Leveraging research, science and innovation to strengthen social and regional cohesion

Policy Paper by the Research, Innovation, and Science Policy Experts (RISE)

Andrés Rodríguez-Pose
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Member of RISE

Directorate-General for Research and Innovation
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EXECUTIVE SUMMARY

The European Union (EU) has the objectives of enhancing the competitiveness of, increasing the productivity of and fostering employment in its member states with the ultimate goal of improving the well-being of its citizens and promoting sustainable, inclusive economic growth at both the national- and continental-level through the promotion of research and technological development (RTD). This, however, is not the only priority of the EU; the goal of harmonious development and territorial cohesion is included in article 174 of the Treaty.

These dual goals are not necessarily immediately reconcilable. Knowledge intensive, innovative activities have a tendency to concentrate in 'core' areas rather than peripheral ones meaning that EU efforts to foster research and innovation could significantly undermine the overall cohesion effort and contribute to an increase in the territorial gap between the countries and regions of Europe, ultimately jeopardizing the well-being of citizens living in the fringes of the EU. As such, policy makers need to walk a tightrope of sorts, devising strategies and policies that foster research and innovation without increasing the gap between core and peripheral areas.

Much of the effort to make the EU more competitive through the promotion of research and innovation thus far has focused on the achievement of quantitative targets. Notably, the Lisbon Strategy (2000-2010) established the objective of increasing research and development (R&D) investment in the EU to levels of 3% of GDP by 2010, a target that has since been adopted by Europe 2020. This focus on R&D has resulted, at least until the outbreak of the crisis, in considerable increases in the R&D expenditure in core and peripheral economies alike. Total investment in R&D in core countries has risen more or less steadily from levels of 2% of GDP in 1995 to close to 2.4% in 2011. Similarly, countries in the periphery of the EU have increased their R&D effort from 0.75% in 1995 to 1.2% in 2011. Trends at the regional level have roughly mirrored those at the national level though the level of convergence between core and peripheral regions has been lower than between countries.

This sizeable increase in R&D expenditure in the periphery has not, however, yielded the anticipated broader socio-economic benefits, with R&D investment associated to significant improvements in scholarly outputs, but not with higher levels of economic growth, nor with employment in peripheral regions.

The limited of socio-economic benefits from increased R&D investment in peripheral areas is a result of the well documented difficultly peripheral areas face in transforming both basic and applied research and the knowledge it generates into innovation – a phenomenon that has been termed the "European Paradox". This difficulty is attributable to a variety of factors, the exact combination of which inevitably varies across countries and regions. That said, an assessment of conditions in peripheral areas reveals four prominent and seemingly ubiquitous structural factors. These 'common denominators' are: a) deficits in the supply of suitably skilled human capital; b) economic fabrics whose structural and sectoral compositions make them less prone to knowledge-intensive, innovative activity; c) brain drain and the loss of valuable highly qualified personnel; and d) deficient institutional settings.

It may be safely asserted then that the R&D-oriented one-size-fits-all, European-wide policies of the past are unlikely to deliver the objectives of greater competiveness, employment, growth, and well-being in peripheral areas as these areas are simply not positioned to capitalize upon increased R&D expenditure.

In light of this, there is an immediate need to adopt a new approach to innovation policy in the periphery of the EU that complements and goes beyond simple R&D or S&T indicators. Such an approach must acknowledge the importance of territorial specificity and needs to be adapted accordingly to the specific conditions of each territory. Recognizing that research and knowledge generation is not synonymous with, nor does it automatically yield innovation, especially in the periphery of the EU, the approach must focus more explicitly than before on innovation and concentrate on the capacity of individuals and firms to innovate, to generate and participate in innovation systems, to exploit the potential of related variety, and to establish networks and value-chains. Education, training and capacity building policies, as well as regional development strategies would also require greater coordination, not only to ensure a better matching of the supply of human capital to local demand but also to enhance the capacity of a territory to absorb knowledge and innovation generated elsewhere and to convert knowledge into economically viable activities. It is also imperative that the approach addresses institutional bottlenecks, promotes institutional efficiency and works to alleviate fundamental institutional barriers that may inhibit innovation. Finally, the approach must promote the integration of the territory and its actors into international networks and global value chains and foster the creation of 'pipelines' that encourage the inflow of new knowledge.

The recent reforms of EU territorial and innovation policies already go, to considerable lengths, in the aforementioned directions. Specifically, the adoption of the smart specialization approach in conjunction with the 2014 reform of the Cohesion policy represents an important step towards the implementation of spatially-targeted, contextually specific policies to identify opportunity and foster innovation in *all* regions. That said, smart specialization strategies may not be, in and of themselves, enough to achieve the innovation-oriented objectives of peripheral economies. There is a need for additional, more specific policies to supplement and work synergistically with smart specialization strategies that prioritize the transformation of the socio-economic and institutional fabric of territories and work to alleviate the constraints imposed on innovation by fundamental structural impediments in peripheral areas.

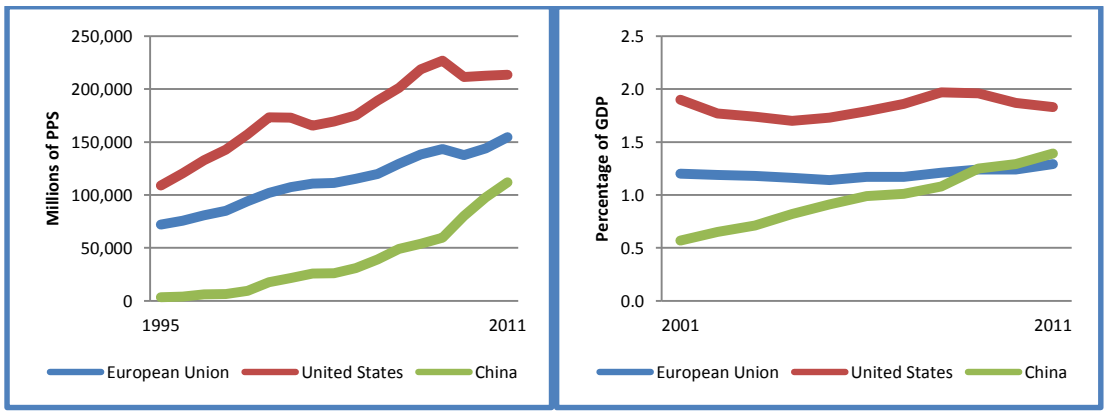
Leveraging research, science and innovation to strengthen social and regional cohesion

1. Innovation and growth

The European Union (EU) has the objectives of enhancing the competitiveness of, increasing the productivity of and fostering employment in its member states with the ultimate goal of improving the well-being of its citizens and promoting sustainable, inclusive economic growth at both the national- and continental-level through research and technological development (RTD).

The generation of new knowledge for growth is essential for the EU to safeguard and ultimately enhance its competitive position in the global economy. The EU is, at present, confronted with 'knowledge-related' pressures from developed and emerging states alike. On the one hand, the knowledge gap between the EU and the largest economy in the world, the United States (US), has been growing in recent decades. On the other, emerging countries, such as China, India, and some of the 'Asian Tigers', are rapidly closing the RTD gap with Europe. Of particular concern is that the EU is seemingly less capable of producing applied, market-oriented innovations relative to both the US and a number of other developed and emerging countries, European firms spend, on average, considerably less on research and development (R&D) than US firms[1] (*Figure 1*) which results in less innovative output (proxied, for example, by patenting activity), hinders their overall innovative capacity and ultimately compromises their ability to compete in increasingly competitive domestic and global economies. Similarly, China has also recently surpassed Europe in its relative investment in business R&D (*Figure 1*).

Figure 1. Business Enterprise R&D Expenditure in the EU, USA and China.



Source: Author's elaboration with Eurostat data.

The EU has for some time been aware of these 'knowledge-related' pressures as possible impediments to economic growth and improvements in the wellbeing of European citizens and has taken action. Since at least the mid-1980s, the promotion of research and innovation has been a priority of the EU. A series of European-level measures have subsequently been implemented that directly target research and innovation and seek to facilitate the innovative capacity of individuals, firms, and territories.

RTD was made an official responsibility of the European Commission in the Single European Act (1986) and, since the Maastricht reform of the Treaty, shoring up research to encourage competitiveness has become a key objective of the EU, as indicated in article 179 of the Treaty: "The Union shall have the objective of strengthening its scientific and technological bases by achieving a European research area in which researchers, scientific knowledge and technology circulate freely, and encouraging it to become more competitive, including in its industry, while promoting all the research activities deemed necessary by virtue of other Chapters of the Treaties".

The objective of strengthening the scientific and technological bases of the EU and making it more competitive through research and innovation has been conducted primarily through the setting of quantitative RTD targets, the most notable of which, perhaps, relates to R&D spending. The Lisbon Strategy (2000-2010) had the explicit aim of making the EU "the most competitive and dynamic

[1] Part of this difference may be due to non-technological innovation, service innovation and design.

knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion". To achieve this goal, it established the objective of increasing R&D investment in the EU to levels of 3% of GDP by 2010. Europe 2020 has chosen to maintain the 3% threshold as its benchmark.

This prioritization of and focus on R&D is reflective of an adherence to linear models of innovation (Maclaurin, 1953; Grilliches, 1979). According to these models, innovation is the more or less inevitable outcome of investment in R&D, and therefore increasing investment in R&D will yield proportional increases in innovation and ultimately economic growth. In spite of being subject of considerable scrutiny along various axes, the most notable, perhaps, being their neglect for relevant socio-economic and institutional influences (Rodríguez-Pose and Crescenzi, 2008), linear conceptualizations of the innovative process have been, and remain the theoretical underpinning of R&D innovation policies and strategies in the EU and beyond.

It should be noted that critiques of the linear model do not discount or ignore the central importance of the generation of new knowledge to innovation and in that regard a focus on R&D expenditure and the generation of knowledge more broadly may lead to greater innovation, productivity and growth. The critiques do, however, question whether the innovative process is a unidirectional, frictionless and, most importantly, aspatial one asserting that it is in fact a process that is dynamic, deeply territorially-embedded and critically dependent on contextual conditions and factors (Lundvall, 1992; Asheim, 1999; Edquist and Chaminade, 2006), suggesting that the promotion of R&D alone – particularly in peripheral areas – is perhaps insufficient in and of itself to foster innovation.

2. Reconciling competitiveness and cohesion

The aim of increasing competitiveness across the EU is matched by the equally important goal of harmonious development stated in Article 174 of the Treaty ("In order to promote its overall harmonious development, the Union shall develop and pursue its actions leading to the strengthening of its economic, social and territorial cohesion"). However, reconciling the goals of competitiveness with those of territorial cohesion is not a simple task.

