratic and administrative burdens¹⁴⁸.

On the other hand, the National Technology Clusters, the Smart Cities and Communities calls, and especially the legal and financial provision put in place for innovative start-ups can be seen as positive steps ahead.

The new R&D tax credit scheme and the new legislation on patent boxes might contribute to the improvement of the Italian KT framework as well. However, in the case of the R&D tax credit, the discussion about reducing the 50% tax credit for R&D performed in collaboration with HEIs and PROs to 25% may be a disincentive to business–public research collaborations.

5.8 Regulation and innovation

The governance of innovation and the impact of regulations on innovation is still not a topic on the agenda of the national authorities. Reports on the impact of regulation on innovation are not yet available, and neither are government initiatives in that area.

The Public Function Ministry released a 3-year strategy, the Action Plan 2014, listing the goals connected to innovation in the public sector. However, public administration innovation is a recurrent theme of the available research strategic documents. For innovative public procurement, the focus is on digital markets, as in the case of the abovementioned call 'ICT-Agenda digitale'.

5.9 Assessment of the framework conditions for business R&I

The current framework for business investment in R&I is quickly evolving towards indirect incentives and towards the implementation of a number of specific measures for SMEs.

In the last 3 years, governments have reformed access to the direct funding of R&I, introduced different typologies of indirect incentives, made available some administrative facilitations, implemented many tax benefits and finally allowed some derogations from the general business laws. Start-up laws, tax credits and the patent box law are the three layers aimed at triggering R&D investments. Since 2014, the political agenda has also focused on the attractiveness of Italy to FDI as a key issue for the success of R&D investments in the business sector. An assessment of the success of the current policies is not yet available. The degree of public–private cooperation is still low, as also indicated by the Italian CIS discussed at length in the previous RIO Country Report 2014.

The current measures are aimed at assisting the private sector side of any public–private partnership and do not deal with the removal of internal barriers from HEIs and PROs.

¹⁴⁸ See for reference: <http://www.ilsole24ore.com/art/notizie/2014-01-29/dottorati-azienda-rischio-flop-per-imprese-e-troppo-costoso-184253.shtml?uuiid=ABySI9s>

6. Conclusions

6.1 Structural challenges of the national R&I system

On the basis of the documentation and the analysis of the previous sections, Italy's R&I system is now facing the following structural challenges:

a) Low levels of business R&I activities and need to increase innovative performance

The gap between Italy and the EU average in terms of firms' innovative efforts and performance is well known. The share of GERD performed by the business sector (54%) is far below the EU-28 average of 63.67%. According to the IUS 2015 (EC, 2015), Italy is a 'moderate innovator' alongside southern and eastern European countries, with a total innovation performance below the EU-28 average. The last CIS, 2010-2012 (ISTAT, 2014a), shows that 51.9% of firms with 10 employees or more have carried out innovative activities but only 33.5% have introduced at least a product or process innovation; even among firms with more than 250 employees this proportion is limited to 66.7% (ISTAT, 2014a, p. 1). Compared with 2010, firms' innovative expenditures have declined substantially (ISTAT, 2014a, p. 4). As a result of the crisis, private investment in R&D and new machinery has fallen, reducing R&I activities further. The consequences for Italy's R&I system could include the permanent loss of a part of its production capacity; a greater presence of foreign firms transferring R&D, innovation and managerial activities abroad; a brain drain in the business sector, with highly skilled personnel searching for new jobs abroad; and a further weakening of the coherence of the R&I system.

b) The governance of the R&I system and the case of universities

Italy's R&I system has long been characterised by a lack of coherence, weak public-private interactions, a lack of strong players such as large firms, inadequate involvement of private finance in funding R&I efforts, and an uneven governance structure. All elements of the system need some reform to play a more dynamic role. However, most attention in recent years has focused on the case of universities and their problems with efficiency; frequent cases of mismanagement, nepotism and lack of consideration for scientific merit have received much attention. Meeting European standards in these regards and in the scientific output of research has been at the centre of much of the policies and institutional reforms introduced in recent years.

c) Territorial inequalities

A persistent, structural problem of Italy's R&I system – but also of its broader economic and social structure – concerns the deep disparities existing at the territorial level between the 'centre' and the 'periphery' of the system and in particular the serious lagging behind of regions of the south in terms of almost all R&I indicators. Such disparities have been made more serious by the effects of the recent crisis, with the reduction of productive capacity and industrial activities, and by the austerity policies introduced in the last 5 years. An old, deep-seated problem of Italy's economy has become even more serious in terms of R&I activities.

More detailed information on such structural challenges has been provided in the RIO Country Report 2014 (Nascia and Pianta, 2015).

