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RELEVANCE AND UTILITY OF EU RTDI POLICIES FOR A SMART GROWTH

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Abstract

The aim of the paper is to assess the relevance and utility of research, technological development and innovation (RTDI) measures within the Cohesion Policy framework. The paper starts from the consideration that regions innovate in different modes, not all being driven by research and technology expenditures. For this reason, our expectation is that RTDI measures are more useful for growth in those regions that are characterized by an R&D driven innovation pattern. Results indicate that RTDI are in general relevant to increase innovation. However, our findings warns on their utility for growth in regions whose innovation patterns do not rely on internal scientific research and technological innovation, since the most innovative regions are better positioned with respect to others to reap the advantages deriving from structural funds expenditures allocated to RTDI initiatives. Interesting policy suggestions emerge which go in line with what conceptualized by the regional innovation smart specialization strategy.

Keyword: RTDI, relevance, utility, innovation, regional growth

1. Introduction

The international literature, both academic and non, is rich of assessment exercises that try to establish the efficiency and effectiveness of cohesion policy funds (for a review, see Bachtler and Wren, 2006). In fact, since the 1988 regulations, a structured approach to the monitoring and evaluation of cohesion funds has been introduced by the EU. Ex-ante, mid-term and ex-post evaluations of the efficiency and effectiveness of each fund were required, and for each programming period, the evaluation requests became more and more stringent, highlighting specific requirements for the evaluation exercises.

Notwithstanding this popularity, the difficulties in running these assessment exercises are well known. The challenge of evaluating the impacts of cohesion policy lies in the complexity of the public policy instruments being used in terms of individual projects, wider measures, operational programs and the entire investment package taken as a whole (Bradley and Untiedt, 2012).

In order to limit the complexity accompanying all evaluation exercises on structural funds, it is important to explain from the beginning what the assessment study can (and is willing to) achieve. The present exercise has in fact a precise aim, i.e. to present an assessment of the relevance and utility of a specific axis, that of research, technological development and innovation (RTDI) funds.

Relevance and utility assume in this work the meaning provided by DGRegio in its glossary (DGRegio, 2014). Relevance refers to "the appropriateness of the explicit objective of an intervention"; utility is defined as "the fact that the impacts obtained by an intervention correspond to society's need and the socio-economic problems to be solved". In the case of RTDI measures, relevance occurs when RTDI funds are able to increase regional innovativeness (the explicit objective of the intervention) and therefore regional backwardness (the socio-economic problem the intervention is meant to solve); utility of

RTDI measures is interpreted as the capacity of RTDI interventions to increase regional growth in those areas that particularly lag behind.

The evaluation of the past experience in RTDI assumes a crucial importance given the increasing role that this measure will have in the next cohesion funds programming period. The paper starts from the consideration that regions innovate in different modes, not all modes being driven by R&D expenditures. For this reason, our conceptual expectation is that RTDI measures are more relevant and useful for growth in those groups of regions that are characterized by an R&D driven innovation mode (sec. 2). Based on a conceptual taxonomy of possible regional innovation modes, linked to the presence/absence of territorial enabling knowledge and innovation factors (sec. 2), the paper highlights the existence of these innovation modes in the real world (sec. 3), and assesses the relevance and utility of RTDI measures in the different regional innovation contexts (sec. 4 and 5). Policy implications are presented in the concluding section.

2. RTDI evaluation and regional patterns of innovation: testable assumptions

Knowledge and innovation have been interpreted for long time as drivers of competitiveness and growth. The Lisbon Agenda in 2000 and the Europe 2020 Agenda, more recently, have emphasized the necessity to lead Europe to lower the gap that exists in R&D investments with other leading countries, like US and Japan, and with emerging countries like China, so to become one of the most competitive and dynamic knowledge-based economies in the world.

Structural funds have not been an exception in this respect. Regional innovation strategies, operational programmes (OPs) and measures in favour of RTDI, or more generally competitiveness, have been designed and funded with the support of the structural funds since

the 1990s, and increased with the Lisbon Agenda since 2000 (DGRegio, 2006). The next 2014-2020 round will confirm further this trend, by registering an increase in the RTDI axis within the total structural funds.

In this perspective, the possibility to run an ex-post evaluation of RTDI funds is crucial. The aim of this study is to assess the relevance and utility of RTDI initiatives. As mentioned in the introductory section, relevance occurs when RTDI initiatives are able to increase regional innovativeness (the explicit objective of the intervention); utility of RTDI initiatives is interpreted as the capacity of RTDI interventions to increase regional growth, especially in those areas that particularly lag behind.

Our study adopts an important theoretical starting point. Regions have different modes of innovation, depending on the presence/absence of specific territorial pre-conditions to generate knowledge, innovation and/or to acquire them from outside the region. The concept of territorial patterns of innovation is proposed and defined as a combination of *territorial specificities (context conditions)* that lie behind *different modes of performing the different phases of the innovation process*. In particular *'territorial patterns of innovation'* consist in spatial breakdowns of variants of the knowledge → invention → innovation → development logical path built on the presence/absence of territorial preconditions for knowledge creation, knowledge attraction, and innovation (Capello and Lenzi, 2013a).

Among all possible combinations between innovation modes and territorial elements, the 'archetype' ones may be indicated in the following, each of which reflecting a specific piece of literature on knowledge and innovation in space: a) *an endogenous innovation pattern in a scientific network*, where local conditions fully support the creation of knowledge, its local diffusion and transformation into innovation and its widespread local adoption; b) *a creative application pattern*, characterized by the presence of creative economic actors interested and curious enough to look for knowledge outside the region – given the scarcity of local

knowledge – and creative enough to apply external knowledge to local innovation needs; c) *an imitative innovation pattern*, where local actors base their innovation capacity on imitative processes, that can take place with different degrees of adaptation of an already existing innovation.

Conceptually speaking, these three patterns represent by-and-large the different ways in which knowledge and innovation can take place in a regional economy. Given the extremely different nature of these innovation patterns, we expect the relevance and utility of RTDI initiatives to be dependent on the specific context conditions characterizing a region's socio-economic profile and, more importantly, its innovative activities, i.e. a region's territorial pattern of innovation. In particular, we expect RTDI measures – traditionally mainly concentrated in the scientific and technological domains – to be more relevant and useful in those regions whose innovation pattern relies on internal research and technological innovation.

If this is the case, interesting policy suggestions emerge which go in line with what conceptualized by the regional innovation smart specialization strategy (RIS^3). The latter, in fact, calls for regional innovation strategies based on each region's technological specialisation, or – in the words of RIS^3 experts – on each region's *technological domains*, by which is meant the technological fields in which regions are specialized and to which regional policies should be tailored to promote local innovation processes (Camagni and Capello, 2013; Camagni et al., 2014; McCann and Ortega-Argilés, 2011 and 2014). In order to be relevant and useful for sustaining regional competitiveness, cohesion policies in RTDI should adapt smart specialization strategy more carefully, as it seems the case in the new programming period 2014-2020.

