Knowledge for Growth – Industrial Research & Innovation (IRI)

Innovation Performance and Policy Reforms

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CORPORATE R&D: AN ENGINE FOR GROWTH, A CHALLENGE FOR EUROPEAN POLICY

Supporting corporate R&D

Abstract

This paper discusses the determinants of policy initiatives across EU Member States in the policy domain of R&D and innovation. In particular, this analysis verifies whether national governments react to past R&D performances by means of new policy initiatives aimed at supporting public R&D spending, private R&D investments and the supply of skilled human resources. In doing so, we exploit the detailed information on R&D spending provided by EUROSTAT and the original European Commission's MICREF database (October 2009 release), which track product market reforms over the period 2004-2008 for the 27 European Member States.

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Abstract

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Executive Summary

Improving the innovation performance of European economies is a major challenge for European policy makers. Over the past decade, a broad consensus has developed among policy makers on the need to implement structural reform aimed at improving the overall employment, growth and innovation performance of Europe. Increasing monitoring and analysis of the reform process is part of this joint effort between the European Commission and European Member States to understand the linkages between economic performance and reform measures.

Within the context of the Lisbon agenda, this effort has led to the creation of the European Commission's MICREF database. This original source of information provides a systematic record of the adoption of reform measures in the field of product markets by European Member States.

By exploiting such wealth of information, this paper provides a first attempt to discuss the determinants of policy initiatives across EU Member States in the domain of R&D and innovation. More specifically, this analysis investigates the linkages between (previous) economic performance and reform measures adopted in a specific policy field - namely a set of representative policies in support of the knowledge economy - and thus contributing to the political economy literature by means of such field-specific approach.

Empirical results suggest (1) the increasing attention towards policy initiatives aimed at supporting public and private R&D investment, (2) the responsiveness of Member States' policy measures to the underlying economic performance in specific product areas (R&D) and to general business cycle conditions, (3) the role of structural country-specific factors in explaining the propensity by EU Member States to engage in R&D policy initiatives.

Finally, this paper provides a methodological framework for the comparison between MICREF data and other available sources of information on the innovation performance and the regulatory activity across countries, such as the European Innovation Scoreboard and the OECD's Product Market Regulation index.

1 Introduction

R&D and innovation are increasingly acknowledged as the main drivers of economic growth, jobs and social welfare. Within the context of the "Lisbon" strategy for growth and jobs, EU Member States have expressed their ambition to increase Europe's overall level of investment in R&D to 3 % of GDP, of which 2/3 funded by businesses. Latest available data for the EU-27 indicates that Europe is still far from this target since overall R&D spending represents 1.85% of EU-27 GDP in 2007 (the equivalent figure is 2.67% in the US and 3.4 in Japan). Being at the core of the growth policy agenda, it is not surprising that many policy initiatives have been registered in the field of R&D in many National Reform Programmes prepared by European Member States as part of Lisbon strategy. Moreover, the economic crisis has increased budgetary pressures and the need to find new and more effective policy instruments to sustain national systems of R&D which can be strongly affected by the economic downturn.

This paper reviews the innovation performance of different EU Member States and their reforms record in the domain of the "knowledge economy". Moreover, it provides an empirical assessment of the factors which affect the propensity of a country to engage into product market reforms. The aim is to shed some light on the underlying factors which drive reforms in the area of R&D by means of an original dataset and with a sector-specific focus. In particular, country data on R&D performance - drawn from EUROSTAT - are matched with data on reform measures registered in the European Commission's MICREF database which systematically records product market reform measures adopted in the Member States. In doing so, this paper seeks to extend the empirical basis for understanding the political economy influences that lead to structural reform in the area of R&D. As a first attempt in this direction[1], the paper is mostly empirical with a focus on specific economic factors beyond the control of governments - although the empirical analysis may be extended to include some factors endogenous to the political process itself.

This paper is organised as follows.

Section 2 presents some key analytical references for interpreting the linkages between economic performance and policy reforms. Sections 3 and 4 provide, respectively, a descriptive analysis of R&D performances and reform measures across European countries. Section 5 provides the results of

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[1]To authors' knowledge, there are neither other empirical papers dealing with the determinants of reforms specifically in the area of R&D nor by using evidence from MICREF data.

the empirical analysis on the linkages between economic performance and a country's propensity to introduce reform measures. Section 6 provides some guidance on the comparison between MICREF data and other available sources of information on the innovation performance and the regulatory activity across countries. Finally, Section 7 highlights the main conclusions of the paper and some possible avenues for future analysis.

2 The Role of R&D and Innovation in the context of Structural Reforms

There is a widespread consensus on the recognition of R&D as the main engine of long-run economic growth (Romer, 1990). Indeed, R&D activity generates new knowledge (invention) which is then transformed into commercially-viable innovations (the development stage of the R&D process). These innovations diffuse in the economy (through adoption by consumers and imitations by firms) and, thus, induce the long term positive effect on economic growth (Schumpeter, 1934)[2]. This is the main reason why public authorities take an active role in stimulating a country's R&D system by providing the infrastructure and the institutional framework for supporting innovation activity.

A second reason refers to the specific features which make R&D different from other types of profit-motivated investments. For example, R&D is characterised by indivisibilities and economies of scale that create strong incentives for firms to monopolize markets. Moreover, the uncertainty inherent to innovation itself makes R&D activities highly risky from a firm's perspective[3]. This uncertainty, together with asymmetric information on the ultimate nature of the R&D investment, makes it more difficult for firms - especially in the current economic conditions - to obtain external financing. Finally, the partial non-excludability of R&D undermines private incentives to invest in R&D (Jones and Williams, 1998; Mansfield *et al.*, 1977)[4], which in turn explains why there is a

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[2]Endogenous growth theory extends the framework depicted by Solow (1956 and 1957) by providing a formal link between the creation of knowledge (Romer, 1986), the accumulation of human capital (Lucas, 1988) and economic growth. For a review of the literature on technological change and growth, see Conte (2006).

[3]In particular, the additional "technological uncertainty" embedded in the innovation itself, together with the common "market uncertainty" faced by firms acting in markets, makes R&D activities highly uncertain and risky from a firm's perspective.

[4]A crucial determinant of this outcome is the role played by technological "spillovers" (Mansfield, 1985; Jaffe, 1986; Acs et al., 1994).

role for government policies in promoting R&D and restoring R&D investments to their socially desirable level[5].

Indeed, both the current economic slowdown and the gap between the 3% target and the actual R&D performance of European countries makes "R&D and innovation" one of the policy fields where there has been the highest policy activities by governments. The former requires policy initiatives aimed at counteracting the possible slowdown in R&D - due to its cyclical nature, especially in the private sector - and, thus, preserve the knowledge base built in these years. The latter is mirrored in the policy initiatives taken within the context of the Lisbon agenda aimed at moving the baseline condition of long-term R&D evolution under the standard TINA argument - There Is No Alternative[6]. On the other side, policy measures such as the expansion of direct public R&D investments or more generous schemes of fiscal incentives for business R&D do not come for free and become even more difficult when deteriorating economic conditions creates more stringent budgetary pressures.

There are several contributions in the political economy literature which investigate the determinants of policy reforms across countries (Fernandez and Rodrik, 1991; Duval and Elmeskov, 2005; Hoej *et al.*, 2006). Most of these studies adopt a general approach to the determinants of reforms by testing different sets of economic and political variables. On the contrary, this paper is one of the few adopting a policy field-specific approach. This naturally lead to focus the choice of the determinants more on R&D-specific indicators while the more general dimension of the political economy argument (i.e. institutions, governance etc.) will be discussed only marginally.