According to recent theories and empirical investigations, there is a tendency for advanced research and knowledge-intensive, innovative activities, more broadly, to concentrate in core areas. Core areas are understood to provide a socio-economic and institutional environment that is conducive to both knowledge intensive and innovative activity. Research and knowledge generation greatly benefit from the presence of critical masses of researchers, research institutions, and knowledge, from economies of scale, and from the externalities and knowledge spillovers these generate.

The effectiveness of R&D investment relies significantly on the quality of the human resources involved in the research process (Audretsch and Feldman, 1996; De Bondt, 1997; Engelbrecht, 1997). Top researchers tend to concentrate in leading research centres and universities, as well as in advanced firms, all of which benefit from being located in densely populated large agglomerations in the core of Europe (Scott et al., 2001). Large agglomerations also provide the physical, social and institutional proximity that permit the necessary interactions, knowledge flows and spillovers which lead to greater innovation (Boschma, 2005). Research has proven that knowledge spillovers in Europe and elsewhere suffer from significant distance-decay effects, meaning that individuals and firms located far away from the innovative centres attain limited benefits from the knowledge being generated there (Moreno et al. 2005; Crescenzi et al. 2007; Sonn and Storper, 2008). Finally, from a Schumpetarian perspective, knowledge generation is greatly affected by thresholds (Dosi, 1988; Acemoglu et al., 2006). Over the last decades the entry costs for large research projects have risen considerably and, for areas far away from the technological frontier, additional investment in research is often considered a sunk cost. Put together, all these factors unveil a panorama dominated by cumulative processes which enhances the returns of R&D investment in core areas, often to the detriment of the periphery.

It comes therefore as no surprise that the empirical analyses have identified a greater territorial concentration of dynamic RTD activities in core areas in different parts of the world. The EU is no exception to this trend and large, pre-existing research hubs have become even more prominent in recent years. This increasing concentration of RTD activities may contribute to the achievement of the central aim of enhancing the competitiveness of the EU and its member states. It also, however, raises questions about both the potential efficacy of recent approaches to the promotion of research and innovation as well as the compatibility of the goals of increasing competiveness through research and innovation and promoting territorial cohesion.

The European research and innovation policy is targeted, as per Article 179 of the Treaty, at strengthening the scientific and technological bases of the EU. Efforts to do so thus far, as

addressed, have largely consisted of the relatively non-discriminant support for and promotion of R&D. It may be inferred, however, from the propensity of R&D activities to concentrate in a limited number of locations that supporting limited and/or thinly scattered research resources across the periphery of Europe – which is a EU policy priority – may not deliver the expected increase in competitiveness and could, according to the dominating theories on research and innovation, represent a waste of limited R&D resources. The prioritization of research and the associated expenditure of resources to foster knowledge-generation in the periphery has, in fact produced mixed results. Said efforts have resulted, in some instances, in the emergence of new hubs or sub-hubs of knowledge with the potential to drive economic growth and, in other instances, the creation of 'cathedrals in the desert' where the socioeconomic and institutional conditions were simply not suitable to sustain and ultimately embed knowledge-intensive activity, which is critical for the realization of economic benefit stemming from research and innovation.

It is conceivable given the aforementioned agglomerative tendencies, that the pursuit of excellence in knowledge generation could significantly undermine the overall cohesion effort and contribute to an increase in the territorial gap between the countries and regions of Europe, while jeopardising the well-being of citizens living in the fringes of the EU.

How can this conundrum be resolved from a policy perspective?

3. R&D trends in the core and the periphery of Europe

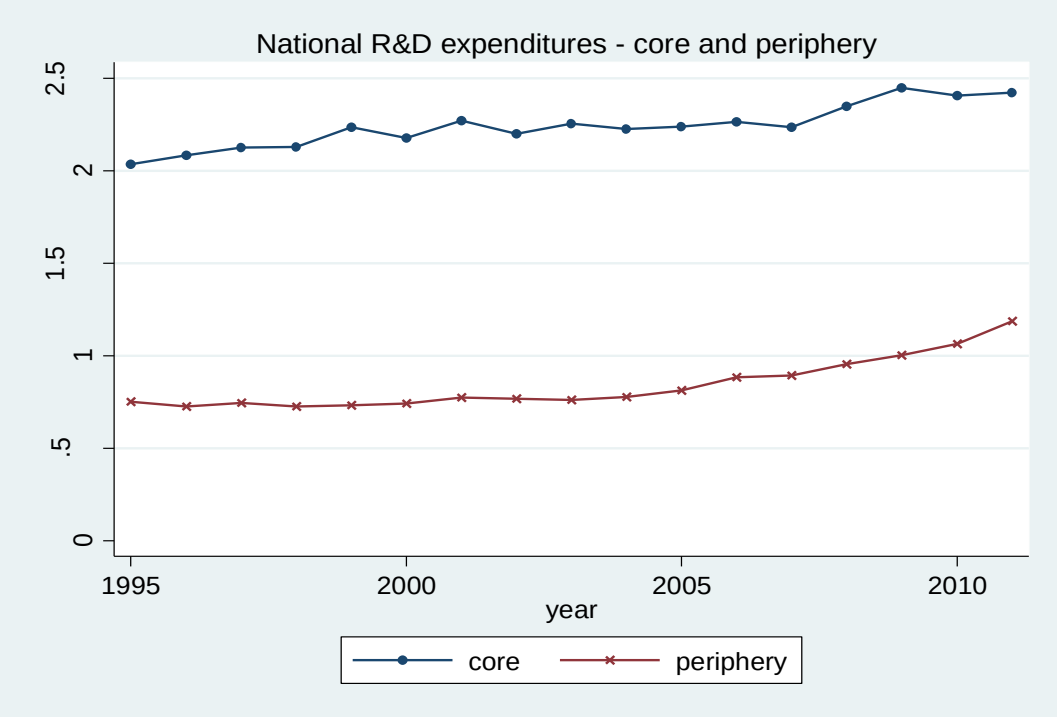
R&D policies in the EU, implemented at both the EU and the national level, have had to walk an economic and political tightrope of sorts. Policy makers have been forced to devise policies that seek both to simultaneously maximize the returns of the R&D effort and stimulate greater economic, social and territorial cohesion. Following the philosophy of the Lisbon Strategy and Europe 2020, European countries and regions have increased investment in R&D in order to foster greater knowledge generation and competitiveness, but have done so in a manner that attempted to prevent the enlargement of the gap between the core and the periphery in terms of R&D effort.

Despite not achieving the R&D investment target of the Lisbon Strategy, the increase in the R&D effort has been considerable. While it remains to be seen whether the economic crisis may further dent the possibilities of achieving the 3% of GDP objective set in Europe 2020, R&D expenditure as a percentage of GDP has increased steadily in both core and periphery countries[2] since at least the mid-1990s. Total investment in R&D in core countries has risen more or less steadily from levels of 2% of GDP in 1995 to close to 2.4% in 2011 (*Figure 2*). Countries in the periphery of the EU have increased their R&D effort by a larger order of magnitude: from 0.75% in 1995 to 1.2% in 2011 (*Figure 2*). Most of this increase has taken place since 2005, and despite recent travails in some of the countries in the periphery, the early stages of the current crisis did not massively dent the aggregate R&D effort of the periphery of the EU.[3]

[2] For the purpose of this analysis, core and periphery countries in the EU are defined according to their GDP per head in 2012. Core countries are all members of the EU which in 2012 had a GDP per head which was above that of the EU-27. Periphery countries are those whose GDP per capita was below the European average. Lack of time series of data for Croatia implies the exclusion of the country from the analysis. A list of core and periphery countries is included in the Appendix A1.

[3] R&D as a share of total public spending stood in 2012 at 1.4% of GDP. This represented a small decline from the pre-crisis level (1.5%). There is therefore no strong evidence that EU countries, on average, sacrificed their R&D budgets more than other government expenditure during the crisis. However, this may have been part of a one-off stimulus effort by European governments. More recently, declines in R&D expenditure have been sharper, especially in the periphery of the EU. That said, the share of R&D in public budgets remains low in comparison to countries such as Japan, South Korea, Switzerland, the US and, as said earlier, China.

Figure 2. Evolution of total R&D expenditure in core and periphery countries of the EU (1995-2011).

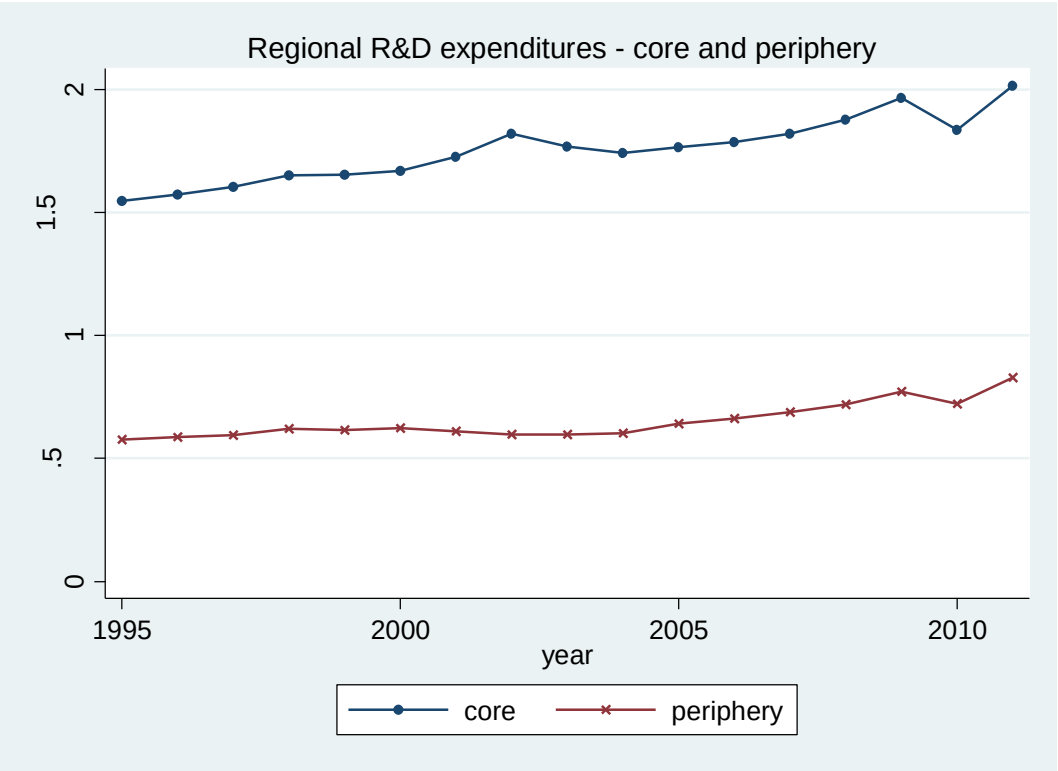


Source: Own elaboration using data from Eurostat and national sources.

