Journal of Economic Policy Reform

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gpre20

An empirical test of the regional innovation paradox: can smart specialisation overcome the paradox in Central and Eastern Europe?

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Published online: 03 Mar 2015.

Journal of Economic Policy Reform, 2015
Vol. 18, No. 2, 153–171, http://dx.doi.org/10.1080/17487870.2015.1013545

An empirical test of the regional innovation paradox: can smart specialisation overcome the paradox in Central and Eastern Europe?

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The regional innovation paradox is the greater need of lagging regions to invest in innovation and their relatively lower capacity to absorb funding compared to more advanced regions. Using data on regional public spending, industry composition and economic performance, we test empirically whether there is a differential impact of European funding on regional economic growth between Eastern and Western European regions. We conclude that the paradox is proven and consider the extent to which smart specialisation strategies may help to improve the quality of governance of regional innovation systems.

Keywords: regional innovation systems; smart specialisation; Eastern Europe; European funding

JEL Classifications: O18, O31, O38, R11, R58

1. Introduction

The regional innovation paradox is the

> apparent contradiction between the comparatively greater need to spend on innovation in lagging regions and their relatively lower capacity to absorb public funds earmarked for the promotion of innovation and to invest in innovation related activities, compared to more advanced regions (Oughton, Landabaso, and Morgan 2002, 98).

In the decade since the paradox was identified, significant changes have occurred:

- geopolitically, the European Union (EU) was enlarged by 12 Member States (EU12), including eight Central and Eastern European countries (EE).[1] A significant shift of EU regional funding towards the EU12 occurred;
- economically, there was on-going shift of production and market power towards emerging economies. Post EU entry, the EU12 enjoyed high economic growth due to the inflow of funds, fuelling a consumption and real estate bubble, until the 2008 financial crisis hit. The economic crisis exacerbated divergences in income levels and increased levels of social exclusion and poverty across EU countries;
- innovation systems are under strain from the growing internationalisation of R&D (OECD 2008) and the "openness" of innovation (Gassmann, Enkel, and Chesbrough 2010) has profound consequences for regional capacity to develop, attract and retain resources (funds or people);

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- environmentally, an economic growth model based on over-consumption of resources and carbon-based energy means that "business as usual is no longer an option". Economic, science and innovation policies must be aligned to develop a coherent response to environmental challenges (EIO 2013).

Regional governance systems need to be sufficiently strong to develop strategies supporting medium-term structural change and respond to short-term shocks. These strategies must focus funding on measures that provide the highest return in terms of sustainable economic and social development. Quality of governance (QoG) is highly correlated with regional indicators of socio-economic development and levels of social trust, yet is statistically unrelated to variables such as population or area size Charron, Lapuente, and Dijkstra (2012). A region with a low QoG will not be able to use EU funds in an efficient and effective manner and may remain stuck in a low growth and low QoG equilibrium. Moreover, the regional government remains sheltered from the financial consequences of low QoG through continuing EU support. Hence, a targeted effort to improve QoG in such regions could substantially improve economic prospects.

The EU's structural funds (SF) and research framework programmes (FP) have invested significantly in research and innovation both in the private and public sector. The aims of these EU interventions in the "knowledge economy" are different: the first provides a "fiscal transfer with strings" to less developed regions to foster socio-economic cohesion; while the second invites research organisations to bid for competitive funds with projects selected based on "excellence". There is limited evidence on the extent to which these measures have boosted regional innovation performance and fostered structural change towards higher value-added activities.

Empirical studies on regional convergence (Boldrin and Canova 2001; García-Solanes and María-Dolores 2002; Rodriguez-Pose and Fratesi 2002; Cappelen et al. 2003; Beugelsdijk and Eijffinger 2005; Ederveen, De Groot, and Nahuis 2006; Dall'Erba and Le Gallo 2008) explore the effect of public interventions on regional growth and the location of economic activity. Explanations for positive effects on growth include moral hazard and substitution effects in the allocation of funds, and the prior existence of a favourable economic environment (low unemployment, high R&D capabilities). Others argue that the lack of positive convergence is because SF policies are largely driven by political rather than economic motivations (Boldrin and Canova 2001). The effectiveness of EU funds is conditional on the type of funds allocated (e.g. positive medium term effects of investments in education and training, Rodriguez-Pose and Fratesi 2002) or to the extent that recipient regions have strong institutions (openness and institutional quality, Ederveen, De Groot, and Nahuis 2006).

The potential impact on regional economic growth of SF support for research and innovation or of securing competitive FP funding varies. FP funding is concentrated in regions already endowed with research infrastructures (e.g. capital regions in the EU12) and with a significant "human potential" to compete internationally for these funds. The majority of EU regions that are "leading absorbers" of FP funds have good to very good regional innovation performance (Hollanders, Rivera Léon, and Roman 2012; Hollanders et al. 2014). In contrast, the SF are managed nationally and governance systems vary from fiscally autonomous regions, through decentralisation of specific powers to regional authorities to central management of operational programmes by national authorities. In short, not all regions are equally equipped to manage SFs.