6.2 Meeting structural challenges

Current policies have introduced actions that attempt to address the structural challenges listed above; however, other policies in place are likely to have little effect on such challenges and may worsen some aspects of the R&I system. A detailed analysis follows.

a) The low levels of business R&I activities and the need to increase innovative performances

The main policy addressing this challenge is the 2015 law on innovative start-ups and innovative SMEs. In this way the government is channelling more resources to business, stimulating private efforts in R&I. However, although this law creates a large pool of firms that are potential beneficiaries, there is little control over the effective additionality of the R&I efforts carried out. In particular, affiliates of foreign firms could benefit from such measures while introducing modest improvements in their R&I activities. Moreover, tax credit measures produce a loss of tax income that could be significant.

A second government initiative is the creation of the 'patent box', which allows firms greater appropriability of patented inventions and attempts to limit the use of patent licensing in multinational groups as a cover for tax evasion. While this is likely to favour innovation-related profits by firms, there is little evidence that such changes could result in greater domestic R&I efforts, as Mazzucato (2013), among others, points out.

To conclude, such measures could stimulate firms to carry out more R&I efforts but the effective outcome is not clear yet.

b) The public sector funding of R&I and the need to increase the country's R&D

As documented in the previous chapters, the budgetary constraints on public expenditure have seriously hit Italy's public R&D funds, making it difficult to reduce the gap from EU averages and from the Europe2020 headline target in terms of R&D as a percentage of GDP. Concern over the ability to reach such targets in the context of budgetary restrictions has been clearly expressed by the EC in its review of Italy's policies (EC, 2015). In this field, policies have shown little progress in the course of 2015.

c) The governance of the R&I system and the case of universities

Reforms in different aspects of the R&I have been undertaken by the government, with different degrees of implementation and effectiveness.

In the case of universities, several steps have been taken to improve efficiency. The reform of the qualification system is expected to be introduced at the end of 2015. Plans for hiring 500 researchers who are currently abroad were announced by the government in October 2015 and further steps have been taken – documented in the previous sections of this report – to increase internationalisation, public-private cooperation, etc.

The impact of recent policies has emerged in a number of evaluations. The state of Italy's research was assessed by the first ANVUR VQR for 2004-2010 (ANVUR, 2013), focusing on universities and departments. As documented in the RIO Country Report 2014 (Nascia and Pianta, 2015), ANVUR shows that the growth of Italy's share of worldwide publications is one of the fastest in Europe, above the EU average, and a strong performance is also found for cooperation with foreign institutions. In the same years, the Italian share of top publications (those included in the top 10% cited in each field) was also above the world average. Italy's output productivity for both universities and PROs is among the top countries. In terms of scientific specialisation, Italy expanded its efforts in industrial engineering, mathematics and computer science, agriculture, and earth sciences, and recorded lower shares in physics, chemistry, health and biology.

A second ANVUR report addressed the state of universities and research (ANVUR 2014), investigating the productivity of Italian researchers by relating scientific output – documented by the SciVal-Scopus database for 2010 – to the expenditure on R&D. Italy shows 3.88 publications per USD 1m of R&D expenditure (at 2005 prices), as opposed to 2.33 in France, 1.78 in Germany and 4.14 in the UK. When only public R&D is considered, the values are 9.15 for Italy, 6.55 for France, 5.42 for Germany and 11.31 for the UK. The latter indicator had increased substantially over the previous 5 years for Italy, while it declined for Germany and remained stable for the other countries. It is remarkable that in a context of drastic reduction of public resources the productivity of Italian researchers continues to improve and ends up 40% higher than German productivity (ANVUR 2014, p. 516). Even more striking results are obtained when

productivity is measured in relation to the number of researchers: in 2010, Italy produced 0.54 articles per researcher compared with 0.31 in France, 0.27 in Germany and 0.38 in the UK (ANVUR, 2014, p. 518).

No recent study has been carried on the effectiveness of the R&I system for Italy in comparative perspective. However, the results of the 2013 study carried out by SciVal-Elsevier (2013) for the UK government also shed light on Italy's performance. The study *International Comparative Performance of the UK Research Base* ranks Italy at the top in terms of the productivity of university research, measured by the number of articles per €1m spent on R&D and by the citations obtained per €1m spent on R&D; in these indicators, Italy is at the same level as top performing countries such as the UK and Canada (SciVal-Elsevier, 2013).

Additional studies on this issue include work from the Bank of Italy (Montanaro and Torrini 2013; Ciani and Mariani 2014) and studies providing empirical evidence on the impact of the qualification process on the quality of university professors (Marzolla, 2014; Abramo and D'Angelo, 2015). Although the picture they provide continues to present strengths and weaknesses, the evidence of improvements in research efficiency is by now solid.

d) Territorial inequalities

Public R&D budget reductions, greater pressure and lower funds for less efficient universities and the effects of the crisis on firms have led to a worsening of the deep-seated inequality between northern and southern regions in Italy. The key policy tool in this regard has long been the use of EU Structural Funds, particularly in the four Convergence regions of the south: Sicily, Calabria, Puglia and Campania. However, there has been little orientation of such resources towards a clear R&I strategy, and disparities have been increasing as a result. A variety of other policy tools is likely to be required for addressing in an appropriate way such a long-standing problem of Italy's R&I system.