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[5] Market failures in R&D can be addressed either directly (i.e. by targeting them at their source) or by influencing the incentives faced by private actors (Goolsbee, 1998; Hall and Van Reenen, 2000; Martin and Scott, 2000).

[6] This means that higher policy activity should be registered in those policy areas - such as R&D - where targets are clearly defined and the gap with the actual performance generates incentives for active policy.

3 R&D Performances across EU Member States

This section provides some descriptive statistics on the main R&D variables across EU Member States. Although aggregate figures on R&D spending are available from EUROSTAT up to 2007, disaggregated R&D data by sources of fundings and sectors of performance cover only the years until 2006.

A closer look at Gross Expenditure on R&D (GERD) as a % of GDP and its development over time allows distinguishing between four groups of countries (see Figure 1) . Sweden, Finland, Germany, Denmark and Austria are the countries where the level of R&D, measured as a percentage of GDP, is the highest. These five countries perform well both in terms of their static and dynamic position amongst the EU 27 Member States[7]. A second set of countries, namely those located in the upper left quadrant, are defined as catching-up countries in terms of R&D since they start from a low level of R&D as a percentage of GDP but have increased their ratio at a faster rate than the EU average. A third set of countries, namely France, the United Kingdom, Belgium, Luxembourg and the Netherlands have a level of R&D close to the EU average, but they have shown a lower R&D growth. Finally, a fourth group of countries located in the lower left quadrant appear rather weak in their overall R&D performance.

Figure 1. GERD as a % of GDP

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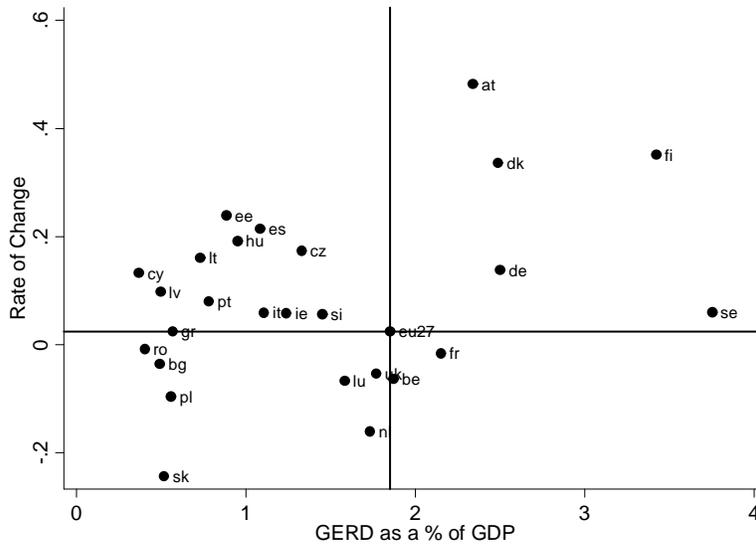
[7]The rate of change is the average growth between the periods 2002-2006 and 1997-2001. The rate of change is expressed in GDP % points.

Data on R&D performed in the government sector provides evidence of cross-country differences in the involvement of the public sector in research activities. It also illustrates the occurrence of different institutional features among the EU 27. This refers, in particular, to the institutional and funding balance between government and higher education sectors, the relative role of public and private institutions within the latter, and the size of the government sector. Firstly, R&D activity is organised in different ways across EU Member States. For instance, in France, Hungary, and Bulgaria most of the public R&D investment occurs in the government sector whereas higher education institutions are responsible for a large share of public R&D spending in Sweden, Austria and Denmark. Secondly, an assessment of public R&D investment in the higher education sector needs to take into account the relative balance between public and private research institutions and universities, as well as differences across countries in the public funding rules of private tertiary education institutions. Finally, differences in (1) the role/activities of government institutions across countries and in (2) the legislation on appropriability of intellectual property rights (IPRs) within public bodies may affect the data on patents by the government sector. The former refers to the relative size of the government sector and the possibility of a wider range of R&D and patenting activities in some countries. The latter refers to the rules on the recognition of ownership of IPRs to individual researchers working in public institutions, and the possible patenting and commercialization of such innovation activities.

In light of the institutional differences described it is not surprising that different patterns emerge across European Member States if government or higher education spending in R&D is considered. France and Germany are the countries with the highest percentage of government GERD in terms of GDP (Figure 2) but they perform slightly above the EU 27 average in terms of GERD in higher education (Figure 3). On the contrary, Sweden, Austria and Denmark perform well in terms of higher education GERD while they do not appear to be leading in terms of Government GERD. Finland is the only country where GERD in both sectors is significantly above the EU 27 average. Bulgaria and Slovenia have high levels of government GERD while another NMS, that is Hungary, records the highest growth in GDP points among EU 27.

Aggregate growth rates between the two periods under consideration for the EU 27 indicate a substitution from GERD in the government sector towards GERD in the Higher education institutions. This is especially the case for Denmark and Italy, which record the highest decrease of both

government GERD, and the highest increase of GERD in Higher Education institutions at the same time among the EU 27.

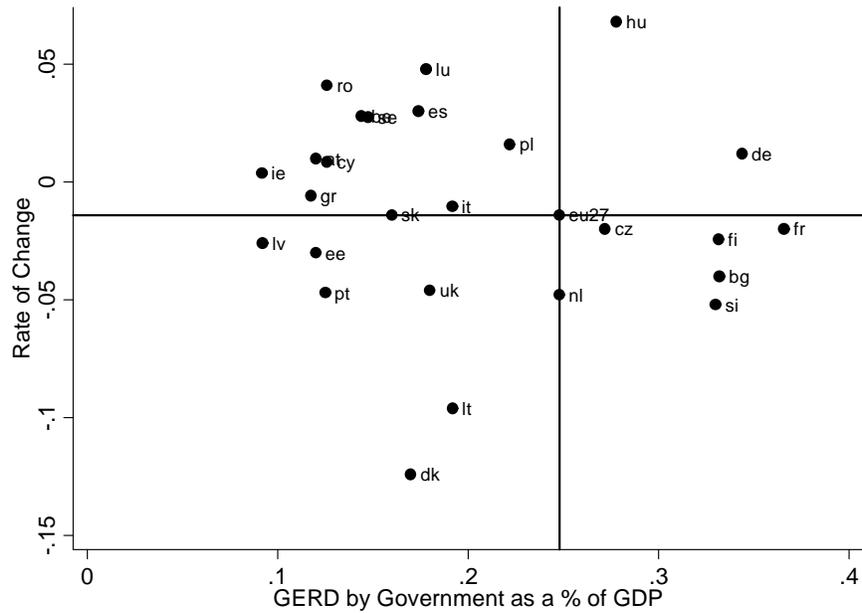Figure 2. R&D by the Government as a % of GDP