3. Territorial patterns of innovation in Europe

An approach like ours calls for the partitioning of the European space among ‘innovative’ and ‘non-innovative’ regions. Most of the existing taxonomies group European regions only on the basis of their intensities of knowledge production, taking it for granted that knowledge leads (and equates) to innovation while ignoring the territorial conditions behind local innovation modes (OECD, 2010 and 2011). Although interesting results are achieved, the methodologies employed merge together indicators as diverse as innovation performance, knowledge inputs like R&D, sectoral structure, presence of spatial innovation enablers, with no clear conceptual expectations on the linkages among the different variables, in a purely inductive way (Hollanders et al., 2009a; Wintjes and Hollanders, 2010). In the end, many of these partitioning exercises are mostly data-driven rather than theoretically-driven. Our own goal, on the contrary, is to detect regional ‘patterns’ based on a clear conceptual definition of the different phases of any innovation process, and of the context conditions that are expected to support the different phases of the innovation process, presented in section 2.

In a recent work, territorial patterns of innovation have been empirically detected by means of a k-means cluster analysis based on a series of indicators capturing the different knowledge and innovation propensity across European regions: namely the regional EU share of total patents, the regional share of firms introducing product and/or process innovation, and the regional share of firms introducing marketing and/or organizational innovation (Capello and Lenzi, 2013b).[1] The empirical results show a larger variety of possible innovation patterns than the ones conceptually envisaged, still consistent with the theoretical underpinnings presented before. Two clusters can be associated to our first conceptual pattern, albeit with

[1] For further details on the variables used in the cluster analysis and the variables representing the key territorial distinctive traits of the different groups of regions see Capello and Lenzi (2013b).

some relevant distinctions between the two; two clusters can be associated to the second pattern, again with some important differences, and one cluster can be associated to the third pattern.

Notwithstanding important differences from the previous ones, the last cluster, however, does not enable to distinguish the possible innovative behaviours characterizing imitative regions, especially in terms of different degrees of elaboration and creativity in the adaptation and imitation of already existing innovations and ends up grouping all Eastern European regions together with some exceptions in Southern Italy. By favouring the between-group variance with respect to the within-group variance, in fact, cluster analysis maximizes the distance among groups according to the selected variables. Therefore, better to emphasize the within-group variance in the last pattern in terms of knowledge and innovation intensity, we performed a new cluster analysis, based on the same indicators (i.e., the regional EU share of total patents, the regional share of firms introducing product and/or process innovation, and the regional share of firms introducing marketing and/or organizational innovation), but only for the last group associated to the third conceptual pattern (i.e., that composed of imitative regions), which generated two clusters.

Hence, this two-layer cluster analysis ultimately enabled to identify six different groups of regions. In particular:

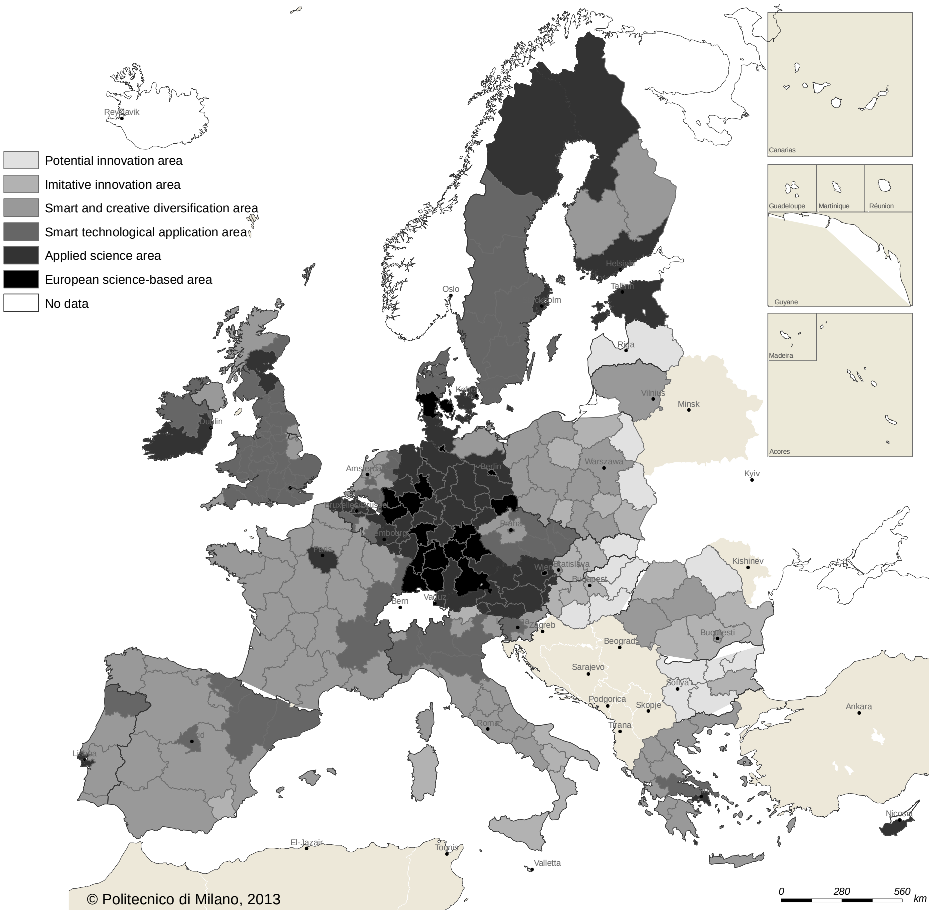
- a **European science-based area (ESBA)**, composed of strong knowledge and innovation producing regions, specialized in general purpose technologies, with the highest generality and originality of the scientific local knowledge, and the highest degree of knowledge acquisition from other regions. R&D expenditures, too, are the highest in these regions. They are mostly located in Germany, with the addition of Vienna, Brussels, and Syddanmark in Denmark;