At a regional level, the trend has been roughly similar: a steady increase in the R&D effort in both core and peripheral regions until the crisis (*Figure 3*).[4] However, the level of convergence between core and peripheral regions has been lower than between countries. Whereas core regions have witnessed an increase in R&D expenditure from levels of 1.5% of GDP in 1995 to 2% in 2012, R&D expenditure in peripheral regions has risen from 0.6% to 0.8% in the same period (*Figure 3*). This implies that a significant part of the rise in the R&D effort over the last 20 years has taken place in the core regions of the periphery: regions such as Attica, Bratislava, Catalonia, Lazio, Lisbon, Lombardy, Madrid, or Prague, belonging to peripheral countries, but far too developed to be supported at the highest level by the EU.

[4] Core and peripheral regions for the purpose of this analysis are defined according to the level of support received from the EU. The least developed regions or 'Objective 1' regions which received the maximum level of support during the programming period between 2000 and 2006 are classified as peripheral regions. All other regions are included in the core. No data was available for Croatian regions. A list of core and peripheral regions is included in the Appendix A2.

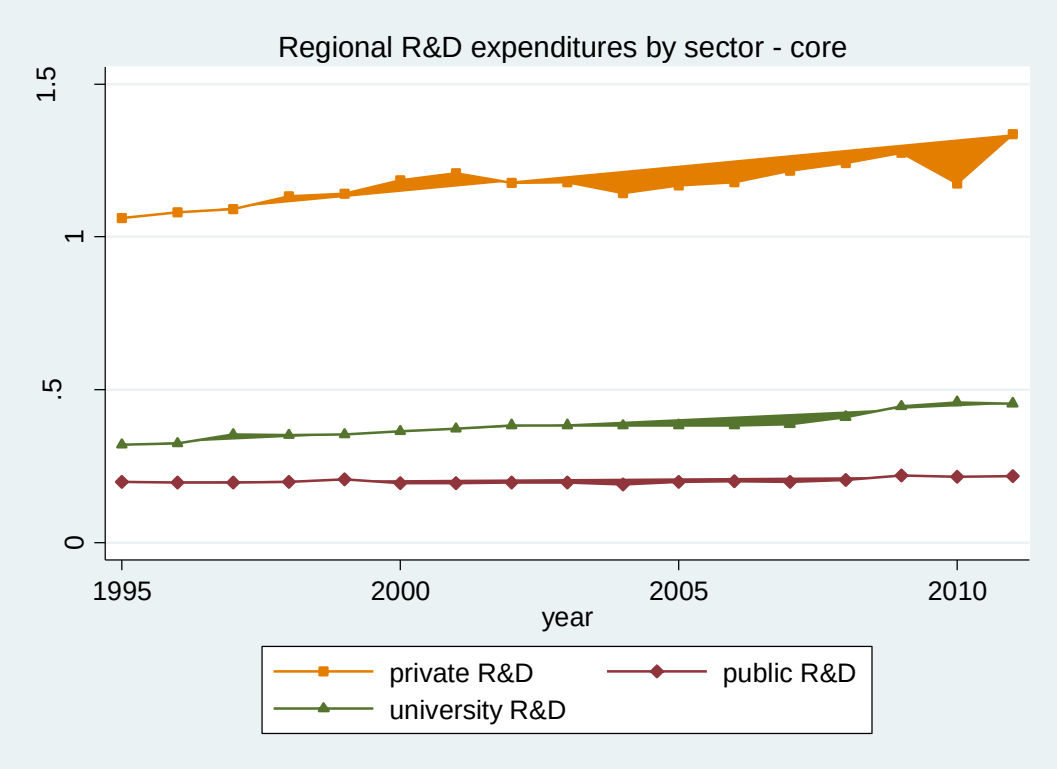
Figure 3. Evolution of total R&D expenditure in core and peripheral regions of the EU (1995-2011).



Source: Own elaboration using data from Eurostat and national sources.

An important difference between the core and the periphery is related to who is behind the R&D effort. In core regions of Europe, the majority expenditure in R&D is attributable to the private sector. Firms spend more on R&D than the public sector and universities put together. Two thirds of R&D expenditure in core regions comes from the private sector. This ratio has remained more or less stable since 1995 (*Figure 4*).

Figure 4. Evolution of R&D expenditure, by sector, core regions EU (1995-2011).



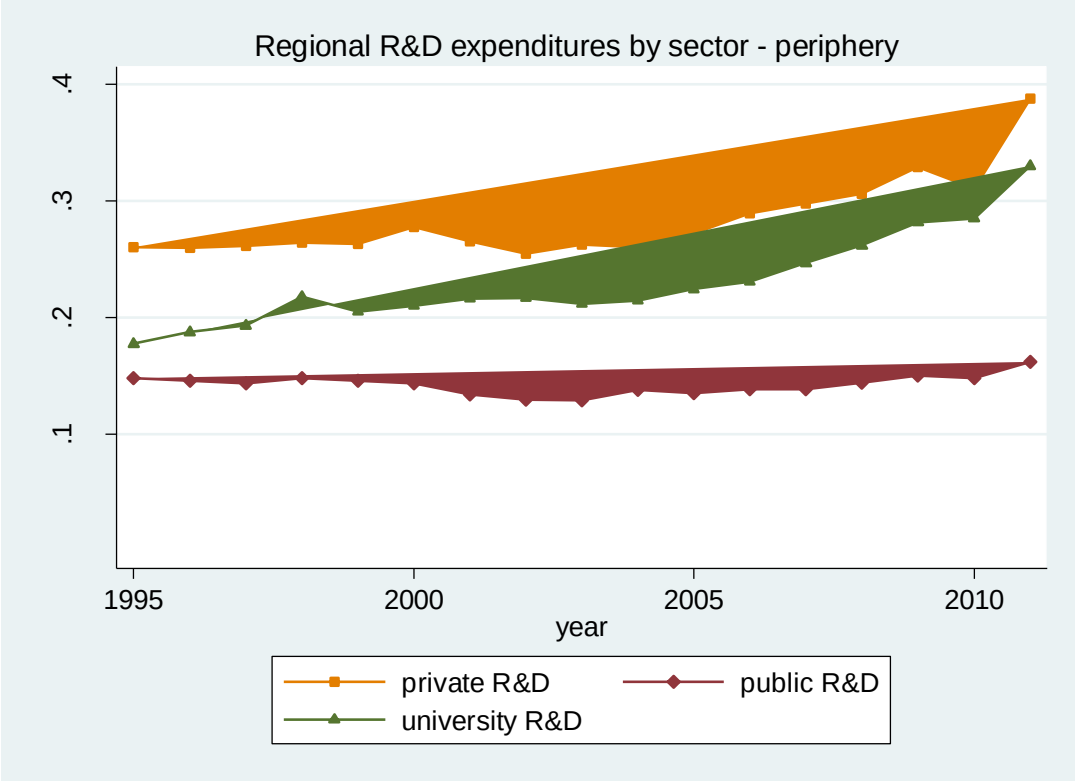
Source: Own elaboration using data from Eurostat and national sources.

By contrast, the majority of R&D expenditure in the periphery of the EU originates from a combination of the public sector and universities (*Figure 5*). A large proportion of the increase in the innovative effort in peripheral regions of Europe is, in fact attributable to increases in university R&D. Since 1995, R&D expenditure conducted by universities in the periphery of Europe has almost doubled in relative terms (*Figure 5*). The most immediate outcome of this effort has been a considerable rise in scientific output. This increase in scientific output, however, has not necessarily translated to improvements in local productivity or employment, as the following section illustrates. This outcome is partially attributable to private underinvestment in R&D. In peripheral economies of the EU, university R&D spending is almost equivalent to that of the private sector. Private underinvestment in R&D not only inhibits the production of new knowledge by firms (it itself stifling innovation), but perhaps more importantly, also prevents firms from developing a suitable knowledge base or basic level of competency that would permit them to absorb and subsequently internalize and exploit knowledge generated via other sources – i.e. universities or other public research facilities (Cohen and Levinthal, 1990). In short, firms are not positioned to capitalize upon the knowledge generation efforts of other actors. This ultimately compromises the extent to which increased aggregate R&D expenditure may yield benefits for the broader economy manifested in enhanced productivity or employment.

Another critically important point that must be addressed relates to the fields within which public R&D, and university R&D more specifically is occurring. Research in the social sciences and humanities are particularly prevalent in peripheral countries. In 2011, university R&D expenditure in humanities and social sciences accounted for, on average, 8.07% of total R&D in peripheral countries compared to an average of 5.78% in core countries. Similarly, public R&D expenditure on humanities and social sciences accounted for on average 11.05% of total R&D in the peripheral countries versus 7.92% in core countries. The prevalence of the social sciences and humanities is also reflected in composition of tertiary education graduates. In 2011, 48.37% of tertiary graduates in peripheral countries completed their education in arts, humanities or social sciences compared to 44.71% in core countries. Research in humanities and social sciences produces knowledge that is less likely to yield commercially viable innovations meaning that not only do peripheral economies invest less in R&D, the investments that are being made are less likely to result in the broader immediate or short-term economic benefits associated with innovation. Additionally, and of equal concern, the focus on humanities and social sciences in universities contributes to a mismatch between the human capital that is available and being developed and what is necessary for the promotion of innovative activity.

Additionally, evidence shows that a large number of successful research departments in the periphery of Europe have failed to establish connections with other local research centres and/or firms meaning that the positive outcomes of aggregate knowledge generation efforts are not necessarily being realized within the jurisdictions where the R&D is actually occurring. They, by contrast, tend to be more successful in reaching out to research and economic actors located outside their regions of origin.

Figure 5. Evolution of R&D expenditure, by sector, peripheral regions EU (1995-2011).



Source: Own elaboration using data from Eurostat and national sources.

4. Linking R&D trends to productivity, employment, and growth

To what extent has the increased R&D effort, especially in the periphery of Europe, contributed to the overall EU objectives of promoting greater competitiveness, increasing employment and economic growth?