Figure 3. R&D by Higher education Institution as a % of GDP
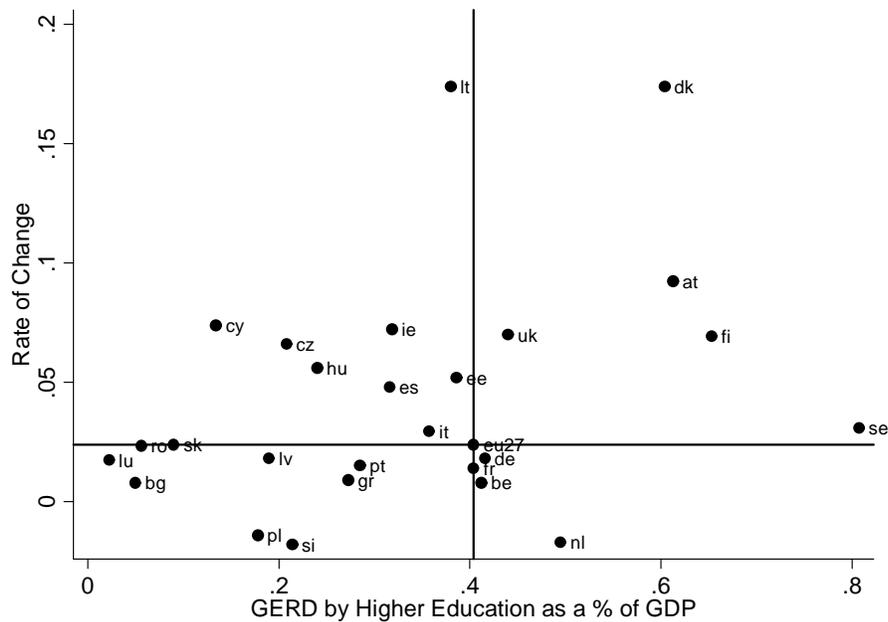
R&D in the business sector represents more than 60% of overall R&D across EU Member States. It has shown a stable rate over the period. Overall R&D performance depends clearly on the level of R&D in the business sector. Indeed, the five best performing countries in terms of business R&D, namely Sweden, Finland, Germany, Denmark and Austria, are also the countries with the highest level of overall R&D.

Figure 4. R&D by the Business Sector – % of GDP
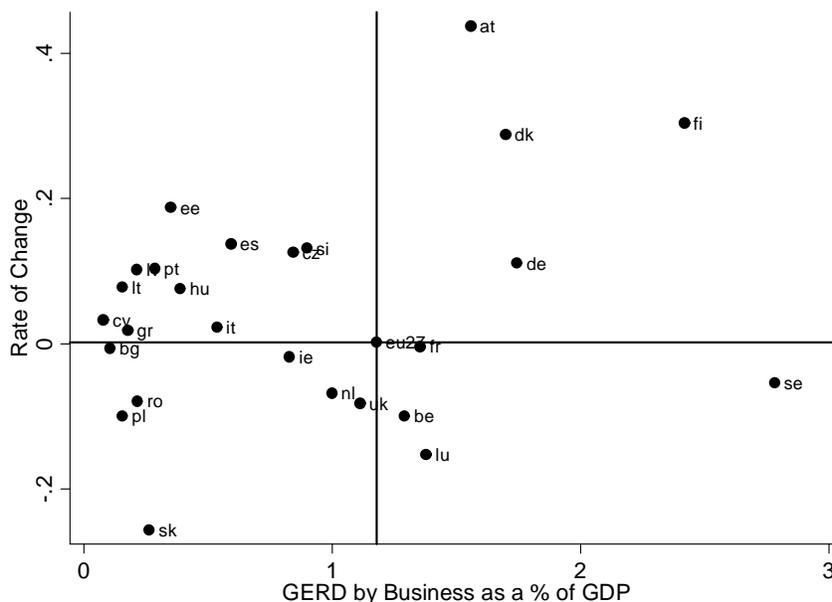
Enhancing private R&D investments represents a fundamental policy initiative for meeting the targets set out in the Lisbon strategy for growth and jobs. In recent years a number of Member States witnessed a significant shift in the policy mix from direct subsidies to fiscal incentives (Figure 5). The acceleration of the shift towards more tax incentives after 2000 did not happen at the expense of direct subsidies. Instead, countries have chosen to focus on strengthening of the whole portfolio of policy instruments by maintaining or even increasing their level of direct funding (e.g., Portugal, Spain, the United Kingdom) while keeping generous R&D tax incentives. Some countries with high R&D intensities and a favourable business innovation climate (such as Finland, Sweden or Germany) have both low R&D tax incentives and low direct subsidies for R&D.

Figure 5. Direct subsidies versus R&D tax incentives (Source: Warda, 2006)

Analytical Category	1991	2000	2006
Strong direct funding and unfavourable tax treatment	UK, IT, SE, DE	CZ, IT, PL	IT
Little direct funding and unfavourable tax treatment	BE, DK, EL, FI, HU, IE, NL, PT, JP	BE, DE, EL, FI, SE, UK	DE, EL, FI, SE
Little direct funding and favourable tax treatment	AT	AT, DK, ES, FR, HU, IE, NL PT, JP, US	AT, BE, DK, FR, HU, IE, NL, PT, JP
Strong direct funding and favourable tax treatment	ES, FR, US	No countries	CZ, ES, PL, UK, US

4 Reform Patterns in the field of R&D across EU Member States

The comprehensive structure of the MICREF database allows the investigation of the reform initiatives registered for all 27 EU Member States (EU-27) over the recent years. In particular, the last release of the MICREF database (October 2009) includes 2387 reform measures adopted over the period 2000-2008. The time frame for the analysis at the EU-27 level focuses on the period 2004-2008 (1727 reform measures) since data for the previous period (2000-2003) are only consistently available for EU-15 countries. Over the period 2004-2008, 611 reform measures are registered in the broad policy field of the "knowledge-based economy"[8]. It is important to keep in mind that (1) MICREF registers only significant new reform measures or important changes in the implementation framework of measures already in place since the purpose is to gauge the "change" ("progress or retreat") in the reform process.

The results of the analysis do not aim, therefore, at explaining all reform activities of countries, but rather their main reform priorities in the period under consideration; (2) measures are registered only once, according to their perceived main reform area or their main characteristic[9]. Moreover, (3) the existence of reform measures in a specific area (one or more measures) has been considered rather than the number of reforms since the size and the scope of reform measures might differ within/across policy areas or similar measures might be replicated at lower administrative levels (i.e. Member States with federal institutions, see Annex) . Finally, (4) the adoption year of a reform measure - rather than the implementation year - is used as a reference point[10].

To summarise, a binary scoring system has been used with value "1" for the existence of any (one or more) policy measure in a specific reform area (the lowest level of the database tree) and value "0" otherwise. The information is aggregated to the higher levels of the databases by weighting the "1" values by the number of reform areas on each level of the database for each year. In turn, this allows to identify country-specific and EU-wide trend in the adoption of reform measures in each policy area.

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[8] The following reform areas are not included in the analysis: "pre-school education" and "secondary education".

[9] It is possible that measures might be broader in scope and therefore affect more than one reform area. For this reason an updated, enlarged version of the database is foreseen which will allow multiple entries of reform measures.

[10] The adoption year is a mandatory feature of the MICREF database, the implementation date is optional and it is therefore missing for a large share of measures in the database. The focus on the adoption year stresses more the timing of the political decision rather than the effects of the reform.

Table 1. Correspondence between reform areas and policy domains[11]

Reform domain	No. of reform areas	Area of policy intervention	No. of reform areas
Open and competitive markets	26	Market integration	7
		External Openness	8
		Sector specific regulation	11
Business environment / entrepreneurship	26	Start-up conditions	10
		Improving the business environment	16
Knowledge-based economy	22	R&D	18
		Education	4

For the specific scope of this study, reform areas registered under the broader "Knowledge-based economy" domain are analysed (neglected areas in grey).