- an **applied science area (ASA)**, similarly made up of strong knowledge producing regions albeit characterized by a local knowledge base of an applied nature, and by a high degree of knowledge acquisition from other regions. R&D activity is high in this group of regions as well. Regions of this type are mostly agglomerated and located in central and northern Europe, namely in Austria, Belgium, Luxembourg, France (i.e. Paris), Germany, Ireland (i.e. Dublin), Denmark, Finland and Sweden, with some notable exceptions to the East such as Prague, Cyprus and Estonia and to South such as Lisbon and Attiki;
- a **smart technological application area (STAA),** with a high product innovation rate, with a limited degree of local basic science, but a high level of creativity which enables the translation of external basic and applied science knowledge into innovation with respect to the other four clusters. The knowledge intensity is lower than in the previous two cases, although not negligible. This group of regions includes mostly agglomerated regions in EU15, such as the northern part of Spain and Madrid, Northern Italy, the French Alpine regions, the Netherlands, Czech Republic, Sweden and the UK;
- a **smart and creative diversification area (SCDA)**, with a low degree of local scientific knowledge in the form of patents and R&D, a non-negligible internal innovation capacity, a high degree of local capabilities (i.e. non-scientific and tacit knowledge embedded in professionals), of creativity and entrepreneurship, and of acquisition of external knowledge embedded in professional capabilities, with respect to the other four clusters. These regions are mainly located in Mediterranean countries (i.e. most of the Spanish regions, Central Italy, Greece, Portugal), in EU12 agglomerated regions in Slovakia and Slovenia, Poland and the Czech Republic, in a few regions in northern Europe, namely in Finland and the UK;

- a **imitative innovation area (IIA)**, characterized by a relatively low knowledge and innovation intensity with respect to the previous groups but higher entrepreneurship, collective learning, and innovation potentials with respect to the last group, and relatively more frequent urban locations. These regions include Southern Italy, and some regions in Hungary, Poland, Romania, and Slovakia with a relatively closer location to the EU geographical core.
- a **potential innovation area (PIA)**, characterized by the lowest knowledge and innovation intensity and, unfortunately, also lacking those preconditions such as entrepreneurship, collective learning, and innovation potentials that may open to virtuous innovation catching up trajectories. These regions have relatively more rural locations and are all in Eastern European countries, such as in Bulgaria, the eastern and southern border of Hungary, the eastern border of Poland and Romania, Latvia, and Malta.

These groups, shown in Map 1, differ not only in terms of their knowledge and innovation endowments, but, interestingly, also in the type and nature of the knowledge used in innovative activities and in the enabling territorial factors supporting the creation and acquisition of different types of knowledge and its successful conversion into innovation. Whereas scientific and technical knowledge (being either generic or specific), as captured by patents and R&D expenditures is prominent in the first three groups, in the others, the relevant knowledge is less science and technology based, i.e. embedded in the human capital of specialized workers.

Map 1. Territorial patterns of innovation in Europe



Interestingly, the last two groups of regions, differ significantly not only in their knowledge and innovation intensity (with the exclusion of product innovation) but, more importantly, in those preconditions that can allow a region to engage into virtuous innovation catching-up trajectories and progress upward along the innovation chain, such as entrepreneurship, collective learning, innovation potential (as measured by the FDI penetration rates in different sectors). These differences, and their statistical significance, are summarized in Table 1 below. The definition of these variables and their measurement is available in Table A1 in annex.

Table 1. Cluster analysis - Mean values by cluster and t- test statistical significance (*p* value)

	Imitative innovation area – IIA	Potential innovation area - PIA	Average value	T-test p-value
N of observations	22	15	37	
Knowledge	0.02	0.006	0.015	0.05
Product innovation	4.13	4.13	4.13	Not significant
Process innovation	7.53	3.47	5.88	0.01
Product and process innovation	9.01	6.84	8.13	0.01
Product and/or process innovation	20.66	14.44	18.14	0.01
Marketing and/or organizational innovation	15.97	10.98	13.94	0.01
Entrepreneurship	15.83	12.28	14.39	0.10
Collective learning	26.72	25.19	26.1	0.10
Attractiveness	7.86	11.78	9.45	0.01
Innovation potential	68	23	50	0.05
Agglomerated and urban regions	14	9	23	Not applicable
Rural regions	8	6	14	Not applicable
EU12	15	15	30	Not applicable

4. The regional growth model

4.1. The conceptual logic

The general idea inspiring the empirical strategy followed in the assessment of the relevance and utility of structural funds expenditures allocated to RTDI initiatives for regional growth is based on three initial observations.

First, this field of intervention (FOI) groups expenditures classified under intervention code 18, as defined by the European Commission (Böhme, 2008); on average, it accounts for slightly less than 6% of total structural funds expenditures in the 2000-2006 programming period, albeit this share is increasing in the current financial framework (2007-2013) and in the prospect one (2014-2020). According to Technopolis (2006), 29% of these RTDI funds are dedicated to measures in favour of boosting applied research (e.g., funding of pre-competitive development and industrial research projects and related infrastructure), 24% to direct and indirect support for knowledge and technology transfer, 20% to actions seeking to improve the overall environment in which enterprises innovate (namely, innovation financing, regulatory improvements and development of human capital), 17% to direct or indirect support for the creation and growth of innovative firms, 8% to improving governance capacities for innovation and knowledge policies, and 2% to innovation poles and clusters. Despite the high number of different measures, the nature of all interventions is linked to the scientific and technological character of innovation.

Second, according to the FOI classification, the field code 18 belongs to the productive environment area of intervention which is meant to finance initiatives to improve a region's productive environment and more generally its competitiveness (Technopolis, 2006);

accordingly, the link between these expenditures and economic performance indicators is likely to be mediated by their impact on competitiveness indicators such as innovation.

Third, regions differ in the share of structural funds planned for RTDI initiatives; for example, Objective 1 regions planned to dedicate on average 4.9% of total structural funds to RTDI programs whereas this share amounts to 9.8% in Objective 2 regions (Technopolis, 2006). This heterogeneity suggests that the relevance and utility of these funds for regional growth can be dependent on the specific context conditions characterizing a region's socio-economic profile and, more importantly, its innovative activities, i.e. a regions' territorial pattern of innovation.

The empirical analysis calls for the estimation of a regional growth model designed to assess the utility of structural funds expenditures allocated to RTDI for regional growth in Europe, while controlling for additional determinants of regional growth (i.e. those elements which enable a region to find a position in the international division of labour and maintain that position over time) suggested in the literature, and testing for spatial heterogeneity of the impacts of RTDI funds in the different patterns of innovation presented above. In order to estimate such a model, a preliminary empirical step is required, that allows to separate out regional endogenous innovative efforts from those driven through interventions financed by RTDI structural funds and to assess the relevance of such expenditures to improve regional innovation.