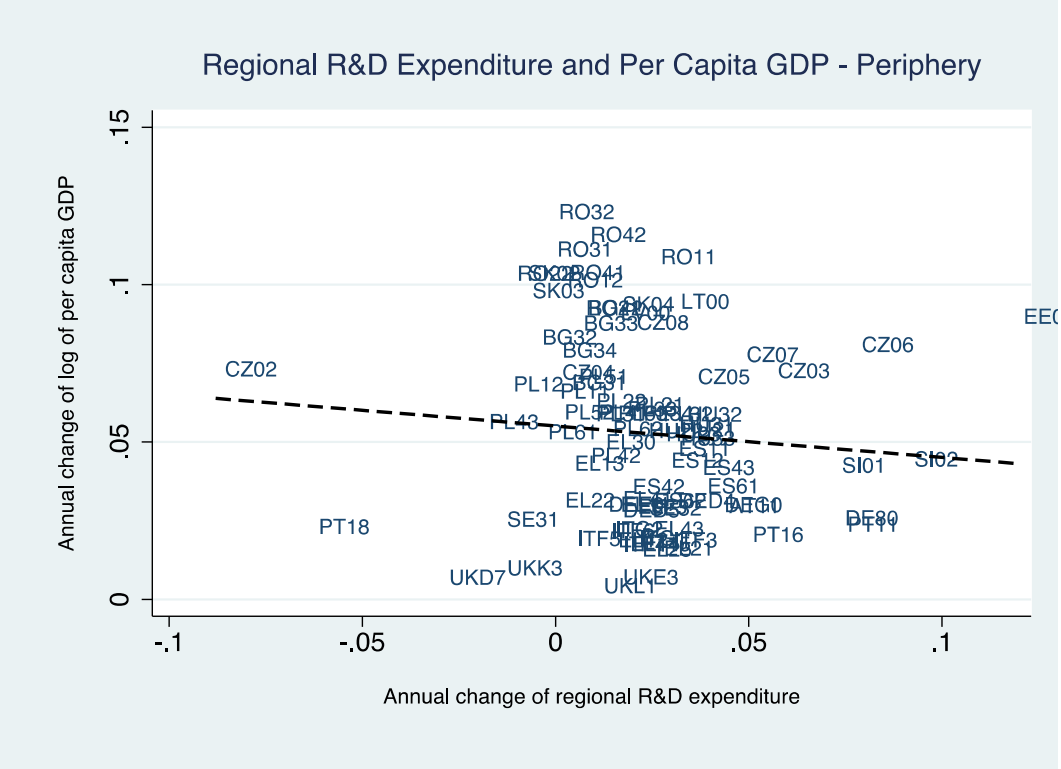
A great deal of recent research has addressed the question of whether greater R&D investment in peripheral countries can reasonably be expected to yield broader socio-economic benefits (e.g. Rodríguez-Pose, 2001). Most of this research, following the neo-Schumpetarian, technology frontier and new economic geography strands, has expressed considerable scepticism about the capacity of what is often considered as piecemeal and dispersed R&D investment to yield economic impacts. Such scepticism is largely attributable first to the neo-Schumpeterian belief that R&D is only (or certainly, more) effective beyond certain thresholds or minimum levels of investment and the notion of cumulative and increasing returns to R&D investment (Lucas, 1988; Romer, 1990), and second to the perception that certain socio-economic and institutional contexts are more 'prone' (or, conversely, 'averse') to innovation and transforming knowledge and knowledge-generation efforts into economic growth and benefit (Rodríguez-Pose, 1999). The European experience, as the following macro-economic analysis demonstrates, seemingly validates this scepticism.

Prior to delving into the results of the macroeconomic analysis, it must be stressed that there have been peripheral regions where an increased R&D effort has produced the intended results. These 'success stories', such as Apulia in southern Italy where a comprehensive "integrated and long-term strategy for innovation" (Florio et al., 2014, p.12) – in which R&D expenditure plays a prominent role – is already producing tangible improvements in innovative output and the innovative capacity of the region, confirm and reinforce that there is a crucial, even central, role for the prioritization of R&D investment (Florio et al., 2014). As such, R&D is rightfully emphasized. The cases also, however, vividly illustrate the necessity of the integration of knowledge generation efforts into broader strategic frameworks and approaches work to address the broader research and innovation system and the actors that comprise it. While the case of Apulia, or any other 'success stories' for that matter, may be exceptional, they affirm that an interest in the promotion of R&D and knowledge generation, needs to be complemented with measures specifically aimed at facilitating the transfer of new technology to the local production system. Success stories also offer valuable insight into why the focus on R&D has not yielded similar results across much of the periphery of the EU.

4.1. Economic outcomes the R&D investment: A macroeconomic analysis

Figure 6 illustrates the relationship between changes in R&D expenditure (y-axis), and the annual change of the log of GDP per capita (x-axis) in the regions of the periphery of Europe between 1995 and 2011. The relatively neutral regression line indicates that the observed increases in R&D discussed in preceding sections have not been associated with higher levels of economic growth. The correlation coefficient between the change in R&D expenditure and change in GDP per capita is close to 0 and it is not statistically significant.

Figure 6. Average change in R&D expenditure vs. average change in GDP p/c, peripheral regions (1995-2011).



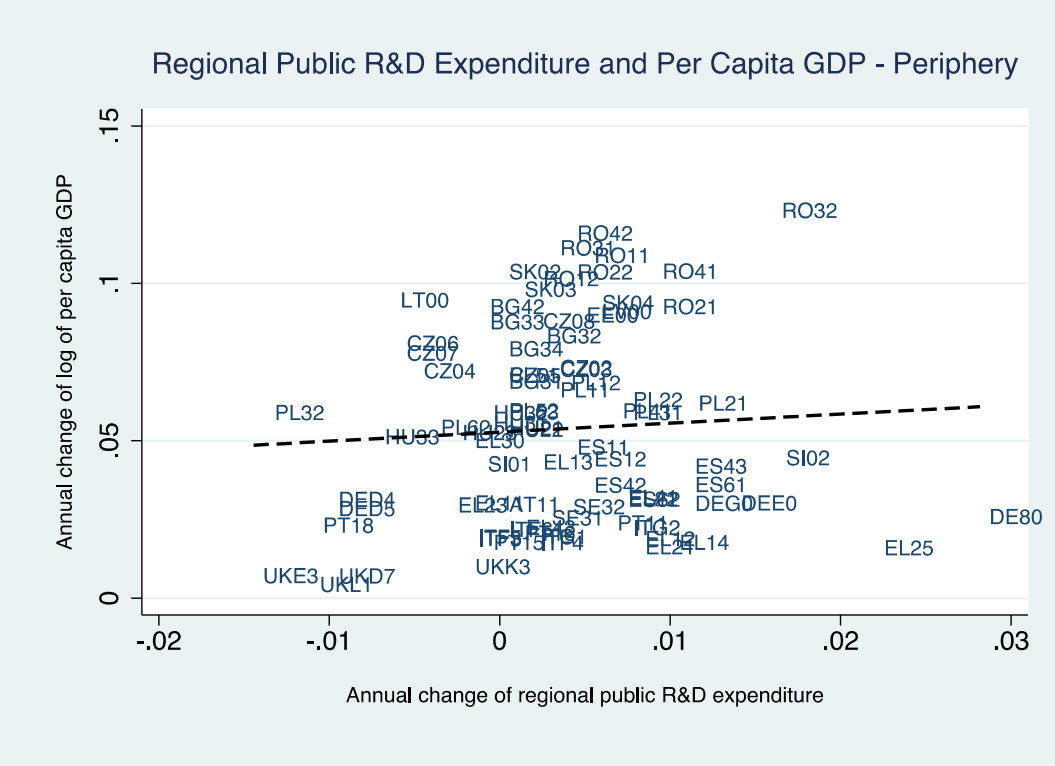
A list of the peripheral regions included in this Figure and their codes is provided in Appendix 2.

Source: Own elaboration using data from Eurostat and national sources.

When we focus exclusively on public R&D expenditures, which, as addressed, constitute the bulk of the new R&D investment in the periphery of Europe, the results are largely the same. Once again, the regression line in *Figure 7* is almost flat. Greater investment in public R&D expenditure has not been associated with higher growth. The relationship between annual changes of public R&D as a percentage of GDP and the growth of GDP per capita is not statistically significant.

Further insight may be garnered from considering the economic performance of regions that experienced the greatest increases in R&D expenditure. In the case of total R&D (Figure 6), regions such as Jihovýchod (CZ06) in the Czech Republic or Eastern and Western Slovenia (SI01 and SI02) have failed to achieve economic growth that is at all proportional to the regions' increased R&D expenditure. With respect to public R&D more specifically (*Figure 7*), Mecklenburg-Vorpommern (DE80) in Germany and Peloponnisos (EL25) in Greece have not, in spite of substantial increases in public R&D investment, displayed the economic growth expected of this increased expenditure. These more extreme cases supplement the broader trends discussed in the preceding two paragraphs and provide evidence that increasing the R&D effort in regions that are perhaps too far from the technological frontier and that may have a weak industrial fabric may not always yield greater economic growth.

Figure 7. Average change in public R&D expenditure vs. average change in GDP p/c, peripheral regions (2000-2011).

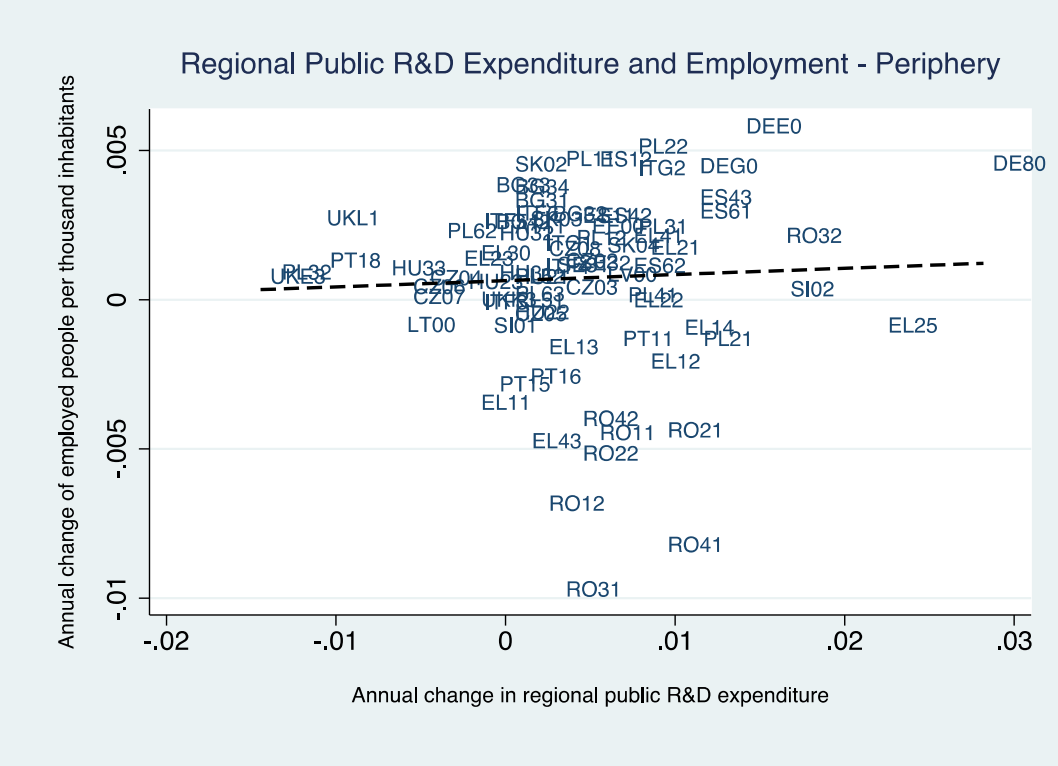


A list of the peripheral regions included in this Figure and their codes is provided in Appendix 2.