While there is a degree of economic convergence (in productivity or employment rates), the gap between the lower income convergence and more developed regional competitiveness and employment (RCE) regions remains significant. Moreover, there is little convergence, even divergence, in regional innovation performance (Hollanders, Rivera Léon, and Roman 2012). This hinders a shift to knowledge-intensive and higher valued added goods and services. These observations underpin the European Commission's (EC) ex-ante conditionality for regions to submit a "smart specialisation strategy" (RIS3) as a means to improve the quality of the 2014–2020 SF planning. The RIS3 should serve to focus funds on a limited set of priorities with the most potential to drive economic transformation (McCann and Ortega-Argiles 2013).

This article investigates the determinants of regional economic performance and whether EU funds have promoted an increase in performance. In a second step, we assess whether past funding influences regional capacity to use funds in subsequent periods. We assume that less favoured regions need to invest more intensively in innovation and that the EU funds for such investment are available. Our hypothesis is that due to insufficient QoG, the funds do not improve innovation performance, competitiveness and economic convergence.

2. New structural economics, transition economies and smart specialisation

A clear distinction can be made in terms of the potential for convergence of innovation capabilities and performance between the cohesion countries (Greece, Southern Italy, Spain, Portugal and Ireland) and the EE countries. At EU accession, the former were "under-developed", largely agrarian and poorly educated whilst the latter were highly educated, industrialised and had a relatively strong scientific and technological basis for an innovation system (Radosevic 1999). The capacity to develop highly performing governance systems also varied: the Cohesion countries were characterised by a mix of functioning of weak democratic systems; while the EE were emerging from five decades of totalitarian rule and planned economies.

In the 1990s, the EE policy agenda was driven by the transition agenda (privatisation, trade liberalisation, bank reforms, enterprise restructuring) rather than innovation-led economic restructuring. By 2000, the innovation systems had undergone a significant restructuring towards a Western model. The "branch" research institutes and research institutes of the academies of science were closed or merged into universities. Pre-EU accession, science, technology and innovation policy in the EE countries was not well developed or funded. Public and private R&D expenditure levels were insufficient to maintain an internationally competitive science base, encourage technological adoption or sustain product and service innovation. From 2004 onwards, policy makers realised that a low-labour cost strategy would not support convergence. This led to a shift towards more innovation intensive policies, a change fostered by the in-flow of SFs. However, despite SF co-financed investment into research infrastructure, the intensity of co-operation between research and business remains limited; and business innovation performance has not improved significantly (Reid 2011).

Thanks to improvements in total factor productivity (TFP), the EE countries had more or less eliminated the productivity gap (relative to countries with a similar GDP per capita) by the mid-2000s. Berglof (2015) argues this was done by copying institutions rather than by copying industries. Indeed, price liberalisation and opening-up to the outside world were one-off effects in the transition economies. Hence, the former transition economies are likely to grow more slowly in future, unless there are additional, productivity-enhancing reforms. In short, the EE countries risk being caught in a middle-income trap (15–16,000 USD per capita) (Eichengreen, Park, and Shin 2013).

Moreover, the productivity catch-up from 1990 to 2005 does not obscure the remaining large productivity gap with Western Europe or the relative fragility of manufacturing and knowledge-intensive business sectors (e.g. the automotive, electronics or financial sectors), largely dominated by foreign direct investment (FDI). In most EE countries, the inflow of FDI resulted in improved performance of indicators such as share of medium high-tech employment or exports. However, much of this production is at the low end of advanced manufacturing and global value chains. For instance, Slovenia, a pre-crisis top-performer, lags the EU average in the share of high-tech products exported and the majority of Slovenian technology-intensive industries (with the exception of pharmaceuticals) trail considerably the EU productivity average (IMAD 2013). A second factor may be the low share of knowledge-intensive business services in manufacturing intermediate consumption. This undermines the potential to differentiate products and increase value added (VA) of the manufacturing sector.

After a decade of convergence, Europe's periphery (low-middle-income economies) is experiencing strong competitiveness problems and the crisis reinforced the strong differentiation in industrialisation potential in the EE (Foster-McGregor et al. 2013). There is a need to balance FDI-induced technology transfer and structural change with a boost domestic firms innovation capacity and technological adoption. Although there has been a transfer of technological know-how and non-technological innovation via FDI, co-operation between (larger) foreign-owned firms and indigenous businesses on product development remains weak. The financial crisis further weakened the capacity of EE businesses to invest in innovation (Izsak, Markianidou, and Lukach 2013).

Hence, there is an urgent need to (a) implement additional productivity-enhancing reforms by removing structural rigidities; and (b) to identify means by which to support an upgrading of technological and non-technological "endowments" that allows the EE private sector to enhance their position in global value chains.

The new structural economics (NSE) (Lin 2009), although primarily addressed at emerging economies, provides a complementary insight on how to reinvigorate the convergence of the EE with the more advanced Western European economies. NSE argues that the best way to upgrade a country's endowment structure is to develop its industries at any specific time according to the comparative advantages determined by its given endowment structure at that time. NSE (Lin 2009) provides a rationale for a proactive state that facilitates the process of economic development.

In contrast, neo-classical economics assumes a minimalistic state with a limited role to ensure the protection of property rights, maintain law and order and compensate for externalities. In neoclassical growth models, public funds for innovation and infrastructures finance greater levels of physical capital. Due to the higher marginal product of capital, this higher investment rate results in an increased convergence rate of emerging economies towards rich economies, but only transitionally, without any effects on the long run growth rate.