The empirical model is based on the one presented in Capello and Lenzi (2013a and 2013c), with the introduction of a few novelties. In particular, the model includes:

a) indicators capturing knowledge and innovation intensity,
b) territorially embedded elements that facilitate their creation (i.e. socio-economic local factors that enable knowledge and innovation to take place), and

c) region’s economic dynamics and development stage controls.

a) Knowledge and innovation intensity

Consistently with the literature on regional growth and with endogenous growth theory (e.g. Rodríguez-Pose and Crescenzi, 2008; Ertur and Koch, 2011), an indicator of formal and basic knowledge, measured through R&D expenditures on GDP, was included in order to capture knowledge inputs. This was complemented with an indicator of informal knowledge embedded in human capital, labelled ‘capabilities’, in order to control for different types of knowledge base locally available (Asheim and Coenen, 2005; Fagerberg and Srholec, 2008). Moreover, differently from previous studies (e.g. Rodríguez-Pose and Crescenzi, 2008), innovation was distinguished from R&D expenditures, the expectation being that this variable has an additional explanatory power with respect to knowledge; this variable directly accounts for the impact of new products and/or processes introduced in the market on the GDP growth rate.[2] Lastly, as a novelty, this work separates out the innovative efforts endogenously produced in each region from those that can be associated to structural funds expenditures allocated to RTDI programmes; the empirical strategy followed to implement this distinction is explained in Section 4.2.

[2] Empirically, the presence of both R&D expenditure and innovation may be problematic; as the R&D variable includes both commercialized and non-commercialized knowledge, one cannot rule out that it already captures innovative efforts by firms. Multi-collinearity between knowledge and innovation as discussed in Capello and Lenzi (2013a and 2013c).

b) Knowledge and innovation territorial enabling factors

Innovation is a territorially embedded process, and it cannot be fully understood independently of the social and institutional conditions (Rodríguez-Pose and Crescenzi, 2008). For this reason, the second group of variables considered in the empirical framework included socio-economic local factors that make the presence of favourable systems of innovation more likely.

Several contributions from the milieu innovateur theory (Camagni 1991) to institutional economics (Tabellini, 2008) stress the importance of a cooperative and trustworthy economic environment for enhancing local knowledge creation, innovation, and more generally the business atmosphere and economic performance. For this reason, an indicator of social capital was introduced as a measure of trust, cooperative propensity and collective actions within a region. Higher cooperation should promote knowledge and innovation circulation and socialization, thus enhancing local growth potentials.

An indicator for agglomeration economies was also added. This was meant to capture the synergic effects, complementarities, collective learning effects and local knowledge spillovers arising in the dense agglomerations of economic activities at the base of knowledge and innovation creation, and local growth. The importance of agglomeration economies has in fact been consistently documented in the literature (for a review, see Beaudry and Schiffauerova, 2009) on innovative and regional performance, as well as in the New Economic Geography (NEG) debate (Krugman, 1991); *ceteris paribus*, an agglomerated region grows more because of synergic effects and complementarities arising in densely populated areas.

Moreover, a control for functional specialization was inserted, since the literature has widely debated its role as an element stimulating innovation (Beaudry and Schiffauerova, 2009). Generally, upper-level occupations are more skill-intensive and more inclined to stimulate

knowledge and innovation, and therefore the growth rate, than lower-level occupations (Duranton and Puga, 2000).

Furthermore, a measure of accessibility to the region was introduced, the expectation being that the greater the accessibility, the higher the probability of acquiring new knowledge, new ideas, and new information, and therefore the higher the growth rate. The role of accessibility and infrastructure has always been central in studies on regional growth, and it has been more recently re-launched in the NEG debate (Krugman, 1991).

c) Economic dynamics and socio-economic development stage

A last group of variables are necessary to control for a region's economic dynamism. In order to assess whether GDP growth was the outcome of employment or productivity increases, the dynamics of the regional labor market were taken into consideration and measured through an indicator of employment growth rate in manufacturing.

To control for a region's economic attractiveness and the relevance of trade (consistently with the literature on trade and integration theory, e.g. Grossman and Helpman, 1990), an indicator of foreign direct investments (FDI) penetration rate was introduced. This was expected to affect the GDP growth rate positively, and it was supposed to generate a push effect on the local economy.

Finally and consistently with the literature on regional growth and convergence (showing possible divergent club-like growth patterns, (Ramajo et al., 2008)), two additional controls were added: a dummy variable for regions located in New Member States (NMS), which showed a remarkable distinctive growth behaviour with respect to EU15 regions in the early 2000s (Capello et al., 2008) and structural funds expenditures in order to account for the likely positive impact of public expenditures aimed at stimulating growth in developing

regions and for a region's learning, and ability to apply, to be granted and to mange structural funds. Table 2 reports the description of the variables and their sources, and Table 3 their descriptive statistics.

Table 2. Variables description

Indicators	**Measures**	**Computation**	**Year**	**Source**
GDP growth	Economic growth	Annual rate of growth	2006-2010	EUROSTAT
Employment growth rate in manufacturing	Employment dynamics	Annual rate of growth	2004-2006	EUROSTAT
New Member States	Bulgaria, Cyprus, Czech Republic, Hungary, Estonia, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia	Dummy variable equal to 1 if the regions is located in a EU12 country	2004	EUROSTAT
Social capital	Trust	Share of people trusting each other	2000	European Value Survey
Accessibility (infrastructure endowment)	Rail and road network length by usable land	Km of rail and road network on usable land	2000	ESPON
FDI	Foreign direct investments	Number of FDI on total population	Average value 2003-2005	FDI-Regio, Bocconi-ISLA
Structural funds expenditures	Expenditures on population	Natural logarithm	1994-1999	ESPON
Functional specialisation	% blue collars occupations	Share of craft and related trades workers, plant and machine operators, and assemblers on total employment	Average value 2002-2004	European Labour Force Survey
Mega (agglomeration economies)	FUAs with the highest scores on a combined indicator of transport, population, manufacturing, knowledge, decision-making in the private sectors	Dummy variable equal to 1 if the region is classified as mega	2000	ESPON
Capabilities	Share of managers and technicians	Factor analysis on the share of production and specialised service managers and science and engineering associate professionals (ISCO codes 13 and 31, respectively); factor scores min-max normalised	Average value 1999-2002	European Labour Force Survey
R&D	R&D expenditures	Share of R&D	Average	CRENoS database

		expenditures on GDP	value 2002-2004	
Innovation (product and/or process)	Firms introducing a new product and/or a new process in the market	Share of firms introducing product and/or process innovations	One value for the period 2004-2006	Authors' estimation on CIS (EUROSTAT) data
RTDI funds	Structural funds expenditures allocated to RTDI	Share of structural funds expenditures allocated to RTDI (i.e. Field of intervention – FOI - 18) on total structural funds expenditures	2000-2006	DG Regio

Note: for details on the estimation methodology of innovation data see Capello and Lenzi (2013a).