Source: Own elaboration using data from Eurostat and national sources.

The employment outcomes associated with increased public R&D expenditure are consistent with the aforementioned economic growth outcomes. *Figure 8* depicts the relationship between increases in R&D expenditure in the periphery of the EU and employment growth. It is established that changes in R&D expenditure are not correlated with changes in employment. The correlation coefficient of the relationship is close to 0 and statistically not significant.

Figure 8. Average change in public R&D expenditure vs. average change in employment, peripheral regions (1999 -2011).

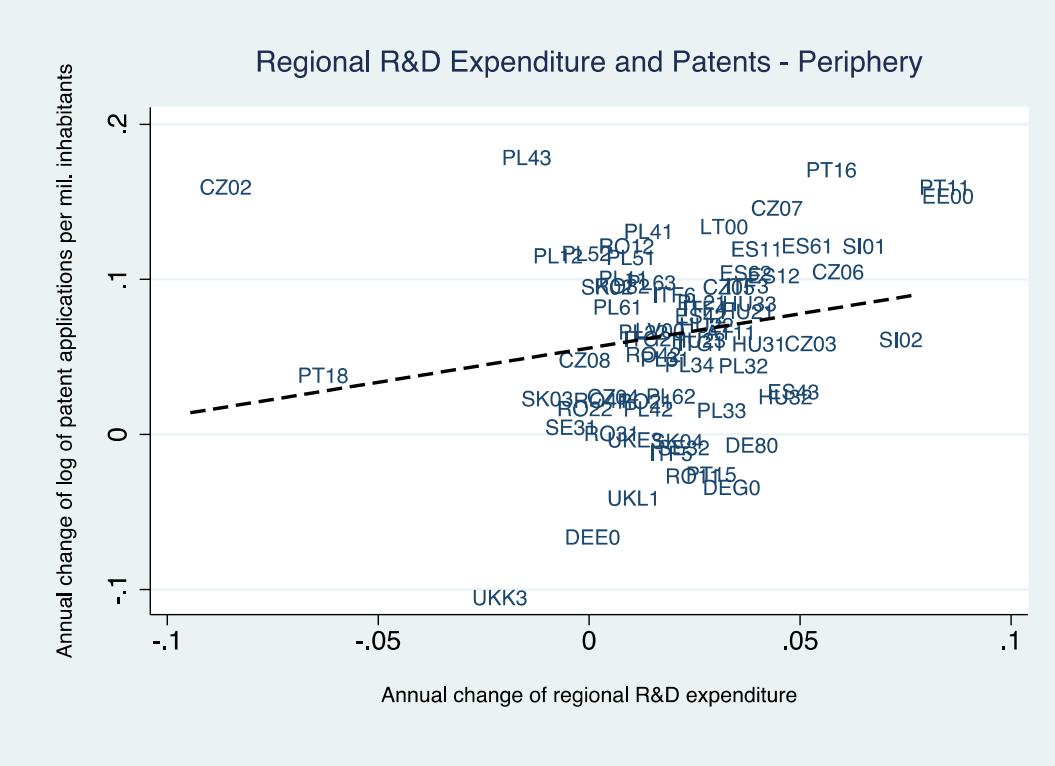


A list of the peripheral regions included in this Figure and their codes is provided in Appendix 2.

Source: Own elaboration using data from Eurostat and national sources.

Despite the absence of strong positive relationships between increases in R&D expenditure and economic growth (proxied by GDP per capita) (Figures 6 and 7) and employment (Figures 8) respectively, there is some positive connection between the R&D effort and patenting outcomes in the periphery. Regions experiencing the greatest increases in R&D investment as a percentage of GDP have also witnessed a modest increase in their capacity to patent. The association between both variables is marginally positive, albeit not statistically significant (*Figure 9*).

Figure 9. Average change in R&D expenditure vs. average change in patents per million inhabitants, peripheral regions (1999 -2011).



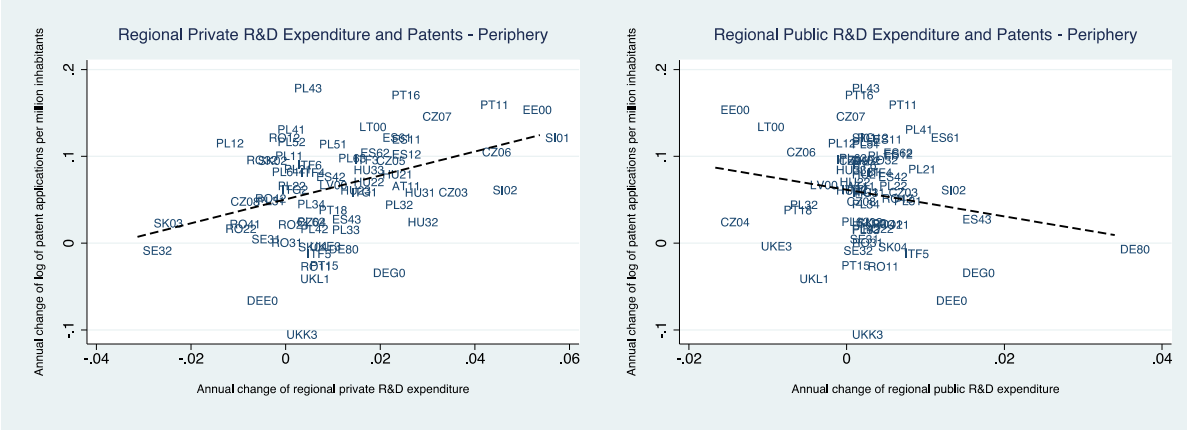
A list of the peripheral regions included in this Figure and their codes is provided in Appendix 2.

Source: Own elaboration using data from Eurostat and national sources.

This positive association is, however, mainly driven by those firms in the private sector with a greater capacity to patent (*Figure 10a*). Regions in the periphery of the EU, whose firms have most increased their R&D investment, have also seen their patenting levels rise. However, public investment in R&D has not been associated with similar rises in patenting. Regions which have undergone the greatest improvement in public R&D have increased their patenting capacity less, not more, than those that – either because of choice or lack of adequate resources – have pumped less additional resources into R&D (*Figure 10b*). This result underlines, once again, the lack of capacity of most firms in the periphery of the EU to realise benefit from increased local public R&D.

Figure 10. Average change in business (10a) and public (10b) R&D expenditures vs. average change in patents per million inhabitants, peripheral regions (1999 -2011).

9a. **9b.**



A list of the peripheral regions included in these Figures and their codes is provided in Appendix 2.

Source: Own elaboration using data from Eurostat and national sources.

5. Innovation outputs in the periphery of Europe

Although all of the above figures represent correlations rather than actual measures of impact and say nothing about the direction of causality – i.e. whether it is greater R&D that leads to greater growth, or vice versa – they provide a graphic indication of what many researchers are unearthing about the recent R&D drive in Europe in general, and in its periphery, in particular. Europe, relative to other parts of the world and, most notably, the US, struggles to transform basic and, to a lesser extent, applied research into innovation a phenomenon that has been termed the 'European innovation paradox' (European Commission, 1995; Oughton et al., 2002; Dosi et al., 2006; European Commission, 2007).

An inadvertent outcome of the prioritization of R&D and focus on the generation and supply of knowledge is the neglect of the 'demand-side'. That is, the prioritization of knowledge generation across the EU has resulted in substantial increases the in the supply of knowledge in member economies, while adequate attention has not been paid to the local demand for this knowledge nor to the capacities of regions and their actors to assimilate and apply that knowledge. Knowledge generated via R&D activities in the private or public sector must be 'applied' – that is internalized and transformed into innovation – to yield broader economic benefit. It may be inferred then if demand-side conditions are inadequate and left unaddressed, the outcomes of supply-side knowledge generation efforts may be limited.

The neglect of demand-side conditions is particularly problematic in peripheral economies. Demand for knowledge is often lower in the periphery as a result of the composition of their production systems and sectoral specialization (i.e. the prevalence of industries and sectors with lower levels of technological sophistication). Furthermore, peripheral areas are often less able to absorb and mobilize both internally and externally generated knowledge again due to their weak economic fabrics, as well as other socio-economic and institutions influences discussed later in this section.

The disequilibrium between knowledge supply and demand is a critical piece of the explanation for the aforementioned "European Innovation Paradox" across the EU and in the periphery more specifically.

This mismatch is compounded by a host of other factors. Duplication, cross-national redundancies in research, and what is perceived to be an excessive geographical dispersion of the R&D effort are among the other more prominent factors curbing the economic impact of greater investment in R&D. The structural and sectoral composition of production systems is also of relevance. Sectors with lower levels of technological sophistication characterized by lower levels of R&D expenditure and innovation are particularly prevalent in the periphery of Europe. Additionally, the vast majority of firms in peripheral countries are classified as SMEs that typically invest less in R&D and knowledge generation (Nooteboom, 1994). The combination of, first, sectors and, second, firms with a lower propensity to invest in R&D and knowledge generation presents an industrial fabric that is less able to absorb knowledge and translate it into innovation and broader economic impacts (Cohen and Levinthal, 1990).

Despite exceptions, such as the case of Estonia, the poor innovative performance of many countries and regions in the periphery of Europe indicates that focusing mainly on R&D is unlikely to deliver the objectives of greater competiveness, employment, growth, and well-being.

The Spanish case is a useful exemplification of the 'European innovation paradox' – an emphasis on R&D (consistent with the Lisbon Agenda) resulted in a significant increase in R&D expenditure that ultimately led to a sizeable increase in scientific output and knowledge generation. This did not, however, yield increases in innovative activity nor broader economic benefit.