A comparative advantage defying (CAD) strategy that attempts to promote advanced industries in economies further from the technological frontier will result in non-viable enterprises in open, competitive markets. The alternative is to adopt a comparative advantage following (CAF) strategy to enable firm to follow the economy's comparative advantage in choosing technologies and markets only if the relative prices reflect latent comparative advantages. In a dynamic perspective, economic development depends on upgrading industrial structures, upgrading endowments and improving infrastructure.

The CAD vs. CAF argument can be compared with one of the core tenets of the smart specialisation approach: the "related variety" concept. Analogous to economies of scope at the firm level, Boschma (2005) suggests that knowledge spillovers within a region, or smaller country, occur primarily among related sectors, and only to a limited extent among unrelated sectors. The concept of "related variety" suggests that strengths in a particular sector, or value chain, can have positive spillovers (niche expertise in, say, automotive control systems leading to an opening for similar development in another sector) in other related sectors. Hence, the emergence of new specialisations should be based on existing skills and knowledge endowments, a process that is analogous with the CAF concept.

The core principle of the smart specialisation literature is that resources (public-private) should be concentrated on selected technological or market priorities that have the potential to not only foster the emergence of new activities but also foster the adoption, dissemination and adaption of "general purpose technologies" across a wide range of sectors (Foray and Goenega 2013). In the RIS3 process, priorities should be selected through an entrepreneurial discovery process.

It is striking that both NSE and RIS3 incorporate the self-discovery concept of the "new industrial policy" literature, (Hausmann and Rodrik 2003). Foray and Goenega (2013) argue prioritisation is no longer the role of the omniscient planner, but requires an interactive process in which the private sector discovers and produces information about new activities. Government's role is to assess the potential and then empower those actors most capable of realising this potential.

Both the NSE and smart specialisation concepts emphasise the role of entrepreneurial dynamics and of adjusting priorities to fit closeness to the technological frontier, underlines the Schumpeterian influence, which has also been integrated belatedly in transition economics (e.g. Aghion, Harmgart, and Weisshaar 2011). All three streams of thinking recognise the facilitating role for the public sector to help resolve coordination problems and ensuring the framework conditions that allow identified priorities to be pursued by broad-based partnerships (business, public agencies, higher education/research organisations, social sector, etc.).

Weak governance capacity and its effects on innovation and economic performance has been addressed in the regional economic growth literature. Rodriguez-Pose and Garcilazo (2012) explored the extent to which the quality of local or regional governments mitigates or enhances the effects of public investments. They found that both regional expenditure on cohesion and quality of government make a difference for regional economic growth; and that the greater the level of expenditure and the better the quality of the local government, the higher the economic returns of public expenditures on cohesion.

Moreover, Barca, McCann and Rodriguez-Pose (2012) argue that space matters and shapes the potential for development not only of territories, but also of individuals who live in them. The World Bank (2009) and Barca (2009) for the European Commission emphasised the need to take account of the interactions of economic geography and local and regional institutions, and to capitalise on the knowledge of local and external actors by engaging them in participatory processes when developing policies. Although this place-based approach has been integrated into the SF policy for 2014–2020, some national and regional economic and innovation policy mechanisms remain based on spatially blind and top-down approaches (Barca, McCann and Rodriguez-Pose 2012).

The debate on a place-based approach coincided with the emergence of the smart specialisation concept and a new generation of regional innovation policy. For Huber (2011), this constitutes a major challenge to the conventional public policy paradigm, where policy is defined *ex-ante*, and controlled *ex-post*. Morgan (2013) argues that smart specialisation presents three different challenges for EU regions: conceptual, concerning the meaning of the concept and what it implies for the theory and practice of regional innovation policy; operational, related to the ability of regions to translate the concept into a coherent policy agenda; and political, regarding how to ensure that regional stakeholders are mobilised to meet the operational challenge. In his view, the smart specialisation process will force regional governments to recognise innovation as a collective effort in which the capacity to work in coordination will be a decisive success factor.

The launch by the European Commission of a policy development process, based on "entrepreneurial discovery", may lead to a more effective outcome in terms of economic transformation. However, it will also test the limits of regional innovation governance systems that have struggled to cope with more standard programming methods.

3. Innovation systems, regional policy and the regional innovation paradox

In the innovation systems literature, the ability to innovate is one of the key determinants of economic performance. Income gaps between regions are associated with a region's capacity to innovate, and, thus, closing the innovation gap is a necessary prerequisite to closing income and productivity gaps. Innovation is a key policy instrument if productivity and income per capita are the policy targets. Innovation activity thus dictates relative economic success (Lundvall 1999).

Innovation activity is also determined by how well the different parts of the system interact (Michie and Oughton 2001). The central idea is that innovative performance depends on the innovative capabilities of enterprises and research institutions, and on the ways they interact between them and with government institutions. In fact, several authors have suggested that innovation and technological development can only be effective if it is organised as a problem-solving process, if it is assimilated in a non-linear and interdependent process and if it is embedded in an interactive system favourable to innovation (Lundvall and Borras 1997; Dosi et al. 1998). However, the transfer of knowledge is neither linear nor automatic (Doloreux 2002). For instance, following Porter (1990), the success of enterprises in a given region and industry is influenced by four elements: local factors conditions; demands conditions; strategies or relating and supporting industries and firm strategy; structure and rivalry. With its emphasis on knowledge, learning and institutions, the systems approach has highlighted the need for institutional change and better integration between technology policy, industrial policy and other aspects of public policy (Lundvall 1999).