Table 3. Descriptive statistics

Variable	Obs	Mean	Dev.Std.	Min	Max
Average annual GDP growth rate 2006-2010	262	0.55	2.72	-20.84	6.39
Average annual GDP growth rate 2006-2009	262	-0.22	2.17	-9.71	5.97
Average annual GDP growth rate 2006-2008	262	2.18	2.33	-1.89	14.93
Average annual GDP growth rate 2006-2010 (ARIMA)	262	0.73	2.11	-15.32	6.40
Average annual GDP growth rate 2006-2009 (ARIMA)	262	1.47	2.03	-14.24	7.28
Employment growth rate in manufacturing (2004-2006)	262	0.60	5.01	-14.32	31.79
Trust (2000)	262	30.97	15.77	0	82
Accessibility (2000)	262	27.03	39.48	0	453.51
FDI (2003-2005)	262	0.19	0.40	0.00	4.29
Structural funds expenditures (1994-1999)	262	33454.3	561408.8	0	4348666
% of blue collar occupations (2002-2004)	262	33.3	7.1	16.33	58.73
Capabilities (1999-2002)	262	0.36	0.16	0	1
R&D (2002-2004)	262	1.38	1.21	0.1	7.6
Innovation (2004-2006)	262	34.59	13.13	11.07	87.75
RTDI funds (2000-2006)	262	5.87	6.62	0	32.11

4.2. The estimation procedure

As previously mentioned, the model to be estimated is a regional growth model, made dependent on knowledge and innovation intensity, while controlling for the territorial enabling factors and the economic dynamics and socio-economic development stage, as Equation 1 below specifies:

$$\Delta GDP_r = \alpha_0 + \beta_1 \Delta Empl_r + \beta_2 NMS_r + \beta_3 Social\ Capital_r + \beta_4 Infrastructure_r + \\ + \beta_5 FDI_r + \beta_6 Structural Funds_r + \beta_7 Functional\ Specialization_r + \beta_8 Agglomeration\ Economies \\ + \beta_9 Capabilities + \beta_{10} R\&D_r + \beta_{11} Innnovation_r + \varepsilon_r \quad (1)$$

where ΔGDP_r is the regional annual GDP growth rate in the period 2006-2010. As the 2006-2010 period includes the years of the burning of the financial crisis started in Europe in 2008, the dependent variable is also computed in the period 2006-2009 to check the robustness of our key results. Moreover, to control for the possible confounding effects of the crisis, adjusted regional growth rates were computed by using as the regional GDP level at 2009 and 2010 out-of-sample estimates of regional GDP level produced by ARIMA estimations with time trend, on the basis of the regional GDP series in the periods 1995-2008 and 1955-2009, respectively. As the analysis reported in Section 5 will show, our results are largely robust to these controls.

Importantly, in order to assess the relevance and utility of structural funds expenditures allocated to RTDI programs, there is need to distinguish the impact of regional endogenous innovative efforts and of the innovative efforts that can be induced by structural spending in such programs. For this purpose, the innovation variable was preliminarily regressed on the share of structural funds allocated to RTDI programmes, while controlling for eligibility for funding under the 2000-2006 structural funds regulation. In this programming period, a few regions were not eligible for structural funds and all Romanian and Bulgarian regions were excluded too as the two countries did not join yet the EU. Two dummy are therefore added to control for non eligibility due either to more favourable socio-economic conditions in a region or to non eligibility due to non membership. The following Equation 2 was estimated:

$$Innovation_r = \alpha_0 + \beta_1 RTDI_r + \beta_2 Eligibility_r + \beta_3 Bulgaria\ \&\ Romania_r + \varepsilon_r \quad (2)$$

where *Innovation*$_r$ indicates the share of firms introducing product and/or process innovation in the period 2004-2006, *RTDI*$_r$ the share of structural funds allocated to RTDI programmes in the programming period 2000-2006, R&D$_r$ is the average share of R&D expenditures on GDP in 2000-2, *Eligibility*$_r$ is a dummy taking value 1 if the region was eligible for structural funds support in the 2000-2006 period and zero otherwise, and *Bulgaria&Romania*$_r$ takes value 1 for Bulgarian and Romanian regions and zero otherwise.

Although one may argue that the relationship between innovation and the share of structural funds allocated to RTDI programmes can be affected by endogeneity as the amount of resources that a region is willing to allocate to research activities is likely linked to the local research efforts and capacity, consistently with the absorptive capacity argument à la Cohen and Levinthal, the data under examination speak against this possibility.

In fact, t-tests comparing, respectively, the share of R&D on GDP and share of innovative firms in eligible regions that allocate no resources to RTDI programmes with respect to the other eligible regions, indicate that the former are significantly more R&D and innovation intensive than the latter. In particular, R&D and innovation in eligible regions with no resources dedicated to RTDI programmes are, respectively, 2.44 and 40.91 whereas R&D and innovation are, respectively, 1.36 and 34.74 in the others. Their differences are statistically significant at 1% and 10% level, respectively.[3]

The predicted innovation value obtained by estimating Equation 2 is interpreted as those innovative efforts that can be associated with structural funds expenditures allocated to RTDI

[3] As an additional control to exclude the possible risk of endogeneity, Equation 2 was also estimated by structural equation modelling where the share of structural funds dedicated to RTDI was prelimary regressed on the average share of R&D on GDP in the period 2000-2 and the two dummies for eligibility. Results, for equations 2 to 4, available upon requests, are substantially unchanged. Reassured by the similar results obtained, we prefer to present the original estimations, that are more straightforward and less manipulated than those obatined by structural equation modelling.

interventions, and can be defined as *RTDI-driven innovation*, whereas the residuals, i.e. the difference between the innovation variable and the innovation predicted value, are interpreted as those innovative efforts endogenously developed in a region, and can be defined as *endogenous innovation*.

By distinguishing the two innovation components, i.e. the endogenous and the RTDI driven ones, the regional growth model to be estimated can be written as in Equation 3 below:

$$\begin{aligned} \Delta GDP_r = {} & \alpha_0 + \beta_1 \Delta Empl_r + \beta_2 NMS_r + \beta_3 Social\ Capital_r + \beta_4 Infrastructure_r + \\ & + \beta_5 FDI_r + \beta_6 Structural Funds_r + \beta_7 Functional\ Specialization_r + \beta_8 Agglomeration\ Economies_r \\ & + \beta_9 Capabilities + \beta_{10} R\ \&\ D_r + \beta_{11} Endogenous\ Innnovation_r + \beta_{12} RTDI\ driven\ Innnovation_r + \varepsilon \end{aligned} \quad (3)$$

Finally, to unravel the utility of structural funds expenditures allocated to RTDI for regional growth across the EU territory, the RTDI driven innovation variable is interacted with the dummy variables capturing the territorial patterns of innovation described in Section 3. Hence, the enlarged model to be estimated can be written as in Equation 4 below:

$$\begin{aligned} \Delta GDP_r = {} & \alpha_0 + \beta_1 \Delta Empl_r + \beta_2 NMS_r + \beta_3 Social\ Capital_r + \beta_4 Infrastructure_r + \\ & + \beta_5 FDI_r + \beta_6 Structural Funds_r + \beta_7 Functional\ Specialization_r + \beta_8 Agglomeration\ Economies \\ & + \beta_9 Capabilities + \beta_{10} R\ \&\ D_r + \beta_{11} Endogenous\ Innnovation_r + \beta_{12} RTDI\ driven\ Innnovation_r \\ & + \beta_{13} RTDI\ driven\ Innnovation_r * D_r + \varepsilon_r \end{aligned} \quad (4)$$

where D_r represents the dummy variable for regional membership to the different territorial patterns of innovation.