Spain increased the resources devoted to R&D considerably in the last few years. Although the increase benefitted both the core and the periphery of the country, many peripheral regions saw levels of R&D investment soar, albeit from very low starting points. The Spanish research community gained as a whole. According to the SCImago country rank 2013, scientific publications in Spain increased by 336% between 1996 and 2013. This rise was, in any case, below that of other European peripheral countries, such as Cyprus (1229%), Malta (1140%), Portugal (749%), Romania (718%), Lithuania (561%), Estonia (419%), Latvia (392%), Slovenia (380%), the Czech Republic (371%), Croatia (353%), or Greece (340%). Only Bulgaria (165%) and Hungary (215%) have struggled to significantly increase their scientific output among the periphery of the EU in the last two decades.

The greater R&D effort has allowed Spain to maintain its rank as the 10th world scientific power in terms of scientific publications. But as in other peripheral countries, Spain has failed to capitalise

on its knowledge generation potential, exhibiting a limited capacity to transform knowledge into invention and innovation. For a country which, as mentioned earlier, is the 10th scientific power in the world, Spain ranks 26th in terms of innovative capacity, according to the Economist Intelligence Unit's 2009-2013 rank and 27th, according to INSEAD's Global Innovation Index 2014. Other countries in the periphery of the EU face similar problems to innovate. The 17 countries with a GDP per capita currently below the average of the EU are placed between positions 24 (Estonia) and 55 (Romania) in INSEAD's Global Innovation Index 2014. In particular, Croatia (42), Bulgaria (44), Poland (45), Greece (50), and Romania (55) exhibit the greatest problems to innovate.

This mismatch between different types of outputs in the periphery of Europe is illustrated in *Figure 11.* In this figure four key types of outputs are considered. Scientific outputs, measured as the number of scientific publications per population in a given country; the impact of these scientific outputs, measured as citations per article; patents, as a proxy for industry innovation, measured by patent applications per million inhabitants; and overall innovation capacity, as defined by INSEAD's composite Global Innovation Index.

Figure 11. Position of countries in the periphery of the EU in different world innovation output indices (2012-2013).

Decile in World index	Research Output	Impact of[5] research	Patenting	Innovation
	Publications per capita	**Citations per article**	**Patent applications per million inhabitants**	**Global innovation index**
Top 10%	Slovenia, Portugal, Cyprus, Estonia, Croatia, Greece			
10-20%	Czech Republic, Spain, Italy, Romania, Hungary, Slovakia			Malta, Estonia, Spain, Cyprus, Czech Republic, Italy
20-30%	Poland, Malta, Lithuania, Latvia, Bulgaria	Italy, Spain, Estonia	Italy	Slovenia, Hungary, Latvia, Portugal, Slovakia, Croatia, Lithuania, Bulgaria
30-40%		Portugal, Greece, Hungary	Poland, Latvia, Spain, Czech Republic, Hungary, Malta, Portugal	Romania, Poland, Greece
40-50%			Greece, Croatia, Romania, Cyprus, Estonia	
50-60%		Slovenia, Czech Republic	Lithuania, Slovakia, Bulgaria	
60-70%		Lithuania, Latvia, Poland		
70-80%		Slovakia, Bulgaria		
80-90%		Romania		
No of countries considered	186	186	88	144

Sources: Own elaboration based on SCimago, WIPO and INSEAD data.

[5] This column is based on a recommendation by RISE member Frédérique Sachwald.

What becomes evident from *Figure 11* is that while the periphery of the EU is not badly positioned in terms of scientific output, it fares much worse in scientific impact, patenting and overall innovation. Portugal, for example, ranks ninth in the world for scientific output, but is 36 in patenting and 34 in overall competitiveness, according to the INSEAD ranking. Greece ranks 18 in scientific output, but is 38 in patenting and 55 in innovation. Romania ranks 31, 42 and 48 respectively. Few countries in the periphery escape this downward trend. Bulgaria, Latvia, Lithuania and Malta are the exceptions and they all start from relatively low levels of scientific output.

Overall, the common trend which emerges from the periphery of the EU is a certain incapacity by local firms to transform locally generated knowledge and to absorb knowledge generated elsewhere and to transform it into economically viable innovation.

6. Innovation bottlenecks in the periphery of Europe

What are the reasons behind the failure to translate greater investment in R&D and improvements in scientific output into innovation and growth? There is no uniform set of reasons behind the limited returns of R&D in the periphery of Europe. The exact combination of factors varies from country to country and from region to region. However, a number of common denominators emerge from the assessment of conditions in the periphery. These include:

- ***Human capital deficits:*** Many peripheral regions and countries face – to different degrees – significant human capital challenges (Rodríguez-Pose and Vilalta-Bufi, 2005; European Commission, 2014). Some display deficits in human capital stock, including shortages in the percentage of workers with completed secondary or university education. Others are confronted with issues linked to poor quality of education and training – as suggested by the PISA and PIAAC tests. Mismatches between educational supply and demand in the local labour market are also particularly prevalent in many areas of the periphery. As a consequence, firms face significant challenges in finding suitable labour locally.

Limited and/or deficient vocational training schemes – relative to Denmark or Germany, the leaders in Europe – are also important barriers to the transformation of knowledge into firm-level innovation in peripheral areas (Wößmann, 2008). Vocational training schemes help to ensure that individuals are not simply well educated, but actually equipped with the skills and specific knowledge necessary to perform certain tasks or functions and in that sense can help to rectify the aforementioned problems associated with labour mismatches. Vocational training schemes also contribute to the development of a base of human capital that may be better able to understand the value of basic knowledge and how it may be usefully applied in various sectors, industries and activities. Additionally, peripheral areas tend to place less emphasis on lifelong learning and on-the-job training programmes. Continual learning is particularly important as it enhances the flexibility of production systems by enabling them, through their supply of labour, to adapt to changing technologies and continually benefit from knowledge generated both internally and externally (Etzkowitz and Leydesdorff, 2000; Filippetti and Archibugi, 2011).

The central importance of training and education is exemplified by the Irish experience where educational reform (consisting of, notably, enhancing the quality and availability of higher education, as well as the promotion of technical and vocational education) and increased expenditure on education and training played a critical role in the upgrading of Ireland's technological sophistication and innovative capacity, the attraction of knowledge intensive FDI and ultimately their rapid, significant economic growth and development (Honohan and Walsh, 2002; Ahier and Esland, 2013).

- ***Brain drain:*** Closely related to the preceding point regarding human capital deficits in the periphery is the notion of 'brain drain' (Docquier and Rapoport, 2012; Stankovic et al. 2013). A weak economic fabric limits the opportunities of finding jobs locally for those with the highest drive and best level of training. The limited capacity of a large mass of very small firms, often in not very dynamic sectors, pushes the most highly qualified away. Regions in the Eastern periphery have experienced this type of brain drain with different levels of intensity since the beginning of transition, but the crisis and levels of youth unemployment higher in some cases than 50% are pushing qualified job-seekers away from the Southern periphery.

- ***Weak economic fabrics:*** Although, once again, the situation changes between countries and regions, the panorama in the periphery of Europe is dominated by large numbers of relatively weak SMEs, with little or no innovative capacity – especially in the majority of the 93% of firms which are micro-firms (less than 10 employees). Many of these firms are, moreover, in traditional or mature sectors where the potential for innovation in limited. This is true of many sectors which have undergone considerable restructuring in the eastern periphery of the EU, but also in the case of declining industrial and personal-service sectors which prevail in the EU's

southern fringe. Small firms also tend to underinvest in R&D and as a result are often unable to absorb externally generated knowledge and innovation (Cohen and Levinthal, 1990; Nooteboom, 1994).

- ***Deficient institutional settings:*** Weak institutional settings significantly curtail the returns of innovation efforts (Rodríguez-Pose et al. 2014). Knowledge production systems in the periphery of the EU are suffering as a result. In particular, areas with a high degree of corruption and low government efficiency are struggling to fulfil their innovation potential. Greater investment in R&D in poor institutional contexts is yielding very limited or no returns, as the most institutionally backward regions lack the adequate conditions needed to obtain high returns from technological investments.

The combination of human capital deficits, weak economic fabrics, brain drain, and deficient institutional settings is creating vicious, self-reinforcing cycles which restrict the capacity of regions in the periphery of Europe to transform knowledge into viable commercial activity and innovations. In these circumstances successful research centres and firms in the periphery end up looking for partners in the core, rather than locally or in other peripheral regions (Grillitsch and Nilsson, 2015). Similarly, highly skilled workers tend to look for jobs elsewhere, or, worse, see how their hard-earned skills become gradually eroded by stints in unemployment or by job opportunities well below their capacity.

The aforementioned factors underpinning failure to translate knowledge into innovation and economic growth amount to deficiencies in the socioeconomic and institutional contexts of peripheral areas. Addressing these factors is imperative should innovation and economic growth be reasonably expected. That said, addressing issues as fundamental as these, however, requires long-term, multi-dimensional approaches that consist of restructurings and large-scale reforms – short-term, 'corrective' approaches will not be sufficient. The profound challenge that arises here relates to the pains associated with those types of approaches that, perhaps not surprising, peripheral regions and the EU are not at the moment willing to endure. Initiating and undergoing the transformations necessary to ensure that benefits are realized from R&D and that innovation can occur will require a significant commitment from peripheral areas.

7. Increasing innovative capacity in the periphery of the EU

How can innovative capacity be increased in the periphery of Europe? The potential of individuals, firms and territories to generate and absorb knowledge and produce innovations is essential for economic development and is likely to remain so for the periphery of the EU for the foreseeable future. Firms and regions at the fringes of the EU need to innovate if they are to remain competitive in a more open and integrated world, and to generate the productivity and jobs needed in order to fulfil the aims of economic growth and well-being. However, achieving that very innovation is fraught with difficulties in environments that, because of their very peripherality, suffer from numerous structural problems and deficits.

What is becoming evident from recent analyses is that the innovative deficit of the periphery of Europe is not necessarily a problem of lack of investment in R&D or of knowledge generation. The majority of European peripheral regions have levels of R&D investment and of knowledge generation which are commensurate with their level of development. Increases in R&D investments since the mid-1990s have been linked to greater scientific output, but, as the preceding discussion and macroeconomic analysis demonstrates, not necessarily with greater innovation, employment and economic growth. Hence, the innovation challenge of peripheral areas in the EU is no longer related to increasing the investment in R&D (providing the R&D effort is maintained), but with how to address the incapacity of a relatively weak economic fabric to transform knowledge, local or otherwise, into innovation and to make local institutions and society more 'innovation prone' (Rodríguez-Pose, 1999).