The regional innovation systems (RIS) concept grew out of the national innovative systems thinking, primarily based on evolutionary theories, applied to understand the dynamics of innovation at regional level. A RIS is defined as a system *in which firms and other organisations are systematically engaged in interactive learning through an institutional milieu characterised by embeddedness* (Cooke, Uranga, and Etxebarria 1998, 1573). Interactive learning implies the existence of knowledge that is combined and made collective for different actors within the productive system. Most importantly, innovation cannot be produced in isolation, but only within a network of actors, or milieu, that translate into agglomeration economies for firms engaging in interactive learning (Doloreux 2002). Additionally, the systems literature suggests that the institutional framework shapes the learning process in a regional economy (Morgan 1997). The originality of the RIS approach is that it tries to understand a process, rather than describing the components of regional success.

Innovation activities vary considerably across regions, although almost 70% of the variation in R&D expenditure is within countries, and only about 30% is across countries (Michie and Oughton 2001). Empirically, quantitative analysis has suggested that there must be a set of regional factors shaping differences in R&D intensity, innovation activity and competitiveness (Oughton, Landabaso, and Morgan 2002). The theoretical rationale for focusing on RIS lies in the fact that factors of great importance to innovation – such as the industrial structure, inter-firm relationships, R&D intensity and industry–science links – vary even more importantly across regions than across countries. Moreover, the industry–government–university nexus identified by the triple-helix model (Etzkowitz and Leydesdorff 2000) that is central to the innovative capacity of countries and regions functions also differently at regional level. Similarly, this is the case for other factors such as knowledge transfer, learning, agglomeration economies and external economies.

Persistent regional differences are partly explained by the regional innovation paradox (Oughton, Landabaso, and Morgan 2002). In Europe, public and private expenditure on R&D is greater in leading regions than in lagging regions both in absolute terms and as a percentage of GDP. The SF is the main EU instrument to counterbalance these disparities. About 11% of the SF budget was allocated to research, technological development and innovation (RTDI) activities in 2007–2013, more than double the share in 2000–2006 (5%) (Rivera-León, Miedzinski, and Reid 2010). Convergence regions increased the RTDI share in SF budgets by 12% on average compared to 8% in RCE regions between the periods. As convergence regions receive the majority of funds, the SF are the main financial measure to close the innovation gap with advanced regions.

However, the main cause of the regional innovation paradox is the mismatch in regional supply and demand for innovation (e.g. lack of private demand for R&D and other innovation inputs, weak embedding of the regional research and technological infrastructure, etc.) and the regional governance capacity. Indeed, funds in lagging regions are often captured by well-established lobbies (e.g. scientific faculties) leading to priorities being switched from innovation to basic research. Additionally, the regional institutional capacity often lacks professional intermediaries such as development and innovation agencies, technology centres with private participation or technology transfer organisations (Grillo 2010).

Part of the explanation for the persistence of the regional innovation paradox is found in the weak linkages between actors in the innovation system (businesses, universities and public research centres) limiting the ability of research to be commercialised into new products and processes. Lundvall (1999) suggests that an innovation systems approach requires institutional change through co-ordinating actors from the supply and demand sides so that a demand-driven perspective is adopted. Similarly, science, education and innovation and industrial policies need to be complementary to each other. Most importantly, in order to increase a region's capacity to absorb public funding in R&D, it is also necessary to increase the investment capacity of the business sector. Oughton, Landabaso and Morgan (2002) argue that technology and industrial policies need to be considered in relation to regional disparities in income and the need to promote real convergence. Solving the innovation paradox requires policies that increase the regional capacity to absorb public investment funds for innovation.

Grillo and Landabaso (2011) identify a need for a new regional innovation policy based on strong public–private partnerships with inclusive planning and implementation processes, including a shared vision for the region. These new regional development policies are about empowerment (i.e. helping regions to help themselves) and levelling the "playing field" from the start rather than equalising the outcomes.

4. Empirical test of the regional innovation paradox

Given the theoretical and conceptual context described above, this section provides the results of an empirical test of the validity of the regional innovation paradox by using VA as an indicator of innovation-driven regional development. Compared to previous studies on regional convergence, we investigate the determinants of regional economic performance by focusing on the effects of EU funding.

The empirical evidence is based on an econometric analysis of regional data analysed at the NUTS2 level, over the period 2000–2009. Eurostat provided indicators of VA, government and business R&D, population and human resources employed in science and technology. Data on SF expenditure for the 2000–2006 period and SF allocations for 2007–2013 are from DG REGIO. Data on regional participation in FP6 and FP7 was sourced from E-CORDA. Finally, data on national regulatory systems is from the World Bank's Doing Business project.[2]

The first part of the econometric analysis tests the extent to which access to SF and FP funding drives VA growth, and whether such subsidies have an effect on EE regional growth. We then test the determinants of regional access to funding for the current programming period.