Finally, there are three developments that may cause more problems in improving the country's position with regard to the structural challenges listed above.

1. The downsizing of technological and productive capabilities
2. While policies strive to increase business R&I activities in existing firms, as discussed above, the effects of the crisis are introducing deep changes in the structure of the country's economic activities and in R&I capabilities. Italy's industrial output in 2014 remained about 20% below pre-crisis levels of 2008. Plants closing, restructuring and takeovers by foreign firms have been increasingly frequent among medium-sized and large firms and especially in high-tech sectors in both manufacturing and services. The crisis has accelerated the consolidation of Italy's specialisation in traditional industries characterised by lower levels of R&I activity and declining markets. Firms have searched for competitive advantages through lower costs (mainly of labour) rather than through innovation. Demand remains stagnant, discouraging the introduction of new products. These developments are weakening the country's overall technological and productive capabilities in a way that could hardly be compensated for by a modest increase in R&I efforts or by the emergence of new innovative start-ups. A broader industrial policy for reconstructing capabilities in dynamic fields – characterised by more R&D, innovation and learning processes, in fields with strong demand and environmentally sustainable products and processes – appears an important policy priority to be integrated with the R&I agenda, in line with the Europe2020 targets (a discussion of these issues was presented in *Intereconomics*, 2015).
3. The downsizing of higher education
4. Since the start of the crisis the number of university students in Italy has fallen substantially; from a peak of 1,824.000 in 2005-2006, it declined to 1,751.000 in 2011-2012 (ANVUR, 2014, p. 41) and fell further in 2014-2015. As a result of spending reductions and of measures to increase efficiency, the number of

research staff in Italy's universities has declined from 62,768 in 2008 to 51,839 in 2014, a decrease of one-sixth (17%). Italy's expenditure on university education and spending per student has remained one-third below the OECD average.

5. The fall in the number of students, and permanent and temporary staff of universities, as well as the expected staffing reductions due to retirement, and the lack of new employment opportunities for young researchers, will lead to a structural downsizing of higher education. This will make universities unable to perform their institutional role exactly at the time when important efficiency gains have been made, as shown above.
6. The downsizing of human capital and the brain drain of researchers
7. Although government documents for the European semester emphasise the importance of human capital and knowledge (see Chapter 2 above), all indicators referring to human capital – from educational levels to the number of researchers – show worsening patterns and growing gaps between Italy and the European averages.
8. As employment opportunities for researchers decrease in Italy, many of them have moved abroad and several thousand Italian researchers are now working abroad (compared with just 50,000 permanent staff in Italy's universities). As discussed in section 5.3, the proportion of doctorate holders living abroad is raising and other sources estimated an outflow of €23b of human capital in 2008-2014 due to the intellectual migration flow.¹⁴⁹ Another study, from the Chamber of Commerce of Milan, also discussed the high educational levels of the new Italian migrants¹⁵⁰. This represents a serious loss for Italy's R&I system, a threat to its sustainability in terms of scientific research and teaching, and a major drawback for the possibility to catch up in terms of innovation and economic performance with the rest of Europe.
9. These downsizings of Italy's activities are likely to emerge as key structural challenges in the future if current trends continue. Besides efforts to increase R&D activities by individual players – both private and public – a systemic perspective has to emerge to preserve key elements and the effective functioning of the R&I system. This is threatened by the current losses in crucial parts of the system: the disappearance of technology-based firms, cuts in R&D budgets, fall in university staff and student numbers, migration of researchers. A new policy mix may be required to address these challenges, including a major increase in R&I resources, a relaxation of constraints for public budgets, and a new balance between public and private actions. A new industrial policy integrated with the R&I agenda may be needed, with a new role for public intervention in shaping and funding on a large scale not only basic R&D in private firms, but also new 'strategic' investment in ICT applications, environmental sustainability, and health and welfare systems, including new business ventures in high-risk activities.