Despite notable exceptions, policies in the past based upon a linear conceptualization of the innovation process have mainly focused on generating convergence between the periphery and the core of the EU in terms of R&D, overlooking to some degree the lack of innovation capacities many of these areas faced and disregarding the considerable structural barriers encountered to develop and absorb innovation. 'One-size-fits-all' European-wide approaches which may have functioned in core areas with good endowments of researchers, research centres, innovative firms, favoured by knowledge spillovers and suitable institutions, have proven largely inefficient in the periphery of the EU.

There is therefore a need to adopt an approach to innovation policy in the periphery of the EU which goes beyond simple quantitative R&D or S&T indicators and which is adapted to the specific conditions of every territory (place-based approach). This approach has to put innovation at its core; it has to coordinate innovation policies with education, training and regional development

policies; it has to address institutional bottlenecks; and, finally, it has to contribute to insert innovative actors in the periphery of the EU in international networks and global value chains.

These elements are now treated in turn:

- ***Spatially-targeted intervention:*** There is simply no one-size-fits-all approach to innovation that is appropriate for the whole of Europe (Asheim and Coenen, 2005). Region-specific structures which cannot be transferred from one place to another shape the returns of any innovation policy. The diversity of territorial conditions across the whole of the EU and, specifically, within its periphery demands different place-specific strategies for knowledge generation (Tödtling and Trippl, 2005). General innovation guidelines and strategies thus need to be adapted to the specific conditions of different territories.
- ***Focus more innovation:*** The problem of the periphery of the EU is no longer one of research and knowledge-generation, but mainly one of lack of innovation. This lack of capacity to transform R&D and basic research into commercially viable products or processes is the greatest challenges and requires the integration of research and innovation in the same strategy (Oughton et al. 2002; European Commission, 2007). This implies strategies which go beyond the simple investment in R&D and concentrate on the capacity of individuals and firms to innovate, to generate innovation systems, and to establish networks and value-chains. Strategies must acknowledge the dynamism and collaborative nature of the innovative process and that innovation is the outcome of interactions between members within a network or 'system' consisting of firms, universities, research institutes and a host of other actors in both the private and public spheres (Iammarino, 2005). The focus of innovation strategies, in addition to promoting the creation of new knowledge, must be the upgrading of the system as a whole as the functioning of the system shapes the innovative capacity of both the system and the actors that compose it (Chaminade and Vang, 2008). This certainly implies a concern for the individual actors that compose the system. More importantly, however, it implies that specific attention must be paid to the creation of partnerships and networks and fostering trust, collaboration and cooperation between actors within a system to ensure the collaboration necessary for innovation. Doing so may be achieved through both direct policy intervention (the promotion of public-private partnerships or formal university-industry linkages, for example) as well as through the more indirect reform of the institutional context to create a culture of openness, trust and interaction (Edquist and Chaminade, 2006).
- ***Coordinating innovation policies with education and training and with regional development policies:*** The capacities and potential of a place's human capital is essential in the process of knowledge-generation and assimilation. Increasing the education and training level of the population and a better matching of the educational supply to local needs have been proven to increase the absorptive capacity of firms in a given territory (Cohen and Levinthal, 1990; Lund Vinding, 2006). A better-educated and trained labour force leads to a better absorption of knowledge spillovers, of innovation generated elsewhere, and to a better conversion of knowledge into economically viable activities (Vandenbussche et al., 2006). Consequently, policies targeted at improving overall education, training, and skill levels, need to be considered in coordination with the innovation strategy. European cohesion and regional development policies, especially after the 2014 reform, may provide an adequate setting to achieve this.

The integration of innovation and human capital policies and programs can assume a number of forms (Borrás and Edquist, 2014). One approach that has achieved considerable success is the DEMOLA "open-innovation platform for co-creation, students, start-ups, and higher-education institutes" (EURIS, p.6) implemented in Finland. [6] The DEMOLA programme establishes connections between firms and higher education by affording students the opportunity to work with firms and develop solutions for the innovative challenges facing local firms. In doing so, students are provided with relevant, practical experience and on the job learning; firms are provided with additional resources to impel innovation and, most importantly substantive connections are forged between firms and universities to the benefit of both parties contributing to the upgrading of innovation systems addressed in the previous point.

Education and training have traditionally been treated as a separate realm from innovation. This, however, must be rectified. It is imperative that the relationship between innovation policies and those targeting human capital is acknowledged and that a concerted effort is made to ensure the horizontal coordination of various policies at the level of the European Commission and the

[6] The highlighting of the DEMOLA program is not intended as an endorsement for the duplication of identical policies in peripheral areas, but rather as both an encouragement to consider 'best-practices' in the design of location specific policies and evidence of the potential for success associated with the integration of innovation and human capital policies.

Structural and Investment funds for training, education and innovation. Doing so will permit the realization of synergies, the avoidance of redundancies and duplications and ultimately the more efficient expenditure of limited resources.

- ***Addressing institutional bottlenecks:*** The institutional context is of particular relevance to the innovative capacity of a given territory (Rodríguez-Pose and di Cataldo, 2015). Innovation policies in poor institutional contexts tend to yield limited or no returns. Often the most institutionally backward regions lack the necessary conditions to take advantage of technological investments. In these areas, greater investment in R&D is simply not the solution. Without improvements in the local quality of government, efforts to innovate may be wasted. Hence, there is a need to complement innovation strategies with measures aimed at addressing the institutional barriers limiting a region's capacity to innovate. In particular, efforts aimed at reducing corruption and improving government efficiency should be considered in conjunction with innovation strategies.
- ***Promotion of international networks and global value chains:*** In recent decades innovation policy has had a penchant for local clusters. While fostering and increasing local interaction among innovative actors can lead to virtuous innovation circles and interactive learning (Storper and Venables, 2004), it still remains to be seen whether cluster strategies are the most valid option for innovation. The absence of a critical mass of innovative actors in many parts of the periphery of the EU, the weak economic fabrics and the relative isolation of many peripheral areas prevents the generation of sizeable externalities, increases the risk of 'lock-in', and precludes the diffusion of new knowledge (Boschma, 2005). Research has shown that economic actors in the periphery of Europe often benefit more from interaction at a distance, with innovators located outside the region, through the formation of arm's length networks and value chains (Simonen and McCann, 2010; Fitjar and Rodríguez-Pose, 2011; Iammarino and McCann, 2013; Araújo et al. 2014). It is therefore essential that the development of targeted 'pipelines' (Bathelt et al., 2004) to permit the inflow of new knowledge – or investing in building channels of communication external to the peripheral region – is made an essential constituent of innovation policies for the periphery of Europe. These extra-local connections or linkages may be established in a number of ways. International linkages may be established through individuals and therefore the provision of support to researchers (and entrepreneurs) to attend conferences, fairs or other relevant events that promote interactions with external actors or for secondment schemes may be viable options (Bathelt and Cohendet, 2014). Connections may also be forged through exposure to and interaction with international firms. In that vein, there is also be a role for policies and strategies (such as the provision of direct and indirect support) oriented towards the attraction of the activities of foreign firms that are understood to be a valuable source of new knowledge, technology and innovation (Blomstrom and Sjoholm, 1998; Blomstrom and Kokko, 1998).

The recent reforms of EU territorial and innovation policies already go, to considerable lengths, in the direction suggested above. The adoption of the smart specialization approach in conjunction with the 2014 reform of the Cohesion policy represents an important step towards the implementation of spatially-targeted, contextually specific policies to identify opportunity and foster innovation in *all* regions (Foray et al., 2009; 2011). The smart specialization approach is fundamentally focused on the comprehensive analysis of contextual conditions, the diagnosis of challenges and the discovery of strengths all to permit the identification of opportunities and the development of targeted interventions to capitalize upon them (e.g. Boschma, 2014; Capello and Lenzi, 2014; Foray, 2014; McCann and Ortega-Argilés, 2014). The approach pays particular attention to issues of stakeholder involvement, to the development of synergies with other policies, while, at the same time, emphasising the need to look outwards and to assess and support the development of global value chains.

The smart specialization approach is a significant first step but the reality is that peripheral environments in which smart specialization strategies are being, or will be implemented have, as addressed, a number of deficiencies and as such, smart specialization strategies may not be in and of themselves enough to achieve the innovation-oriented objectives of peripheral economies. From the preceding discussion, it is immediately apparent that innovative capacity is constrained by fundamental structural impediments. That is, institutional bottlenecks, unfavourable socio-economic conditions (i.e. human capital deficiencies) and problems of inter-regional and inter-national fragmentation and coordination resulting in duplications and inefficiencies among other factors hamper the innovative potential of peripheral economies. Specific policies, then, must be developed that promote institutional reform and the alleviation of institutional bottlenecks, the upgrading of human capital (and other local assets and resources), and foster policy coordination. Smart specialization strategies certainly do work along these axes, however, more specific interventions are inevitably necessary as the focus of smart specialization is the identification of opportunity and the mobilization of resources to realize that opportunity; these strategies do not necessarily prioritize transforming the socio-economic and institutional fabric upon which they are implemented, but rather pursue more narrowly defined innovation objectives.

Such policies will work synergistically with smart specialization strategies. Smart specialization strategies, much like any innovative policies are constrained by the environments in which they are implemented. If steps are taken to enhance the environment and provide a more favourable socio-economic and institutional context, it is far more likely that the outcomes of the smart specialization approaches will be maximized.

It must also be stressed that any and all policies implemented at the regional, national and supranational level must be integrated with one another and carefully coordinated (Borrás and Edquist, 2014). Policies must be developed with explicit consideration for local contextual conditions; however, they cannot neglect a much broader dimension. Coordination will ensure that limited resources are deployed in the most effective and efficient manner and that the outcomes of each individual policy may be maximized through the realization of efficiencies and a host of synergies at any number of territorial scales.