Griffith, Redding and Van Reenen (2004) highlight the convergence effect on total factor productivity of R&D expenditure, stressing that *the further a region lies behind the technological frontier, the greater the potential for R&D to increase TFP growth through technology transfer from more advanced countries* (Griffith, Redding, and Van Reenen 2004, 3). In the EU, long-term data on VA per capita growth does not point to such a straightforward relationship. Figure 1 presents the relationship between VA per capita growth from 2000 to 2009 using national price deflators and R&D effort, expressed in terms of funding and human resources in science and technology (HRST). The first quadrant represents the correlation between Business expenditure for R&D (BERD) in 2000 and VA growth. In the long run, the figure tends to show a flat concave up decreasing curve, with a high degree of dispersion around the intercept. Many regions seem to invest in BERD with limited returns on growth. The relationship between HRST investments and VA growth is even less clear, with many outliers and a high degree of dispersion around the intercept. For FP6 funding, there is an almost constant relationship, while for SF funding there is a flat concave up decreasing curve.

Figure 2 plots VA per capita in 2000 vs. VA per capita in 2009. The plot shows a very high degree of correlation of VA per capita between the two time periods. The plot also shows a lower dispersion at lower values of VA per capita.

The scale of European funding and the potential effects on domestic funding and economic performance raise important issues (Gripaios and Bishop 2006). Cohesion policy aims to promote the development and structural adjustment of less favoured regions. It is based on a shared competence between the EU, Member States and regions (Mairate 2006). Evaluating the impact of SFs implies assessing their contribution in conjunction with national matching funds, in this case for R&D, (proxied by

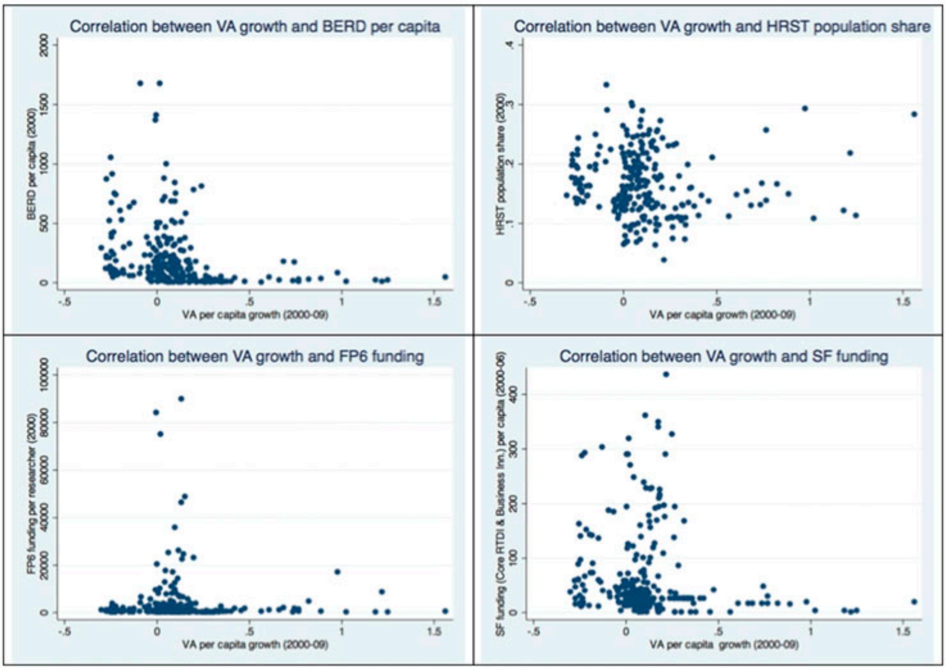

Figure 1. Correlation between R&D effort and VA per capita growth (2000–2009).
Source: Authors' calculations based on Eurostat data.

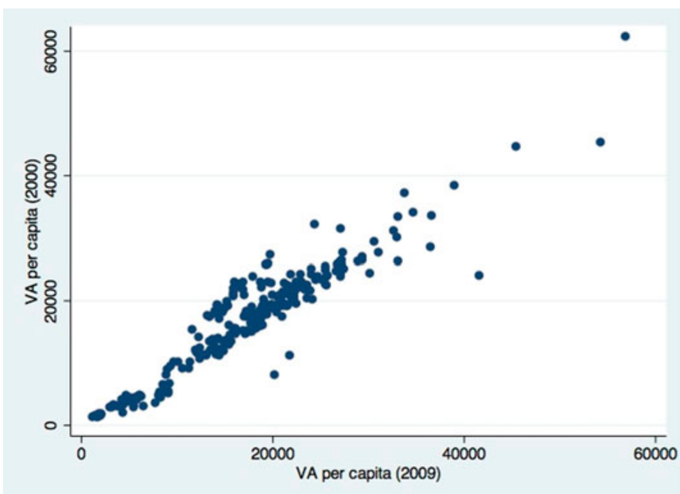

Figure 2. Correlation between VA per capita in 2000 and in 2009.
Source: Authors' calculations based on Eurostat data.

the number of HRST). Evaluation of EU funding programmes are frequent (Esposti and Bussoletti 2008); yet, there are considerable problems in assessing the economic impact of the SFs in the areas that they target (Martin and Tyler 2006).

Table 1. Description of variables used in the econometric analysis.