Lastly, following Anselin (1988), controls for spatial dependency with appropriate econometric techniques (namely spatial lag and spatial error models, indicated as SAR and SEM in the following tables) are implemented in all regressions when statistically relevant.

5. Relevance and utility of RTDI expenditures for regional growth across territorial patterns of innovation

Table 4 reports the estimates of Equation 2. The results highlight that structural funds expenditures allocated to RTDI programs are significantly associated to regional innovative performance, also controlling for spatial dependency (columns 2 and 3). The two dummy variables controlling for a region's eligibility for structural funds indicate that eligible regions are less innovative than non-eligible regions because of higher socio-economic conditions whereas non eligible regions because of non membership (i.e., Bulgarian and Romanian regions) are less innovative. Relevance of RTDI interventions – when this is interpreted as the appropriateness of these measures to increase innovation – is therefore proved.

In order to distinguish the RTDI-driven from the endogenous innovation components, innovation predicted value and residuals have been computed from regression results of the spatial lag model (SAR) presented in the third column. The spatial lag estimation results have been chosen because of the larger value of the robust Lagrange multiplier test (that suggests that the spatial lag is probably more adequate than the spatial error model in the present empirical setting) and because of the larger squared correlation value. Also, the correlation between the results obtained through the spatial lag and spatial error estimation is very high for both the endogenous and the RTDI-driven innovation components (0.99 and 0.98, respectively).

Table 4. Relevance of RTDI expenditures: their impact on innovation

Dependent variable: Innovation (2004-2006)	**OLS**	**SEM**	**SAR**
RTDI funds (2000-2006)	0.424***	0.182*	0.209**
	(0.14)	(0.11)	(0.10)
Structural funds eligibility	-0.159***	-0.121***	-0.126***
	(0.04)	(0.04)	(0.04)
Bulgaria and Romania	-0.115***	-0.039	-0.015
	(0.03)	(0.05)	(0.03)
Constant	0.482***	0.386***	0.146***
	(0.03)	(0.10)	(0.05)
Robust Lagrange multiplier (spatial error)	10.01***		
Robust Lagrange multiplier (spatial lag)	16.58***		
R2 (OLS) – Squared correlation (SEM and SAR)	0.13	0.11	0.38
Lambda(SEM) / Rho (SAR)		0.906***	0.883***
		(0.06)	(0.07)
Observations	262	262	262

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

More interestingly, Table 5 (columns 1 to 4) reports the estimates of the regional growth model presented in Section 4.2 with the regional growth rate in the 2006-2010 period as dependent variable. Columns 5 to 8 present the same set of regressions with the regional growth rate adjusted to take into consideration the possible effect of the economic crisis as dependent variable. As described in Section 4.2, the adjusted regional growth rate in the 2006-2010 period is computed by using the GDP level out-of-the-sample estimate obtained by ARIMA with time trend, on the basis of the regional GDP series in the period 1995-2009; the use of this adjusted regional growth rate provides very similar results in terms of significance and magnitude of the estimated coefficients (the correlation between the two variables is in fact 0.95).

The results for the variables capturing knowledge and innovation territorial enabling factors and the variables capturing the region's economic dynamism, as well as those for the nature and pattern of development, are overall statistically significant and with the expected sign. In particular, as regards a region's economic dynamism, GDP growth positively reacts to the

FDI penetration rate, relatively more weakly to past structural funds expenditures (only in models 5 to 8), and it is higher in Eastern European regions.

As regards socio-economic local enablers of knowledge and innovation, GDP growth is positively influenced by the synergic effects deriving from agglomeration economies. On the other hand, GDP growth is hampered by a region's functional specialization in lower-level functions (i.e. blue-collar occupations) and, more significantly, by the accessibility level, suggesting that congestion effects prevail.

Differently from results obtained for the pre-crisis period (Capello and Lenzi, 2013a and 2013c), the effects of capabilities and trust are not significant, nor the R&D variable achieves the significance threshold. This latter result, albeit quite counterintuitive at a first glance, is in line with Capello and Lenzi (2013c), detecting a vanishing effect of local knowledge assets on regional growth by moving from the 2005-2007 period to the 2005-2009 period.

Importantly, the innovation variable preserves its strategic relevance (albeit with a reduced magnitude with respect to the 2005-2007 period, Capello and Lenzi (2013c)), also when considering only its endogenous component (models 2 and 3), whereas the RTDI-driven innovation component per se (linked to structural funds expenditures allocated to RTDI programs) never achieves the significance level.

This latter result may hide important differences in the way regions are able to exploit the potential innovation benefits deriving from RTDI expenditures, suggesting that these policy tools have different utility according to specific context conditions, i.e., the specificities of the innovation mode characterizing each region. In model 4, therefore, the RTDI-driven innovation variable has been interacted with five out of the six territorial patterns of innovation dummy variables, being the interaction between RTDI-driven innovation and the dummy for the Potential innovation area the reference case. Results indicate that the most innovative groups of regions (i.e., the Applied science area and the European science-based

area) are better positioned with respect to the Potential innovation area to reap the advantages deriving from structural funds expenditures allocated to RTDI initiatives. This result suggests a limited if null utility of RTDI initiatives to improve the economic situation of lagging regions.

Some diminishing returns seem at place being the coefficient of the Applied science area not statistically different from that of the European science-based area. The Potential innovation area, instead, is significantly at disadvantage with respect to the other groups, as confirmed by the negative and significant effect of the RTDI-driven innovation variable.

By controlling for effect of the crisis through the use of the adjusted growth rate in column 8, also regions in the Smart technological area seem able to reap the benefit deriving from structural funds expenditures allocated to RTDI initiatives, confirming the general message presented in column 4 that the most innovative groups of regions are better positioned with respect to the Potential innovation area to exploit the potential advantages deriving from these expenditures. Interestingly, the significant coefficients of the interaction variables confirm some decreasing returns being the coefficient of the Applied science area not statistically different from those of the Smart technological area and of the European science-based area.