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APPENDIX

A1. Core and periphery countries in the EU

Core countries	Periphery countries
Austria	Bulgaria
Belgium	Croatia
Denmark	Cyprus
Germany	Czech Republic
Finland	Estonia
France	Greece
Ireland	Spain
Luxembourg	Hungary
Netherlands	Italy
Sweden	Lavia
United Kingdom	Lithuania
	Malta
	Poland
	Portugal
	Romania
	Slovenia
	Slovakia

A2. Index of NUTS Codes

Peripheral Regions

NUTS Code	Country	NUTS Region	NUTS Code	Country	NUTS Region
AT11	AT	Burgenland (AT)	ITF5	IT	Basilicata
BG31	BG	Severozapaden	ITF6	IT	Calabria
BG32	BG	Severen tsentralen	ITG1	IT	Sicilia
BG33	BG	Severoiztochen	ITG2	IT	Sardegna
BG34	BG	Yugoiztochen	LT00	LT	Lietuva
BG41	BG	Yugozapaden	LV00	LV	Latvija
BG42	BG	Yuzhen tsentralen	PL11	PL	Lódzkie
CZ02	CZ	Strední Cechy	PL12	PL	Mazowieckie
CZ03	CZ	Jihozápad	PL21	PL	Malopolskie
CZ04	CZ	Severozápad	PL22	PL	Slaskie
CZ05	CZ	Severovýchod	PL31	PL	Lubelskie
CZ06	CZ	Jihovýchod	PL32	PL	Podkarpackie
CZ07	CZ	Strední Morava	PL33	PL	Swietokrzyskie
CZ08	CZ	Moravskoslezsko	PL34	PL	Podlaskie
DE80	DE	Mecklenburg-Vorpommern	PL41	PL	Wielkopolskie
DED4	DE	Chemnitz	PL42	PL	Zachodniopomorskie
DED5	DE	Leipzig	PL43	PL	Lubuskie
DEE0	DE	Sachsen-Anhalt	PL51	PL	Dolnoslaskie
DEG0	DE	Thüringen	PL52	PL	Opolskie
EE00	EE	Eesti	PL61	PL	Kujawsko-Pomorskie
EL11	EL	Anatoliki Makedonia, Thraki	PL62	PL	Warminsko-Mazurskie
EL12	EL	Kentriki Makedonia	PL63	PL	Pomorskie
EL13	EL	Dytiki Makedonia	PT11	PT	Norte
EL14	EL	Thessalia	PT15	PT	Algarve
EL21	EL	Ipeiros	PT16	PT	Centro (PT)
EL22	EL	Ionia Nisia	PT18	PT	Alentejo
EL23	EL	Dytiki Ellada	RO11	RO	Nord-Vest
EL25	EL	Peloponnisos	RO12	RO	Centru

EL30	EL	Attiki	RO21	RO	Nord-Est
EL41	EL	Voreio Aigaio	RO22	RO	Sud-Est
EL43	EL	Kriti	RO31	RO	Sud - Muntenia
ES11	ES	Galicia	RO32	RO	Bucuresti - Ilfov
ES12	ES	Principado de Asturias	RO41	RO	Sud-Vest Oltenia
ES42	ES	Castilla-la Mancha	RO42	RO	Vest
ES43	ES	Extremadura	SE31	SE	Norra Mellansverige
ES61	ES	Andalucía	SE32	SE	Mellersta Norrland
ES62	ES	Región de Murcia	SI01	SI	Vzhodna Slovenija
HU21	HU	Közép-Dunántúl	SI02	SI	Zahodna Slovenija
HU22	HU	Nyugat-Dunántúl	SK02	SK	Západné Slovensko
HU23	HU	Dél-Dunántúl	SK03	SK	Stredné Slovensko
HU31	HU	Észak-Magyarország	SK04	SK	Východné Slovensko
HU32	HU	Észak-Alföld	UKD7	UK	Merseyside
HU33	HU	Dél-Alföld	UKE3	UK	South Yorkshire
ITF3	IT	Campania	UKK3	UK	Cornwall and Isles of Scilly
ITF4	IT	Puglia	UKL1	UK	West Wales and The Valleys

Core Regions

NUTS Code	Country	NUTS Region	NUTS Code	Country	NUTS Region
AT12	AT	Niederösterreich	DEA5	DE	Arnsberg
AT13	AT	Wien	DEB1	DE	Koblenz
AT21	AT	Kärnten	DEB2	DE	Trier
AT22	AT	Steiermark	DEB3	DE	Rheinhessen-Pfalz
AT31	AT	Oberösterreich	DEC0	DE	Saarland
AT32	AT	Salzburg	DED2	DE	Dresden
AT33	AT	Tirol	DEF0	DE	Schleswig-Holstein
AT34	AT	Vorarlberg	EL24	EL	Sterea Ellada
BE10	BE	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	EL42	EL	Notio Aigaio
			ES13	ES	Cantabria
BE21	BE	Prov. Antwerpen	ES21	ES	País Vasco
BE22	BE	Prov. Limburg (BE)	ES22	ES	Comunidad Foral de Navarra

BE23	BE	Prov. Oost-Vlaanderen
BE24	BE	Prov. Vlaams-Brabant
BE25	BE	Prov. West-Vlaanderen
BE31	BE	Prov. Brabant Wallon
BE32	BE	Prov. Hainaut
BE33	BE	Prov. Liège
BE34	BE	Prov. Luxembourg (BE)
BE35	BE	Prov. Namur
CZ01	CZ	Praha
DE11	DE	Stuttgart
DE12	DE	Karlsruhe
DE13	DE	Freiburg
DE14	DE	Tübingen
DE21	DE	Oberbayern
DE22	DE	Niederbayern
DE23	DE	Oberpfalz
DE24	DE	Oberfranken
DE25	DE	Mittelfranken
DE26	DE	Unterfranken
DE27	DE	Schwaben
DE30	DE	Berlin
DE50	DE	Bremen
DE60	DE	Hamburg
DE71	DE	Darmstadt
DE72	DE	Gießen
DE73	DE	Kassel
DE91	DE	Braunschweig
DE92	DE	Hannover
DE93	DE	Lüneburg
DE94	DE	Weser-Ems
DEA1	DE	Düsseldorf
DEA2	DE	Köln
ES23	ES	La Rioja
ES24	ES	Aragón
ES30	ES	Comunidad de Madrid
ES41	ES	Castilla y León
ES51	ES	Cataluña
ES52	ES	Comunidad Valenciana
ES53	ES	Illes Balears
FI19	FI	Länsi-Suomi
FI20	FI	Åland
FR10	FR	Île de France
FR21	FR	Champagne-Ardenne
FR22	FR	Picardie
FR23	FR	Haute-Normandie
FR24	FR	Centre (FR)
FR25	FR	Basse-Normandie
FR26	FR	Bourgogne
FR30	FR	Nord - Pas-de-Calais
FR41	FR	Lorraine
FR42	FR	Alsace
FR43	FR	Franche-Comté
FR51	FR	Pays de la Loire
FR52	FR	Bretagne
FR53	FR	Poitou-Charentes
FR61	FR	Aquitaine
FR62	FR	Midi-Pyrénées
FR63	FR	Limousin
FR71	FR	Rhône-Alpes
FR72	FR	Auvergne
FR81	FR	Languedoc-Roussillon
FR82	FR	Provence-Alpes-Côte d'Azur
FR83	FR	Corse
HU10	HU	Közép-Magyarország

DEA3	DE	Münster
DEA4	DE	Detmold
ITC1	IT	Piemonte
ITC2	IT	Valle d'Aosta/Vallée d'Aoste
ITC3	IT	Liguria
ITC4	IT	Lombardia
ITF1	IT	Abruzzo
ITF2	IT	Molise
ITH1	IT	Provincia Autonoma Bolzano/Bozen
ITH2	IT	Provincia Autonoma Trento
ITH3	IT	Veneto
ITH4	IT	Friuli-Venezia Giulia
ITH5	IT	Emilia-Romagna
ITI1	IT	Toscana
ITI2	IT	Umbria
ITI3	IT	Marche
ITI4	IT	Lazio
LU00	LU	Luxembourg
NL11	NL	Groningen
NL12	NL	Friesland (NL)
NL13	NL	Drenthe
NL21	NL	Overijssel
NL22	NL	Gelderland
NL23	NL	Flevoland
NL31	NL	Utrecht
NL32	NL	Noord-Holland
NL33	NL	Zuid-Holland
NL34	NL	Zeeland
NL41	NL	Noord-Brabant
IE01	IE	Border, Midland and Western
IE02	IE	Southern and Eastern
UKC1	UK	Tees Valley and Durham
UKC2	UK	Northumberland and Tyne and Wear
UKD1	UK	Cumbria
UKD3	UK	Greater Manchester
UKD4	UK	Lancashire
UKD6	UK	Cheshire
UKE1	UK	East Yorkshire and Northern Lincolnshire
UKE2	UK	North Yorkshire
UKE4	UK	West Yorkshire
UKF1	UK	Derbyshire and Nottinghamshire
UKF2	UK	Leicestershire, Rutland and Northamptonshire
UKF3	UK	Lincolnshire
UKG1	UK	Herefordshire, Worcestershire and Warwickshire
UKG2	UK	Shropshire and Staffordshire
UKG3	UK	West Midlands
UKH1	UK	East Anglia
UKH2	UK	Bedfordshire and Hertfordshire
UKH3	UK	Essex
UKI1	UK	Inner London
UKI2	UK	Outer London
UKJ1	UK	Berkshire, Buckinghamshire and Oxfordshire
UKJ2	UK	Surrey, East and West Sussex
UKJ3	UK	Hampshire and Isle of

NL42	NL	Limburg (NL)
PT17	PT	Lisboa
SE11	SE	Stockholm
SE12	SE	Östra Mellansverige
SE21	SE	Småland med öarna
SE22	SE	Sydsverige
SE23	SE	Västsverige
SE33	SE	Övre Norrland
SK01	SK	Bratislavský kraj

		Wight
UKJ4	UK	Kent
UKK1	UK	Gloucestershire, Wiltshire and Bristol/Bath area
UKK2	UK	Dorset and Somerset
UKK4	UK	Devon
UKL2	UK	East Wales
UKM2	UK	Eastern Scotland
UKM3	UK	South Western Scotland
UKN0	UK	Northern Ireland (UK)

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Reconciling the goals of simultaneously enhancing the competitiveness of regions in the EU with that of harmonious development and territorial cohesion has not been easy. Member states and the EU have spent considerable resources – mainly focused on enhancing R&D – with the aim of increasing research and innovation in the less developed regions of Europe and reducing the concentration of knowledge intensive activities in 'core' areas. This sizeable increase in R&D expenditure in the periphery has not, however, yielded the expected socio-economic benefits: R&D investment has been associated with improvements in scholarly outputs, but not with higher levels of economic growth or employment. Consequently, there is a need to adopt a new approach to innovation policy in the periphery of the EU. This approach should go beyond simple R&D indicators and acknowledge the specific conditions of each territory. It must focus more explicitly than before on innovation and on the capacity of individuals and firms to participate in innovation systems and to exploit the potential of related variety. Innovation policies in the periphery should also be better coordinated with education, training and capacity-building policies, as well as with regional development strategies. Finally, the institutional bottlenecks inhibiting innovation must also be addressed, alongside initiatives that promote integration into international networks and global value chains.

Keywords: Research, innovation, R&D, public policy, lagging regions, EU.

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