Variable	Definition	Type	Source
VA per capita growth 2000–2009	Regional value-added per capita growth over the period 2000–2009	Continuous	Eurostat
Log SF2007–2013 (Core RTDI & business innovation) per capita	Allocation of structural funds 2007–2013 per capita in the areas of “Core RTDI” and “Business Innovation”	Log, continuous	DG Regio
SMEs’ innovation 2010	Share of SMEs with innovation activity	Continuous	CIS, Eurostat
Log distance from brussels	Distance from brussels	Log, continuous	–
RCE region	SF objective RCE region	Dummy	DG Regio
OBJ1 region	SF objective 1 region	Dummy	DG Regio
Region in EE country	Location of the region in an Eastern European country	Dummy	–
Log VA per capita	Value added per capita, stock level in the base year 2000	Log, continuous	Eurostat
Log SF2000–2006 (Core RTDI & Business Innovation) per capita	Expenditure of structural funds 2000–2006 per capita in the areas of “Core RTDI” and “Business Innovation”	Log, continuous	DG Regio
Log FP6 total funding per researcher	Framework Programme 6, total subsidies per capita	Log, continuous	E-CORDA
Log BERD per capita	BERD per capita, stock level in the base year 2000	Log, continuous	Eurostat
Log HR S&T/population	Share of population employed in science & technology, stock level in 2000	Log, continuous	Eurostat
Log economic activities	Number of enterprises in 2000	Log, continuous	Eurostat
Log services/economic activities	Share of economic activities in the services sector, stock level in 2000	Log, continuous	Eurostat
Doing business index	Aggregate index of business regulations taking the average of country rankings (from 1 to 27) in each of the seven topics in the World Bank database	Continuous	Doing Business project, World Bank
Slope log SF00–06 core RTDI + Business Innovation per capita & EE	Slope dummy between “log SF2000–2006 core RTDI + Business Innovation per capita” and “region in EE country”	–	–
Slope log FP6 total funding per researcher & EE	Slope dummy between “log FP6 total funding per researcher” and “region in EE country”	–	–
Slope log BERD per capita & EE	Slope dummy between “log BERD per capita” and “region in EE country”	–	–
Slope log HR S&T/population & EE	Slope dummy between “log HR S&T/population” and “region in EE country”	–	–

Source: Authors.

Table 1 describes the indicators included in the econometric analysis. Table 2 presents some descriptive statistics of these variables. Along with R&D funding and structure indicators, the model controls for the industrial structure and industry specialisation. Finally, following Djankov, McLiesh and Ramalho (2006), the model controls for the impact of objective measures of business regulation including an aggregate index of business regulations.[3]

Table 3 presents the results of the first step. Following Barro (1991), we test the relation between access to funding and growth. The dependent variable measures the log of gross value added (GVA) per capita growth over the period 2000–2009 using national price deflators, while the regressors include indicators on R&D effort, access to R&D funding and a set of control variables. GVA per head can be seen as a single yardstick by which to compare relative economic prosperity, and arguably single measures are less open to political manipulation through, for example, changing the weights of multiple measures (Gripaios and Bishop 2006). Therefore, GVA per head was the sole criterion for allocating Objective 1 SF, and although the European Commission has been looking at alternatives, it seems likely to remain so for the foreseeable future despite the limitations (Gripaios and Bishop 2006). Dall'erba and Le Gallo (2008) point to an endogeneity problem when estimating the SF impact on growth, due to the criteria used to allocate funds. Convergence regions have an average per capita GDP, over the three years prior to a programming period, below 75% of the EU average. These regions receive funding proportional to their development gap. Dall'erba and Le Gallo (2008) suggest several alternatives to solve the endogeneity problem; the solution selected is to take account of the distance by road to Brussels, as the SF has a centre–periphery distribution.

The first step included only variables on EC funding and regional R&D effort, in a second step slope dummies were included to take into account the combined effect of the former variables and location in EE countries and then other geographical control

Table 2. Summary statistics.

Variable	Obs	Mean	Std. dev.	Min	Max
VA per capita growth 2000–2009	255	0.112	0.266	−0.299	1.564
Log SF2007–2013 Core RTDI + Business Innovation per capita	255	4.464	1.161	1.175	7.009
SMEs' innovation 2010	263	0.473	0.193	0.066	0.863
Log distance from Brussels	269	6.565	0.907	2.771	9.152
RCE region	270	0.633	0.483	0.0	1.0
OBJ1 region	270	0.393	0.489	0.0	1.0
Region in EE country	270	0.148	0.356	0.0	1.0
Log VA per capita	255	9.488	0.815	7.030	11.038
Log SF2000–2006 core RTDI + Business Innovation per capita	241	3.667	1.089	0.444	6.077
Log fp6 total funding per researcher	258	6.278	2.119	1.199	12.975
Log BERD per capita	230	4.265	1.822	−2.068	7.423
Log HR S&T/population	246	−1.855	0.347	−3.285	−1.102
Log economic activities	194	10.871	0.961	7.280	13.481
Log services/economic activities	194	−0.309	0.073	−0.529	−0.056
Doing business index	269	2.298	0.349	1.773	2.708

Source: Authors' calculations based on data sources in Table 1.

Table 3. Robust OLS regression: impact of EU funding on value-added per capita growth (2000–2009).