Table 2. Structure of MICREF – policy domain "knowledge based economy"
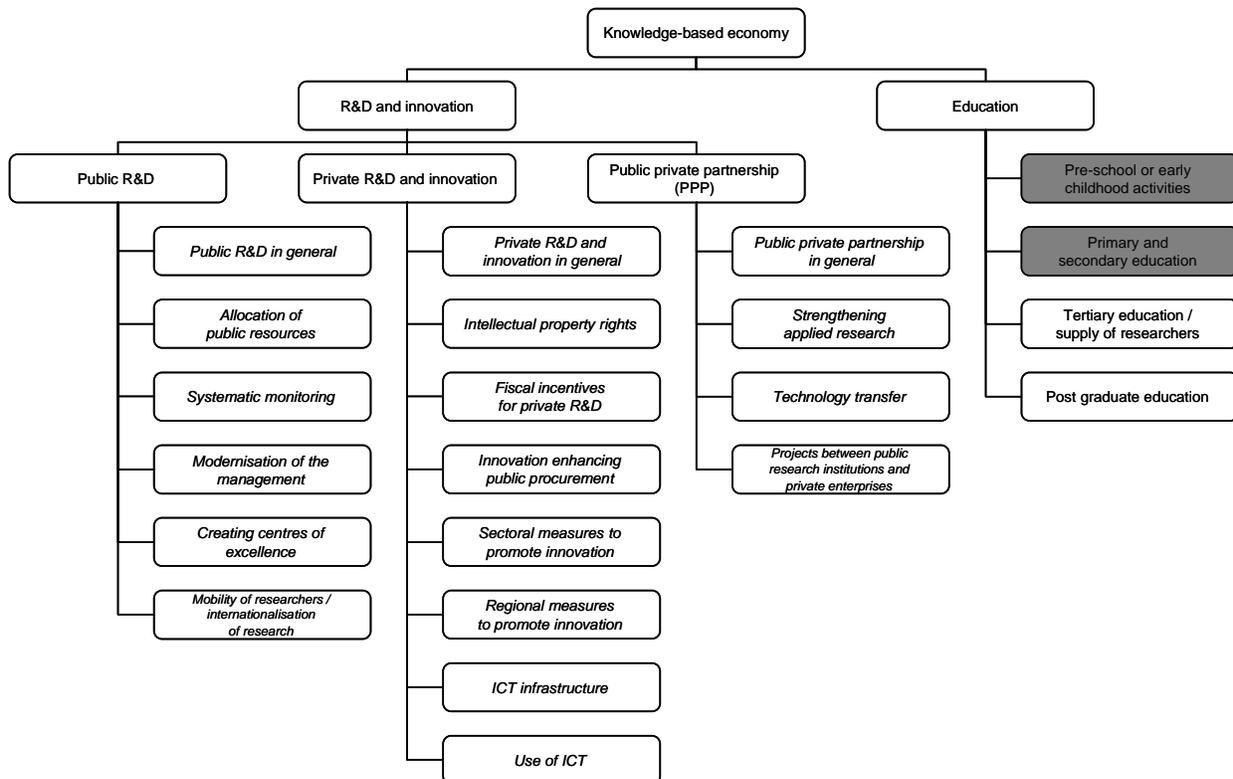
The policy domain "knowledge-based economy" consists of two broad policy fields: "R&D and innovation" and "education". Public R&D comprises measures involving national investments on

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[11]The area of policy intervention "sector specific regulation" is organised by reform areas **within** each sector (market opening, provision of services of general interest etc). To facilitate comparison across policy domains, sectors are considered themselves as reform areas.

R&D and innovation. Measures giving incentives to enterprises to invest in research are put together under Private R&D and innovation. Measures targeting Public private partnerships aim to jointly fund, construct, renovate or operate an infrastructure or the provision of a service. Measures in education include all reforms aiming to adapt education and training systems to new occupational needs, key competences and future skill requirements, i.e. orientation towards innovation and entrepreneurship. It also covers measures improving the openness and quality of education.

The results of the scoring system indicate the variability in the relative importance of policy domains across EU Member States. In particular, reforms in the "Knowledge-based economy" account from less than 30% in Poland and Germany to nearly 70% of overall initiatives in the Netherlands.

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Figure 6: : Share of policy domains (2004-2008)
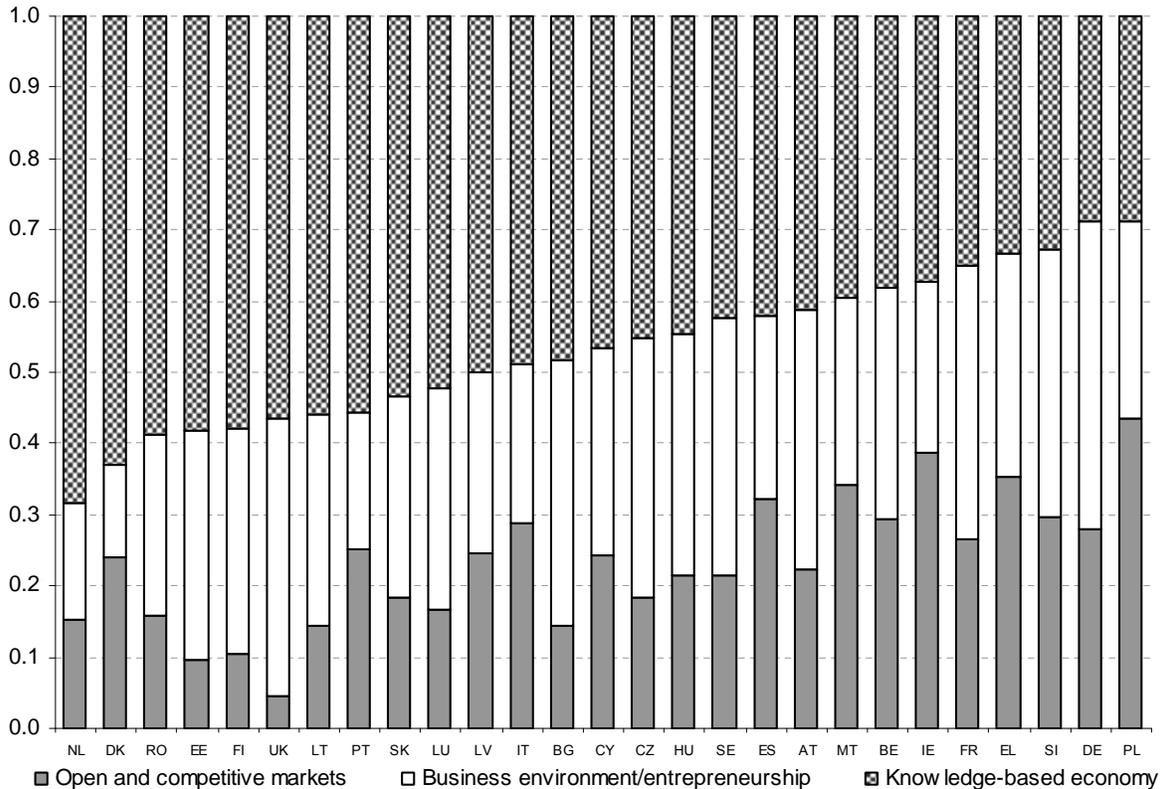
Over the period 2004 to 2008 the quartile of Member States which gave the highest priority of reform measures to the knowledge-based economy were the Netherlands, Denmark, Romania,

Estonia, Finland, the UK and Lithuania (in descending order). European Member States giving the lowest political attention to this domain were Poland, Germany, Slovenia, Greece, France, Ireland and Belgium (ascending order). This result clearly indicates the mix of different reasons which drive reforms since there are catching-up countries and innovation leaders in both tails of the distribution.