¹⁴⁹http://www.repubblica.it/economia/2015/03/23/news/il_laureato_emigrante_un_capitale_umano_costato_23_miliardi_che_l_italia_reg_ala_all_estero-110242042/

¹⁵⁰ http://www.repubblica.it/economia/2016/01/05/news/la_grande_fuqa_dei_giovani_all_estero_non_si_ferma_34_in_due_anni-130654306?ref=HRER2-1

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Abbreviations

AgID	Digital Italy Agency (Agenzia Digitale Italiana)
ANVUR	National Agency for the Evaluation of Research (Agenzia Nazionale per la Valutazione della Ricerca)
ASN	National Scientific Qualification (Abilitazione Scientifica Nazionale)
BERD	Business expenditures for research and development
BES	Business enterprise
CINECA	Interuniversity Consortium for Computational Applications
CIPE	Inter-Ministerial Committee for Economic Planning (Comitato Interministeriale per la Programmazione Economica)
CIS	Community Innovation Survey
CNR	National Research Council (Consiglio Nazionale delle Ricerche)
CRUI	Conference of Italian University Rectors (Conferenza Rettori delle Università Italiane)
CUN	National University Council (Consiglio Universitario Nazionale)
DEF	Document of Economic and Financial Policy (<i>Documento di economia e finanza</i>)
D.lgs	Legislative Decree (Decreto Legislativo)
DM	Ministry Decree (Decreto Ministeriale)
DPO	Department of Equal Opportunities
DPS	Department of Development and Social Cohesion (Dipartimento per lo Sviluppo e la Coesione economica)
EC	European Commission
EPO	European Patent Office
ERA	European Research Area
ERANET	European Research Area Network
ERC	European Research Council
ERDF	European Regional Development Fund
ESF	European Social Fund
ESFRI	European Strategy Forum on Research Infrastructures
EU	European Union
EU-28	European Union including 28 Member States
FAR	Fund for Applied Research (Fondo per la ricerca applicata)
FCS	Sustainable Growth Fund (Fondo per la crescita sostenibile)
FDI	Foreign direct investment
FFO	Ordinary Fund for Higher Education
FIRB	Future in Research (Fondo per gli investimenti nella ricerca di base)
FIRST	Basic Research Investment Fund
FOE	Ordinary Fund for Public Research Organisations

FP7	Seventh Framework Programme
FTE	Full-time equivalent
GARR	Italian Research & Education Network (Gestione Ampliamento Rete Ricerca)
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross domestic product
GERD	Gross domestic expenditure on R&D
GVA	gross value added
HEI	Higher education institution
HIT2020	Horizon Italia 2020
ICT	Information and communication technology
IDA	Italian Digital Agenda (Agenda Digitale Italiana)
IP	Intellectual property
IPR	Intellectual property right
ISS	Istituto Superiore di Sanità
ISTAT	Istituto Nazionale di Statistica
IUS	Innovation Union Scoreboard
JPI	Joint programming initiative
KT	Knowledge transfer
MAE	Ministry of Foreign Affairs (Ministero degli esteri)
MEF	Ministry of the Economy and Finance (Ministero dell'Economia e delle Finanze)
MISE	Ministry of Economic Development (Ministero dello sviluppo economico)
MIUR	Ministry of Education, University and Research (Ministero dell'istruzione, università e ricerca)
n.e.c.	Not elsewhere classified
NRP	National Reform Programme
OA	Open access
OECD	Organisation for Economic Co-operation and Development
PCP	Pre-commercial procurement
PNR	National Research Programme (Programma nazionale della ricerca)
PONREC	National Operational Programme 'Research and Competitiveness'
POR	Regional operational programme
PRIN	National Interest Research Programme (Progetti di ricerca di interesse nazionale)
PRO	Public research organisation
R&D	Research and development
R&I	Research and innovation
RI	Research infrastructure

RIS3	Research and innovation strategies for smart specialisation
SIR	Scientific Independence of Young Researchers
SME	Small and medium-sized enterprise
STEM	Science, technology, engineering and mathematics
TTO	Technology transfer office
VQR	Five-Year Research Evaluation Exercise (Valutazione della qualità della ricerca)

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Annex 1 – List of the main research performers

List the top 10 R&D performers (based on publications for the public sector and on R&D expenditure for the private sector)

Top public sector performers

Ranking of university based on excellent publications in all fields as reported in VQR 2004-2010 by ANVUR.

Roma La Sapienza
Milano Politecnico
Torino Politecnico
Milano Statale
Milano Cattolica
Padova Statale
Torino Statale
Napoli Federico II
Bologna Statale
Firenze Statale

Top private sector business performers

Ranking of R&D investments of private business based on the 2014 EU Industrial R&D Investment Scoreboard.

Company	R&D investments, 2013 (€m)
Fiat	3,362.0
Finmeccanica	1,748.0
Telecom Italia	977.0
Unicredit	407.9
Intesa Sanpaolo	276.0
Pirelli	199.2
Chiesi Farmaceutici	198.0
ENI	197.0
Prada	149.9
Fincantieri	103.9

Annex 2 – List of the main funding programmes

Name of the funding programme	Timeline	Budget (€)	Target group
FFO	2015	6.9bn	HEIs
FOE	2015	1.7bn	PROs
FCS	2015	400m	Private business
Tax credit scheme	2015-2020	2.5bn	Private business

Annex 3 – Evaluations, consultations, foresight exercises

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Supporting legislation*

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