Variables	(1) VA per capita growth 2000–2009	(2) VA per capita growth 2000–2009	(3) VA per capita growth 2000–2009	(4) SMEs' innovation 2010
Objective RCE	0.0245	−0.0203	−0.0536	−0.0442
	[0.0532]	[0.0436]	[0.0507]	[0.0348]
Objective 1	−0.00514	0.0112	−0.0148	−0.0611^{+}
	[0.0704]	[0.0569]	[0.0485]	[0.0339]
Region in EE country	0.431*	2.648**	2.155**	0.164
	[0.180]	[0.574]	[0.555]	[0.249]
Log VA per capita	−0.104	−0.0742	0.0221	0.0687
	[0.0941]	[0.0709]	[0.0784]	[0.0668]
Log SF2000–2006 Core RTDI + Business Innovation per capita	0.0374	−0.00289	0.0715*	0.0367^{+}
	[0.0436]	[0.0360]	[0.0339]	[0.0203]
Log FP6 total funding per researcher	0.0254**	0.0279**	0.0309**	0.0358**
	[0.00821]	[0.00613]	[0.00733]	[0.00539]
Log BERD per capita	−0.0107	−0.0319**	−0.0158	0.00224
	[0.0182]	[0.0110]	[0.0133]	[0.0139]
Log HR S&T/population	0.111^{+}	0.0461	0.220**	−0.0187
	[0.0608]	[0.0450]	[0.0614]	[0.0366]
Slope log SF2000–2006 core RTDI + Business Innovation per capita & EE		−0.351**	−0.386**	−0.00803
		[0.0518]	[0.0539]	[0.0337]
Slope log FP6 total funding per researcher & EE		−0.0584	−0.0386	−0.00956
		[0.0381]	[0.0309]	[0.0144]
Slope log BERD per capita & EE		0.128**	0.114**	0.0154
		[0.0414]	[0.0334]	[0.0220]
Slope log HR S&T/population & EE		0.638**	0.331	0.0330
		[0.208]	[0.216]	[0.0869]
Log economic activities			−0.0731**	−0.0451**
			[0.0117]	[0.00970]

Log services/economic activities			0.242	−0.499**
			[0.255]	[0.122]
Log doing business index			0.0471**	−0.0140**
			[0.00595]	[0.00402]
Constant	0.957	0.824	0.247	−0.109
	[0.945]	[0.758]	[0.880]	[0.708]
Observations	211	211	166	165
R-squared	0.464	0.729	0.799	0.595

Note: Robust standard errors in brackets.
*$p < 0.05$; + $p < 0.1$; **$p < 0.01$.
Source: Authors' calculations based on data sources in Table 1.

variables (Column 3) were included. Column 4 reports the results of the same model using as a dependent variable the share of small and medium-sized enterprises (SMEs) introducing process or product innovation in 2010 at the regional level based on the community innovation survey (CIS). This robustness check is used to corroborate the results of the other regressions.

According to the robust least square estimates (Table 3, column 3), the EE, starting from a lower stock of economic wealth, grew faster than other European regions. However, the non-significant coefficient for the stock of VA per capita in 2000 does not support the hypothesis that poorer regions grew at faster rates than other regions once other factors are taken into account. Other controls also confirm the lack of a significant convergence effect between poorer and richer regions.

We estimate that for every 1% growth in SF (Core RTDI & Business Innovation per capita), VA per capita grows by 7%. Our analysis focused on those funds that are more directly linked to R&D activity, namely “Core RTDI” and “Business Innovation”, but we found no evidence of BERD having any significant impact on growth, at least when the full specification of the model is considered. The opposite is the case for EE regions, where we estimate that BERD investments drive economic growth (for every 1% increase in BERD per capita there is a 11% increase in VA per capita).

FP6 grants drive growth only moderately, when EC funding is considered relative to the stock of researchers per region. Confirming this result, we estimate that the higher the share of population in S&T activities, the higher VA growth. Following Romer (1989), the results confirm that the initial level of investment in human capital (expressed in terms of HRST) is an important driver of growth, even when the stock of VA or other indicators of investments are excluded from the regressions.

Location in EE may affect not only the growth rate, but also the scale of SF resources allocated and spent. To test this effect, we included in the regression a slope dummy allowing the slope coefficients for SF2000–2006 funding to vary between the EE and other regions. The effect of the interaction variable is that the impact of SF funding has different slopes for different locations. Our results show that scale of SF had a lower effect on growth in EE regions than in other EU regions, that FP6 funding did not have a significantly different effect in the EE than in other European regions. Similarly, HRST investments do not have higher effects in EE regions than elsewhere.

Regions with a lower number of enterprises in 2000 grew faster than other regions, confirming the convergence hypothesis. However, specialisation in services had no effect on growth. Following Djankov, McLiesh and Ramalho (2006), the model controls for the impact of business regulation on growth and the analysis confirms that business friendly regulatory frameworks have a positive effect on GVA growth.

As a robustness check, we used as a dependent variable the share of innovative SMEs in the CIS, in 2010. The results of the regression confirm the impact of SF and FP funding on SME innovation. However, we did not find any significant interaction effect of SF and FP funding on SME innovation in the case of EE. This, again, confirms the existence of the regional innovation paradox.

The second part of the econometric analysis is based on the same model specification, but introduces as a dependent variable regional access to EC SFs for the 2007–2013 period expressed in log. The result, see Table 4, is that low-income regions have a greater access to funding in 2007–2013 but, *ceteris paribus*, location in EE countries does not have a significant impact on access to funding.

Cumulative effects are found for both FP6 and SF2000–2006 funding, as greater participation in FP6 and greater access to SFs in the past drives access to funding in

Table 4. Robust OLS regression: regional innovation paradox testing.