The following table summarises in more detail the reform profiles across MSs[12] and specifies the composition of the measures under the knowledge based economy, where the Netherlands again lead in R&D and innovation, followed by Finland. It reveals that a scarcity of education-enhancing measures aimed at education in Germany and Poland triggered the low value in the policy domain knowledge-based economy.

Figure 7: Reform profiles of EU-27 Member States 2004 to 2008
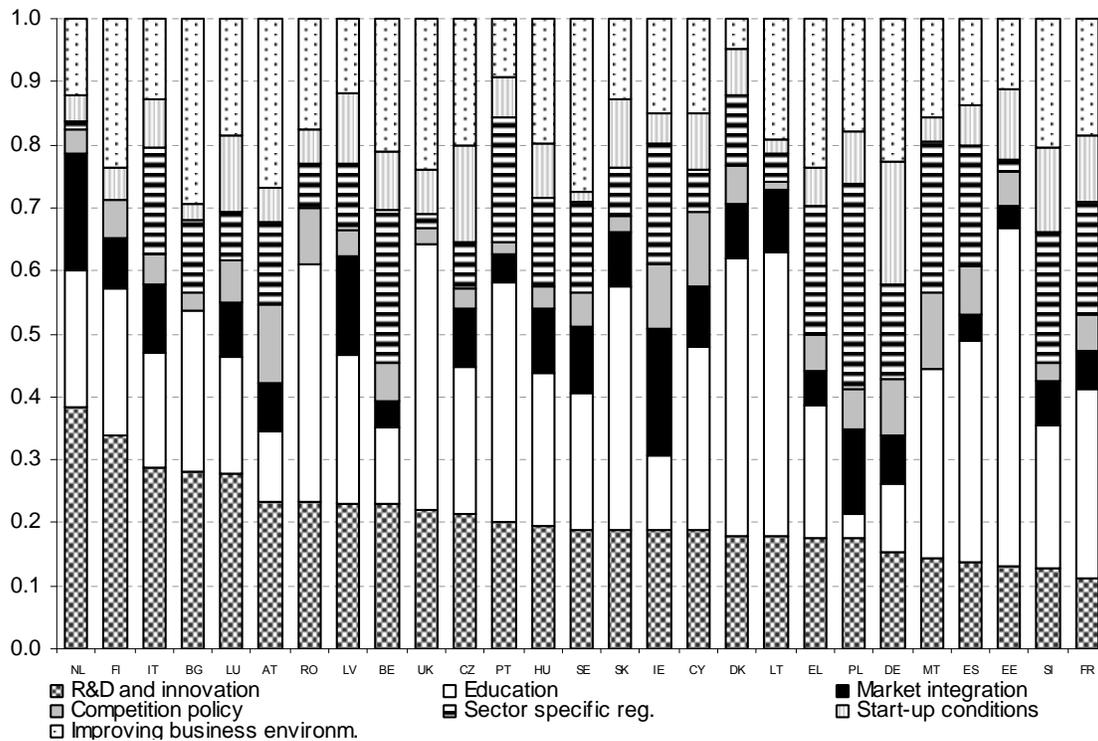
By moving a step further towards a more disaggregated anaysis of reform measures, it is possible to identify the following patterns across EU Member States (MSs) and over time:

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[12]Reform profiles are defined as the shares in each policy field of a particular Member State within the given period. This share of reforms is obtained by dividing the number of reforms in a particular policy field for the specific Member State by the total number of all reforms of the same Member State (or a group of countries if the group is under study).

- The areas of policy intervention with the highest activity across MSs were "administrative regulation", "private R&D and innovation" and "public R&D" (all MSs). Measures in the following areas of policy intervention were also very frequent: "Primary and secondary education" (26 MS), "access to finance for start-ups" (25 MS), "antitrust and merger controls", "tertiary education/supply of researchers" (24 MS), and "public private partnership" (23 MS). A few policy areas received very low attention, especially "water" (2 MS), "public local transport" (4 MS), "wholesale and retail trade" and "transfer of ownership" (7 MS).

- The most diversified reform profiles are found in France (27 areas), Hungary (26 areas), Greece (25 areas), followed by Slovenia and Spain with 24 areas, which suggests an absence of policy prioritisation over the period 2004-2008. In contrast, the Netherlands (14 areas), Luxemburg and the UK (15 areas) set some policy priorities in their reform process. Interestingly, recently acceded Bulgaria and Romania (13 and 16 areas) also clearly focused their priorities on a few policy areas, e.g. the efficiency of the legal system.

Figure 8: Share of policy domains to which priority was given (average annual change over period 2004-2008)

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Legend: ▨ Open and competitive markets   ☐ Business environment   ▥ Knowledge-based economy

This figure suggests a dychotomic pattern between countries in terms of evolution of policy initiatives in the field of the "knowledge-based economy":

- The following countries shifted their reform interest towards measures categorized under the knowledge-based economy: EE, SK, ES, DK, CY, DE and LU.

- In the following countries these measures lost out, especially to the benefit of support of the business environment: RO, PL, HU, NL, EL, IT and FR.

Figure 9: Reform measures across policy fields over the period 2004 to 2008 (average of all Member States)
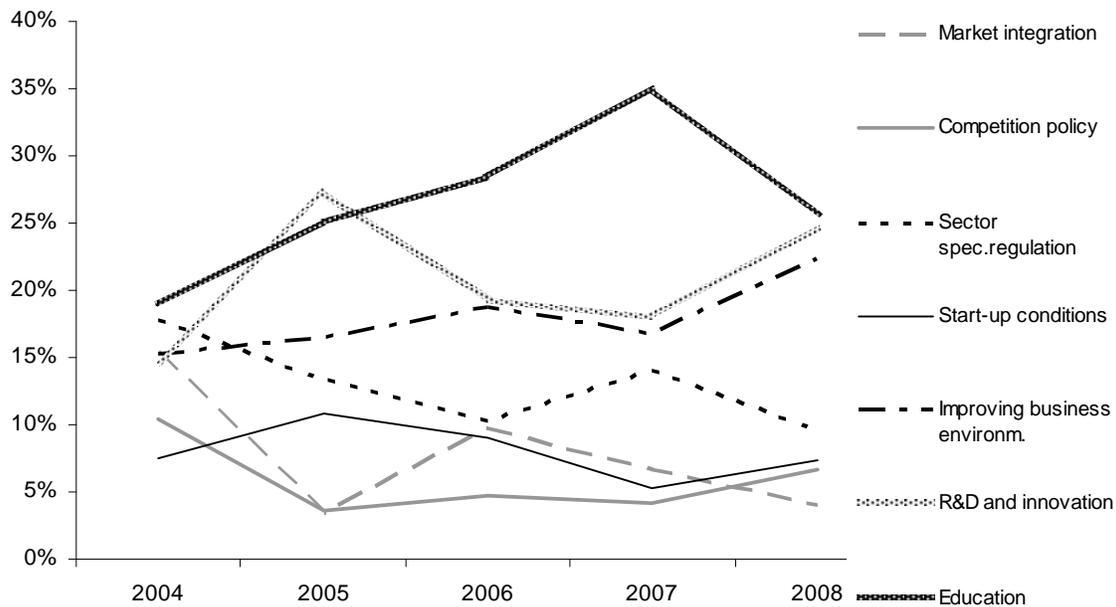
This figure shows the mounting importance paid to education policy measures, whose attention was only topped in 2005 by R&D and innovation, the 2nd highest priority. Competition policy and start-up conditions underperformed in all years like market integration, which, however, fared well in the year 2004, driven by EU-15 and New Member States alike.

If we look at the "R&D and innovation" field only, a significant variation across countries appear over the period under consideration.