If these different results (from column 4) are interpreted as a consequence of the economic crisis affecting European economies since 2008, one can conclude that the crisis has reduced the number of regions potentially benefitting from structural funds expenditures allocated to RTDI programs. Indeed, a similar pattern has been detected in Capello and Perucca (2014).

This interpretation is further supported by the estimates obtained by using a different dependent variable (Table 6), i.e., the regional GDP growth rate in the years 2006-2009 (column 1), also adjusted to control for the possible effects of the economic crisis as described in Section 4.2 (column 2). Interestingly, in this case, the R&D variable has a negative and significant coefficient (model 1) whose significance disappears when controlling for the effect

of the crisis, suggesting that highly knowledge intensive regions have been more deeply hit by the crisis.

Table 5. Utility of RTDI Funds: their role on regional GDP growth rate (2006-2010)

Dependent variable: GDP growth rate 2006-2010	1	2	3	4	5	6	7	8
New Member Countries	0.050***	0.052***	0.053***	0.054***	0.049***	0.051***	0.051***	0.050***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Trust (2000)	-0.002	-0.002	-0.003	-0.004	-0.000	-0.001	-0.001	-0.001
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Employment growth (2004-2006)	0.033	0.033	0.032	0.028	0.021	0.021	0.021	0.014
	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Infrastructure endowment (2000)	-0.004**	-0.005**	-0.005**	-0.005**	-0.004**	-0.004**	-0.005**	-0.005*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
FDI (2003-2005)	0.008**	0.008**	0.008**	0.008**	0.009***	0.009***	0.009***	0.009***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Structural funds (1994-1999)	0.002	0.002	0.002	0.002	0.002**	0.002**	0.002***	0.002**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% of blue collars occupations (2002-2004)	-0.085***	-0.088***	-0.089***	-0.089***	-0.076***	-0.078***	-0.079***	-0.081***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Megas (2000)	0.005*	0.004*	0.004*	0.005*	0.005**	0.004**	0.004**	0.005**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Capabilities (1999-2002)	-0.009	-0.009	-0.009	-0.011	0.005	0.005	0.005	0.003
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R&D (2002-2004)	-0.184	-0.186	-0.164	-0.161	-0.141	-0.139	-0.126	-0.125
	(0.14)	(0.14)	(0.15)	(0.14)	(0.12)	(0.12)	(0.12)	(0.12)
Innovation (2004-2006)	0.027**				0.027**			
	(0.01)				(0.01)			
Endogenous innovation (2004-6)		0.031**	0.030**	0.010		0.030**	0.029**	0.012
		(0.02)	(0.02)	(0.01)		(0.01)	(0.01)	(0.01)
RTDI-driven innovation (2004-2006)			-0.053	-0.638*			-0.032	-0.699**
			(0.06)	(0.36)			(0.05)	(0.32)
RTDI-driven innovation*IIA				0.486				0.481
				(0.36)				(0.32)
RTDI-driven innovation*SCDA				0.362				0.493
				(0.38)				(0.32)
RTDI-driven innovation*STAA				0.496				0.611**
				(0.34)				(0.30)
RTDI-driven innovation*ASA				0.641*				0.714**
				(0.36)				(0.31)
RTDI-driven innovation*ESBA				0.622*				0.663**
				(0.36)				(0.32)
Constant	-0.022	-0.023	-0.021	-0.010	-0.014	-0.015	-0.014	-0.002
	(0.06)	(0.06)	(0.06)	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)
Robust Lagrange multiplier (spatial error)	87.44***	90.85***	85.73***	86.23***	36.80***	40.46***	39.41***	37.49***
Robust Lagrange multiplier (spatial lag)	1.79	1.46	1.92	2.70	0.49	0.25	0.29	0.84
Lambda	0.961***	0.962***	0.962***	0.962***	0.924***	0.925***	0.925***	0.923***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.10)	(0.10)	(0.10)	(0.10)
Squared correlation	0.17	0.17	0.16	0.19	0.19	0.19	0.19	0.22
Observations	262	262	262	262	262	262	262	262

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. ESBA=European science-based area; ASA=Applied science area; STAA=Smart technological application area; SCDA=Smart creative diversification area; IIA=Imitative innovation area. Reference case in models 4 and 8 is the Potential innovation area (PIA).

Table 6. Utility of RTDI Funds: Robustness checks

Dependent variable: GDP growth rate 2006-2009	(1)	(2)
New Member Countries	0.074***	0.049***
	(0.02)	(0.01)
Trust (2000)	0.002	0.006
	(0.01)	(0.01)
Employment growth (2004-2006)	0.031	0.017
	(0.03)	(0.02)
Infrastructure endowment (2000)	-0.005**	-0.005*
	(0.00)	(0.00)
FDI (2003-2005)	0.010**	0.009***
	(0.00)	(0.00)
Structural funds (1994-1999)	0.003***	0.002**
	(0.00)	(0.00)
% of blue collars occupations (2002-2004)	-0.117***	-0.070***
	(0.02)	(0.02)
Megas (2000)	0.004*	0.005**
	(0.00)	(0.00)
Capabilities (1999-2002)	0.004	0.014*
	(0.01)	(0.01)
R&D (2002-2004)	-0.198**	-0.064
	(0.10)	(0.12)
Endogenous innovation (2004-6)	0.017	0.009
	(0.01)	(0.01)
RTDI-driven innovation (2004-6)	-0.749**	-0.517*
	(0.39)	(0.28)
RTDI-driven innovation*IIA	0.633	0.372
	(0.40)	(0.29)
RTDI-driven innovation*SCDA	0.649*	0.323
	(0.38)	(0.29)
RTDI-driven innovation*STAA	0.678*	0.445*
	(0.38)	(0.26)
RTDI-driven innovation*ASA	0.777**	0.482*
	(0.39)	(0.28)
RTDI-driven innovation*ESBA	0.703*	0.432*
	(0.39)	(0.28)
Constant	-0.015	0.001
	(0.02)	(0.02)
Robust Lagrange multiplier (spatial error)	65.29***	24.98***
Robust Lagrange multiplier (spatial lag)	0.19	0.01
Lambda	0.877***	0.887***
	(0.15)	(0.13)
Squared correlation	0.28	0.27
Observations	262	262

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. ESBA=European science-based area; ASA=Applied science area; STAA=Smart technological application area; SCDA=Smart creative diversification area; IIA=Imitative innovation area. The reference case is the Potential innovation area (PIA).

6. Conclusions and policy implications

The paper had the aim to evaluate relevance and utility of RTDI initiatives within the Structural Funds program, in light of their increasing role in the next programming period.