Variables	(1) SF2007–2013: core RTDI & business Innovation per capita	(2) SF2007–2013: core RTDI & business Innovation per capita	(3) SF2007–2013: core RTDI & business Innovation per capita
Log distance by road to Brussels	0.149^{+}	0.124	0.161
	[0.0835]	[0.0827]	[0.0997]
Objective RCE	−0.518**	−0.520**	−0.352*
	[0.164]	[0.168]	[0.176]
Objective 1	0.298^{+}	0.224	0.331^{+}
	[0.171]	[0.176]	[0.194]
Region in EE country	0.0876	−0.269	−0.720
	[0.338]	[1.284]	[1.159]
Log VA per capita	−0.727**	−0.814**	−1.028**
	[0.258]	[0.281]	[0.290]
Log SF2000–2006 Core RTDI + Business innovation per capita	0.391**	0.402**	0.345**
	[0.0506]	[0.0562]	[0.0629]
Log FP6 total funding per researcher	0.00423	0.00425	0.0617*
	[0.0240]	[0.0255]	[0.0252]
Log BERD per capita	−0.110*	−0.156**	−0.142**
	[0.0473]	[0.0504]	[0.0528]
Log HR S&T/population	0.273	0.339^{+}	0.340
	[0.173]	[0.191]	[0.247]
Slope log SF2000–2006 core RTDI + Business Innovation per capita & EE		−0.0668	0.232*
		[0.104]	[0.109]
Slope log FP6 total funding per researcher & EE		−0.0562	−0.0516
		[0.0820]	[0.0648]
Slope log BERD per capita & EE		0.344**	0.281**
		[0.107]	[0.0875]
Slope log HR S&T/population & EE		0.0580	0.323
		[0.416]	[0.430]
Log economic activities			−0.211**
			[0.0583]
Log services/economic activities			−1.715**
			[0.581]
Log doing business index			0.00426
			[0.0207]
Constant	10.22**	11.56**	14.78**
	[2.647]	[2.925]	[3.169]
Observations	211	211	166
R-squared	0.815	0.827	0.849

Note: Robust standard errors in brackets.
$*p < 0.05; +p < 0.1; **p < 0.01$.
Source: Authors' calculations based on data sources in Table 1.

the 2007–2013. A 1% increase in SF2000–2006 funding generates a 28% increase in SF2007–2013. However, there is no significant difference in the impact of the access to SFs in the previous programming period between EE and other regions. As expected, given the SF objectives, regions with lower levels of BERD have greater access to funding in the latter programming period, especially those regions in EE countries. Finally, we find no significant effect of investments in HRST on access to SFs and no significant impact of location in EE countries on access to SFs.

According to the first model, SFs have a marginally stronger effect on growth in EE countries, contributing positively to the convergence process.[4] The same conclusion does not hold for FP6 funding, despite the positive effects of BERD and HRST on growth in the EE, as it does not have a significantly different effect for these regions.

Most importantly, the results of the second set of regressions confirm that, in the case of both the FP6 and the SFs, attracting a large amount of funding in the previous programming period increases the regional capability to attract SF funding in the following programming period. However, once all the factors considered in the econometric model are controlled for, we find that EE regions have no greater capability to attract funding than other regions, suggesting that a form of the regional innovation paradox is present.

5. Concluding remarks

This paper analysed the regional innovation paradox by applying an econometric model to the EU's Eastern European Member States. Our findings confirm that, despite some positive effects on convergence, SF support for research and innovation does not sustain a virtuous cycle in terms of the capacity of these countries to close the gap with more advanced neighbours in Western Europe.

The stagnation in productivity catch-up and the financial crisis underlined that the EE countries need a renewed emphasis on impediments to structural change and well-functioning innovation systems. The 2014–2020 period may be a make or break one for the EE countries if they are to achieve significant structural change and break out of the "middle-income trap".

The EE innovation systems have reached a ceiling in terms of their capacity to absorb SFs for research and innovation (notably due to the limited human and financial capacities of indigenous smaller firms). Hence, pumping more SFs into research and innovation infrastructure may absorb funds, but is unlikely to lead to the expected returns in terms of the stairway to excellence (enabling researchers and enterprises in the EE countries to integrate and compete for competitive European research funds).

The potential of smart specialisation strategies to foster "innovation-driven growth" is seriously constrained by weak governance capacities. This constraint bites both at the strategic (priority setting) level, but especially at the programme implementation level. Logically, smart specialisation requires organisations in the innovation system capable to co-develop and manage innovation platforms driven by a clear market rationale or responding to complex societal challenges.

Resolving the paradox will require an on-going investment in the machinery of governance to increase regional innovation capacity. This includes the "upgrading" of ministries and agencies to strengthen their strategic management capacity (notably a shift from direct financial aid to demand side policies), as well as fostering the emergence of partnerships to manage "innovation platforms" and structure fragmented business capacities that can deliver on the smart specialisation priorities.

Notes

1. EE countries are: the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia and Slovakia.
2. Available at: http://www.doingbusiness.org.
3. The nine topics covered by the indicator are: dealing with construction permits; enforcing contracts; getting credit; paying taxes; protecting investors; registering property; resolving insolvency; starting a business; trading across borders. The ranking for each topic is the simple average of rankings for each of several component indicators. For example, the ranking for starting a business is the simple average of country rankings on the procedures, time, cost and minimum capital requirements to register a business. Higher values indicate more business-friendly regulations (Djankov, McLiesh, and Ramalho 2006).
4. However, this is partly due to distorted data as those countries could not draw EU funds until 2004.

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