Figure 10: Number of Member States addressing reform areas affecting innovation performance over the period 2004 to 2008

|	2004	2005	2006	2007	2008
Allocation of public resources	8	14	20	9	10
Tertiary education/Supply of researchers	7	12	15	17	10
Modernisation of the management	5	5	10	6	2
Intellectual property rights	2	3	10	3	4
Use of ICT	5	11	10	7	5
Systematic monitoring	0	3	9	2	3
Mobility of researchers/Internalisation of research	1	6	9	2	7
Fiscal incentives for private R&D	9	6	8	7	9
Creating centres of excellence	0	4	7	3	1
ICT infrastructure	4	5	7	5	9
Sectoral measures to promote innovation	0	4	6	2	2
Post graduate education	1	2	6	3	0
Regional measures to promote innovation	1	5	5	4	1
Private R&D and innovation in general	2	5	4	9	7
Strengthening applied research	2	4	4	4	2
Public R&D in general	2	4	3	6	6
Innovation enhancing public procurement	1	1	3	2	3
Technology transfer	2	2	3	2	4
Projects btw public research institutions and private enterprises	5	1	3	4	3
Public private partnership in general	1	5	1	3	6

This heterogeneity across countries is also captured by the following figure, which provides a measure of "revealed preference" in the policy portfolio. This is computed as the deviation of the reform profile of each EU Member State from the EU as a whole[13].

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[13]More formally, this is computed as the square root of the sum of the equally weighted squared differences of the particular year 'y' from the reference point average over period $\hat{y}$:

$$RP_j = \sqrt{\sum_i^I \frac{(x_{i,y} - x_{i,\hat{y}})^2}{I}}$$

with $x_{i,y}$ as the number of Member States that carried out measures in reform area i in the year y (compared to all reform areas in the given year), $x_{i,\hat{y}}$ as the average number of Member States that carried out measures in reform area i over the entire period 2004-2008. I is either the number of policy fields under study (=7) or, alternatively, the number of reform areas (=74) according to the chosen level of aggregation.

Figure 11: Revealed Policy Preferences (RPPs)
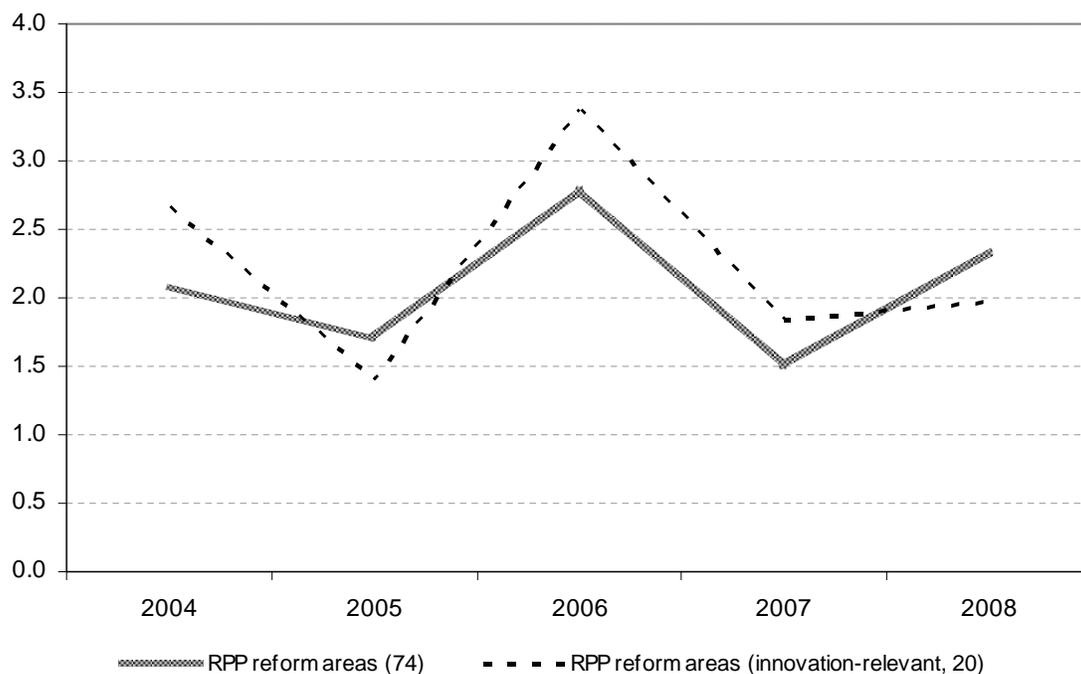
This indicator, calculated on the level of reform areas, is presented for the MICREF database as a whole as well as for the innovation-relevant areas only. It reveals that during the first four years the variation in innovation-related areas was even higher than for the database as a whole, whereas this was not the case in the year 2008. As shown by the indicator, in 2006 the effect of the re-launch of the Lisbon strategy in 2005 on the reform priorities appears to be even more pronounced for reform areas related to innovation performance.

5   Determinants of Policy Reforms in the field of R&D

This Section provides an empirical analysis of the determinants of selected policy measures taken in the MICREF's broad policy domain "Knowledge-based economy". For the purpose of this study, a panel dataset at the country level has been constructed, which contains the most relevant indicators in the area of R&D and innovation for which sufficient data are available. The final dataset contains annual information on all 27 EU countries over the 2000s. Data on R&D spending, Human Resources in S&T and other innovation-specific data are drawn from the "Eurostat - Science and Technology Indicators", which contains information on all EU Member States. Monetary indicators (GDP and

R&D expenditure data) have been rescaled in real terms using the GDP Deflator Index available from DG ECFIN's Annual Macro Economic Database AMECO to make time series data comparable over time. Annual data on reform measures are drawn from MICREF database over the period 2004-2008 (see Annex).

In particular, we focus on the determinants of the following reform measures (RM):

(1) Allocation of Public Resources, (2) Support of Private R&D and Innovation, (3) Fiscal Incentives for private R&D, (4) Tertiary Education / Supply of researchers.

These reform measures are the most representative in the policy domain "Public R&D", "Private R&D" and "Education"[14] and, therefore, have been chosen as the ones to be investigated.

Empirical estimates for each reform measure are based on the following general specification:

$$RM_{ct} = \alpha + L.RM_{ct-1} + \sum_{i=1}^{s} \beta_i L. \ln(R\&D)_{ct} + \gamma L. \ln(GDPpc)_{ct} + \delta D. \ln(GDPpc)_{ct} + \sum_{j=1}^{s} \beta_j CD + \varepsilon_{ct}$$

where RM_{ct} represent the occurrence of a reform measure in each country (c) and year (t). $R\&D_{ct}$ indicates the specific type of R&D expenditure by sector of performance (s) related to the specific policy measure (i.e. government R&D spending, private R&D) as indicated in the standard EUROSTAT disaggregation. The equation also includes GDP per capita as well as a set of country dummies (CD). L stands for lags while D refers to the effect of the variable-in-difference. We used a dynamic specification with lags (L) since we represent the effect of (exogenous) past performance on the political decision to introduce policy measures. Moreover, we test the hypothesis of persistence of policy initiatives in a specific area thorugh the introduction in the model of the lagged dependent variable. We capture the effect of business cycle on policies by means of a percentual change in GDP (log difference). Finally, the inclusion of country-specific fixed effects helps to wipe out time-invariant components such as istitutional or structural country features[15].