The evaluation analysis started from the conceptual consideration that each region develops its own regional innovation mode, either producing knowledge and innovation, or acquiring them from outside, and that these modes will influence the way in which regions will be able to make use of RTDI funds, mainly associated to scientific and technological activities.

The concept of territorial patterns of innovation has been proposed and defined as a combination of *territorial specificities (context conditions)* that lie behind *different modes of performing the different phases of the innovation process*. Conceptually speaking, these patterns represent different ways in which knowledge and innovation can take place in a regional economy. Given the extremely different nature of these innovation patterns, the expectations, empirically proved, was that the relevance and utility of RTDI initiatives are dependent on the specific context conditions characterizing a region's socio-economic profile. In particular, empirical results witnessed that in some cases, RTDI initiatives can turn to be extremely useful, namely when a critical mass of research activities is already present, while they can produce no effect in regions where the path to innovation is not based on the development of an internal, formal knowledge base.

Relevance of RTDI funds exists: RTDI initiatives contribute to the increase of innovation performance in general. However, when the impact of these initiatives on regional growth is evaluated, results indicate that their utility is not high: regions with territorial patterns characterized by high internal knowledge production are better positioned with respect to regions whose territorial pattern is based on imitative innovation, or lacking knowledge, innovation and those preconditions such as entrepreneurship, collective learning, and

innovation potentials that may open to virtuous innovation catching up trajectories, to reap the advantages deriving from structural funds expenditures allocated to RTDI initiatives.

All this has interesting policy suggestions. RTDI initiatives are relevant to increase innovation, but if these policies have to support modernization and innovation processes in *all* European regions, they have to diversify their approach in order, first, to comply with the specificities and potentials of the single regions, and secondly to avoid the opposite risks of dispersion of public resources in un-differentiated ways, or conversely to concentrate all resources in a few regions where the traditional policy action, namely R&D support, is due to grant the highest returns (Camagni and Capello, 2013).

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Annex

Table A1. Indicators and measures

Indicators	Measures	Computation	Year	Source
Knowledge	Share of patents	Regional share of EU total patents	Total patents in the period 1998-2001	Authors' elaboration on CRENoS database
Product and/or process innovation	Firms introducing a new product and/or a new process in the market	Share of firms introducing product and/or process innovations	One value for the period 2002-2004	Authors' estimation on CIS (Eurostat) data
Marketing and/or organizational innovation	Firms introducing a marketing and/or an organisational innovation	Share of firms introducing marketing and/or organizational innovations	One value for the period 2002-2004	Authors' estimation on CIS (Eurostat) data
Product innovation	Firms introducing a new product in the market	Share of firms introducing a product innovation	One value for the period 2002-2004	Authors' estimation on CIS (Eurostat) data
Process innovation	Firms introducing a new process in the market	Share of firms introducing a process innovation	One value for the period 2002-2004	Authors' estimation on CIS (Eurostat) data
Product and process innovation	Firms introducing both a new product and a new process in the market	Share of firms introducing both product and process innovations	One value for the period 2002-2004	Authors' estimation on CIS (Eurostat) data
Entrepreneursh ip	Share of self-employment (local units in wholesale and retail excluded)	Number of local units (wholesale and retail sectors excluded) on total EU local units	Averag e value 1999-2004	Eurostat
Collective learning	Concentration in manufacturing sectors	Herfindal index on the share of employment in manufacturing sub-sectors***	Averag e value 1999-2001	Eurostat
Attractiveness	Regional wage differential with respect to the EU	$W_{EU\ average} - W_{Reg\_i}$	Averag e value 1999-2001	Eurostat

	average			
Innovation potential	FDI penetration rate	Number of FDI in manufacturing on total population	Average values 2005-2007	FDI-Regio, Bocconi-ISLA
Agglomerated and urban regions	NUTS2 with more than 150,000 inhabitants and a population density of more than 300 inhabitants per km2, or a population density between 150 and 300 inhabitants per km2.	Dummy variable equal to 1 if the region is classified as agglomerated or urban	2000	ESPON
Rural regions	NUTS2 with a population density lower than 100 per square kilometer and a center of more than 125,000 inhabitants, or a population density lower than 100 per square kilometer with a center of less than 125,000.	Dummy variable equal to 1 if the region is classified as rural	2000	ESPON
New member states (EU12)	Bulgaria, Cyprus, Czech Republic, Hungary, Estonia, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia	Dummy variable equal to 1 if the regions is located in a EU12 country	2004	Eurostat

Source: adapted from Capello and Lenzi (2013b)

Table A2. Correlation matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	GDP growth rate (2006-2010)	-														
2	GDP growth rate (2006-2010) - ARIMA	0.95*	-													
3	New Member Countries	0.34*	0.36*	-												
4	Trust (2000)	-0.08	-0.13*	-0.37*	-											
5	Employment growth (2004-2006)	0.11	0.13*	0.08	0.01	-										
6	Infrastructure endowment (2000)	0.07	0.05	-0.13*	0.09	-0.07	-									
7	FDI (2003-2005)	0.10	0.16*	-0.02	0.02	0.04	0.35*	-								
8	Structural funds (1994-1999)	-0.37*	-0.38*	-1*	0.31*	-0.05	0.08	-0.02	-							
9	% of blue collars occupations (2002-2004)	-0.02	0.01	0.41*	-0.35*	-0.05	-0.26*	-0.11	-0.34*	-						
10	Megas (2000)	0.17*	0.18*	0.09	0.06	-0.03	0.27*	0.22*	-0.12	-0.14*	-					
11	Capabilities (1999-2002)	-0.22*	-0.06	-0.10	-0.29*	0.12	-0.10	-0.00	0.22*	0.13*	-0.06	-				
12	R&D (2002-2004)	-0.07	-0.12	-0.36*	0.37*	-0.09	0.20*	0.13*	0.26*	-0.44*	0.18*	-0.32*	-			
13	Innovation (2004-2006)	-0.00	-0.04	-0.42*	0.26*	-0.16*	0.26*	0.16*	0.33*	-0.25*	0.13*	-0.30*	0.55*	-		
14	Endogenous innovation (2004-2006)	0.01	-0.01	-0.38*	0.26*	-0.15*	0.26*	0.16*	0.30*	-0.21*	0.13*	-0.29*	0.52*	0.99*	-	
15	RTDI-driven innovation (2004-2006)	-0.08	-0.12*	-0.32*	0.22*	-0.04	0.05	0.01	0.29*	-0.26*	-0.01	-0.10	0.33*	0.31*	0.14*	-
16	RTDI funds (2000-2006)	-0.16*	-0.22*	-0.31*	0.2623*	-0.09	-0.03	-0.11	0.31*	-0.01	-0.05	-0.10	0.21*	0.23*	0.15*	0.53*

Note: * $p<0.05$