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[14]In particular, 45% of the cells "country/year" recorderd a value "1" (meaning the occurrence of policy initiatives in this area) across countries and over the period in the case of "Allocation of public Research"; 20% in the case of "Support of Private R&D and Innovation"; 29% in the case of "Fiscal Incentives for private R&D", 45% in the case of "Tertiary Education / Supply of researchers".

[15]Indeed, standard variables adopted in the political economy literature - mostly drawn from the World Bank's Database of Political Institution - have been used in the analysis - i.e. the political orientation of the government, the extent of majority seats in the Parliament - but given the specific focus of this study on the determinants of R&D-related policy measures they did not turn statistically significant.

Given the binary nature of the dependent variables the model is estimated through means of a probit specification for panel data.

The **main results** of the econometric analysis are summarised below:

- Policy reforms appear persistent over time and across countries in all policy areas except fiscal incentives.

- A lower share of government R&D to GDP ($GovR\&D\_gdp$) leads to more reforms targeting the allocation of public resources. It appears, therefore, that governments are aware of a relative weakness in this area and they try to target it by adopting new policy measures.

- A lower contribution of government funds to business R&D ($BesR\&D\_Govfunds$) leads to more reforms in the area of fiscal incentives. This result seems to confirm again that government's awareness of a relative country's position is then translated into policy initiatives.

- The awareness argument appears significant also in the cases of human resources in S&T ($HRST\_HighTech$).

- GDP per capita ($GDPpc$) as well other country-specific characteristics affect the likelihood of introducing reform measures in all policy areas except fiscal incentives.

- On the one side, reform measures in the areas of public and private R&D appear complementary in terms of a country's overall R&D performance. Indeed, a relatively high share of public R&D ($GovR\&D\_\%$) - and, therefore, a lower share of the business R&D component ($BesR\&D\_\%$) - lead to more policy initiatives in both areas. This seems to be consistent with the idea that European Member States are trying to adjust themselves to the Barcelona target - namely 2/3 of total R&D funded by the business sector since actual data are still biased towards a higher percentage of government R&D.

- On the other side, reform measures in these two areas appear substitute if we look at the business cycle ($D.GDPpc$). Indeed, this is consistent with evidence of governments developing policies to improve their public R&D system during expansionary periods when private R&D does not need additional support. On the contrary, during an economic downturn, reform measures seem to focus more on the support to private R&D with the aim of minimising the possible reduction in procyclical private R&D investments.

Table 3. Econometric Results. Dependent Variable: Reform Measure

Reform Measures	(1)	(2)	(3)	(4)
Variables	Public Resources	Private R&D	Fiscal Incentives	Supply of researchers
Lag Dep.Var.	-8.59***	-3.09**	-0.60	-2.11**
	[2.62]	[1.47]	[0.58]	[0.90]
L2.GovR&D_gdp	-270***			
	[86.2]			
L2.GovR&D_%	0.59***			
	[0.20]			
L2.BesR&D_gdp		-11.0		
		[10.4]		
L2.BesR&D_%		-0.38**		
		[0.17]		
L2.BesR&D_Govfunds			-0.0062**	
			[0.0027]	
L2.HRST_High Tech	-0.098**	-0.068**		-0.29***
	[0.041]	[0.032]		[0.11]
HRST				0.030***
				[0.011]
L.GDPpc	17.7*	40.7**	-0.54	12.4*
	[9.57]	[17.1]	[5.29]	[7.22]
D.GDPpc	128**	-90.3**	-36.1**	19.9
	[54.0]	[45.9]	[18.3]	[42.7]
Country Dummies	V	V	V	V
Constant	-160	-379	2.80	-152
	[110]	[2097]	[1731]	[5698]
Observations	81	81	90	75
Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1				

6 Matching MICREF with the EIS and the OECD's PMR

Innovation is a multi-faceted phenomenon encompassing policy areas as different as basic research, experimental development, diffusion in product markets and education policies. An understanding of the sources and patterns of innovative activity in the economy is fundamental to develop more effective policies. The need of monitoring and evaluating a broad national innovation system in the light of these complementarities between different fields related to the innovation process has led to several attempts to identify synthetic indicators across countries. Among these, the European Commission's European Innovation Scoreboard (EIS) (UNU-MERIT, 2008) and the OECD's Product Market Regulation (Woelfl *et al.*, 2009) provide a reference point for the assessment of innovation performance and economic regulation across countries. This section describes methods for comparing the MICREF database and these two other sources of information. In doing so, it provides an assessment of the value added and shortcomings of MICREF in comparison to these alternative data sources.

In general, the main value added of MICREF refers to the complementary information provided. Indeed, by tracking and evaluating policy measures MICREF data allows to investigate - in combination with other datasets - both the casual relationship which goes from past economic performance to policy initiatives, namely the determinants of microeconomic reforms, and the subsequent linkage between reforms undertaken and economic results, that is the effects of such reforms at a unique level of detail in terms of policy areas. The latter is beyond the scope of this paper which focuses, instead, on the economic determinants of policy initiatives in the area of R&D and innovation. Indeed, the latter depends more on long-term developments. Since the MICREF database is still a novel tool with very recent data on policy reforms, it is still too early to use it for assessing the effects of policies for which related economic data are not registered yet due to lags in data collection[16]. An application of MICREF may allow the comparison between its recorded policy reforms and the data registered in the EIS. In particular, the EIS attempts to benchmark, on a yearly basis, the innovation performance of the EU Member States, drawing on statistics primarily from the EUROSTAT's Community Innovation Survey. Seven dimensions - grouped into three main blocks - bring together a set of related indicators which provide an assessment of the innovation perfor-

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[16] On the macroeconomic effects of regulation and other policy reforms, see Djankov *et al.* (2002); Blanchard and Giavazzi (2003), Giavazzi and Tabellini (2005).

mance in that dimension, trying to accommodate the diversity of innovation processes and models of different national contexts[17]. While the EIS describes the innovation performance of European Member States, MICREF provides a picture of the underlying policies in the "knowledge-based economy" policy field which encompasses R&D, innovation and education.

The linkage between reform measures and quantitative summary indicators is done by comparing the registered measures in the MICREF database with the scores achieved under the different Dimensions of Innovation Performance provided in the EIS. The following table offers such comparison by adopting the most detailed level of the MICREF database's tree structure, the so-called "reform area", which offers the highest degree of homogeneity of policy initiatives[18].

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[17]The three main blocks in the EIS comprise the following indicators: (1) ENABLERS capture the main drivers of innovation external to the firm. It is divided into the following 2 dimensions: "Human resources" and "Finance and support". (2) FIRM ACTIVITIES capture innovation efforts undertaken by firms. This is captured by the following 3 dimensions: "Firm investments", "Linkages & entrepreneurship" and "Throughputs" (the latest being the Intellectual Property Rights (IPR) generated as a throughput in the innovation process). Finally, (3) OUTPUTS capture the result of the innovation activity. This is divided into a pure innovative dimension ("Innovators") and a more general assessment of the economic effect of innovation ("Economic effects").

[18]It is possible to draw the comparison between MICREF and EIS at each level of the MICREF database, i.e. based on "policy domains", "broad policy fields", "areas of policy intervention" or "reform areas".

Table 4. Matching of MICREF with the European Innovation Scoreboard

Policy domain	Policy field	Area of policy intervention	Reform area	Enablers	Human resources	Finance and support	Firm activities	Firm investments	Linkages & entrepreneurship	Throughputs	Outputs	Innovators	Economic effects
Product markets : open and competitive markets													
Product markets : business environment and entrepreneurship													
Knowledge-based economy	R&D and Innovation	Public R&D	Allocation of public resources		-	X		-	-	-			
			Creating centers of excellence		-	x		-	X	-			
			Mobility of researchers/Internalization of research		X	-		-	-	-			
			Modernisation of the management		-	-		-	-	-			
			Public R&D in general		-	-		-	-	-			
			Systematic monitoring		-	-		-	-	-			
		Private R&D and Innovation	Fiscal incentives for private R&D		-	X		X	-	-			
			ICT infrastructure		-	x		-	-	-			
			Innovation enhancing public procurement		-	-		X	-	-			
			Intellectual property rights		-	-		-	-	X			
			Private R&D and innovation in general		-	X		-	x	-			
			Regional measures to promote innovation		-	x		-	X	-		X	X
			Sectoral measures to promote innovation		-	x		-	-	-			
			Use of ICT		-	x		-	-	-			
		Public private partnership	Projects btw public research institutions and private enterprises		-	x		-	X	-			
			Public private partnership in general		-	x		-	X	-			
			Strengthening applied research		-	X		x	-	-			
			Technology transfer		-	x		-	X	x			
	Education	Pre-school or early childhood activities	Pre-school or early childhood activities		-	-		-	-	-			
		Primary and secondary education	Primary and secondary education		-	-		-	-	-			
		Tertiary education/Supply of researchers	Tertiary education/Supply of researchers		X	-		-	-	-			
		Post graduate education	Post graduate education		X	-		-	-	-			

Another possibility could be a comparison between MICREF and OECD's PRM data. The Indicators of Product Market Regulation (PMR) are a set of indicators that measure the degree to which policies promote or inhibit competition in areas of the product market where competition is viable. A distinctive factor of the OECD's economy-wide and sectoral indicators of PMR is their bottom-up approach. Indeed, raw detailed data on existing laws and regulations are used to construct quantitative indicators which measure the "stock" of regulation in the economy. This makes MICREF data a natural complement to PMR indicators since the former registers systematically the "flow" of new laws and regulations. A problem in the comparison of MICREF and PMR data is the lack of a harmonized common structure since the data in the latter are constructed in a much more aggregated way on the one hand (i.e. across subjects in the overall PMR) or with a more specific focus on the other hand (i.e. sector indicators). A comparison between the two datasets has to take into account, therefore, some overlaps in the classification of the data as well as additional differences in the process of data selection and classification across regional units, policy levels and

sector[19]. There is an ongoing work in this direction and some effort is currently made to establish a link between these two data sources in the next future.

7   Concluding Remarks

This paper has provided an empirical analysis of the linkages between economic performance and a country's propensity to introduce reform measures in the field of R&D and innovation.

Empirical results suggest (1) the increasing attention towards policy initiatives aimed at supporting public and private R&D investment, (2) the responsiveness of Member States' policy measures to the underlying economic performance in specific product areas (R&D) and to general business cycle conditions, (3) the role of structural country-specific factors in explaining the propensity by EU Member States to engage in R&D policy initiatives. Moreover, some interesting patterns emerge among different policy measures such as the complementarity between reforms in the public and private R&D domain with respect to business cycle conditions.

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[19]For instance, the PMR indicators do not take specific account of particularities of the EU single market and trade legislation while MICREF does not systematically register the implementation of EU legislation. Any indicator linked to EU-wide not-national driven policy is therefore excluded from the data collection. The complex retail indicator system of the PMR system is not reflected in MICREF which collects measures for wholesale and retail trade under one single header and only distinguishes between reform measures "in general" and "market entry restrictions". The OECD Regulation index in professional services also constitute a challenge, because its dimensions "Accounting, Architect, Engineer and Legal" are not listed as categories in MICREF and might not be systematically registered under the reform area "others". A good example on how to combine the structure applied for MICREF and the one developed for the PMR indicators may provide the "privatization" reform area in MICREF and various dimensions of state control within the PMR structure, which match with the registration of progress in reducing state control within MICREF.

Appendix. MICREF - Database on microeconomic reforms

MICREF systematically records product market reforms adopted in the Member States and presents qualitative information as a set of descriptive features of these reforms. Since its scope refers to the surveillance of micro-economic reforms across EU member States, MICREF provides a detailed composition of all the reform measures conducted by Member States in specific policy areas.

The data sources of MICREF are primarily the reports on the implementation of the National Reform Programmes (known as Cardiff Reports until 2005). Additional sources are used to complement information in the descriptive features of the registered reform. For this end international sources and information gathered by the EU, such as sector inquiries carried out by the Commission Services, the Internal Market Scoreboards, reports on specific policy areas such as the ERAWATCH database and the TrendChart Europe Country Reports, the National Summary Sheets on Education and On-going Reforms (Eurydice) are used.

The database is thematically organized around three broad policy domains: i) open and competitive markets; ii) business environment and entrepreneurship; and iii) knowledge-based economy. These domains correspond to 7 broad policy fields: market integration; competition policy; sector-specific regulation; start-up conditions; business environment; R&D and innovation; and education. Each policy field is subdivided further into areas of policy intervention which are in turn subdivided into reform areas[20].

Within MICREF the broad policy domain "knowledge-based economy" categorizes reforms under the broad policy fields "Education" and "R&D and innovation". In the policy field "education" relevant for this study are efforts regarding tertiary and post-graduate training, which in MICREF are listed under the headers "Tertiary education/Supply of researchers and "Post graduate education". R&D and innovation is subdivided into "Public R&D" which comprises measures involving Member State investments on R&D and innovation; "Private R&D and innovation", measures pro-

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[20]The structure of the database is presented in the MICREF user guide available at the following web page: http://ec.europa.eu/economy_finance/publications/publication13022_en.pdf.

viding for incentives to enterprises to invest in research, including state aid for R&D[21]. "Public private partnership" (PPP) complete the array of measures in this domain, describing a form of co-operation between the public authorities and economic operators with the primary aim to jointly fund, construct, renovate or operate an infrastructure or the provision of a service.

The analysis faces some drawbacks linked to the available information in the MICREF database, the aggregation of the policy reforms and their use in the empirical analysis. Although MICREF records design characteristics of reform measures, e.g. the effects of reforms on both the expenditure and revenue sides, currently low fill-in rates for these features results in a very low unrepresentative sample. This has two major implications. First, it does not allow the weighting of each reform measure and, thus, a true assessment of the relative importance of each reform. Second, it makes counting of reforms a biased exercise which would overestimate the policy initiative in countries with (1) a portfolio of low-profile reforms or (2) institutional settings which lead to a replication of measures within each policy field. An example of this "inflation" problem is indicated in the following table which indicates MICREF measures addressing access to finance for Belgium.

Table A1. Reform measures of Belgium in the reform areas "Access to finance" and "Start-up financing"

Reform area	Title of reform measure	Adoption year
Access to finance	Belgian Knowledge Centre for SME Financing (BeCeFi)	2005
Start-up financing	Introduction of a micro-credit mechanism (Wallonia)	2005
Access to finance	Creation of B2E	2006
Start-up financing	Creation of the Win win loan (Flanders)	2006
Start-up financing	Launch of Spin off in Brussels	2006
Access to finance	Fonds Vlaanderen Internationaal (FVI)	2006
Access to finance	Launch of the Brussels Venture Capital Fund	2007
Access to finance	Federal participation fund	2008
Access to finance	Credit mediator for SMEs in Wallonia	2008
Access to finance	Walloon region: guarantees for larger enterprises, also to support exports	2008

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[21] Any R&D incentive (fiscal, sectoral or regional) might be considered "state aid" if the initiative formally restricts the potential beneficiaries e.g. by way of size, location or sector.

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