# REGIONAL INNOVATION TYPOLOGIES IN CENTRAL AND EASTERN EUROPE: THE PATH TO REGIONAL TRANSFORMATION

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***Abstract:*** *The main objective of this study is to revisit some of the typologies of the European regional innovation systems and to shed light on the features and performances of Central and Eastern European regions in this respect. To this aim, we put in comparative perspective different typologies based on indicators related to economic characteristics, sectoral specialization, social filters, knowledge creation and knowledge absorption capabilities, innovation outputs and economic effects. Our findings reveal the heterogeneity of the regional innovation systems in the Central and Eastern Europe, with most of the regions being classified as "lagging-behind" or "intermediate" regions. The pathways towards regional transformation are revealed in the final section of the paper, which emphasizes the need to address first the macro-structural weaknesses, to invest in human capital, skills and institutions and to adopt the broader view of innovation.*

***Keywords:*** *regional innovation, regional transformation, innovation typologies, Central and Eastern Europe (CEE), lagging regions.*
***JEL Codes:*** *R11, R58.*

## 1. Introduction. Regional innovation systems in the European context

There is a wide consensus among scientists that regions are important engines of economic development and that they should stay at the core of the debates about innovation and competitiveness. The focus on "regions" as units of analysis is motivated by different arguments. According to Porter (2003), there is growing tendency to give priority to micro aspects over the macro ones, as "substantial differences in economic performance (exist) across regions in virtually every nation". In addition, the literature on innovation systems points to the fact that knowledge has a strong cumulative and tacit character (is difficult to exchange over long distances) and the process of accumulation of knowledge is context-specific and spatially "sticky" (Asheim and Gertler, 2005). For these reasons, the regions became the most suitable units of analysis and planning for both scholars and policy makers, in their attempt to identify and advance policies adapted to the local contexts.

"Regional innovation systems" (RIS) have emerged as the most relevant analytical framework to study economic development and innovation at the regional level. Even if there is no standard definition of a RIS, there is agreement in the literature that a RIS contains "subsystems of generation and exploitation of knowledge that interact with other regional, national and global systems for the commercialization of new knowledge" (Cooke et al., 2004). What differentiate RIS approaches from similar concepts (e.g. regional clusters) is the focus on interactive learning processes between actors in geographical proximity and the attempt to gain a better understanding of the uneven geography of innovation. Since its development in the 1990s, the RIS approach has essentially contributed to identifying the factors that shape the knowledge generation and innovation capacities of regions (Asheim et al., 2015), which resulted in the development

of different RIS typologies. Based on the actors and modes of governance constituting RIS, Asheim and Isaksen (2002) distinguish three main types of RIS, namely the ”territorially embedded” regional innovation networks, the regional networked innovation systems and the regionalised national innovation systems. Cooke et al. (2004) make a separation between institutional RIS (IRIS) and entrepreneurial RIS (ERISs), the first one being suited to promote incremental innovations in traditional sectors, while the second one offering good conditions for radical innovation and emergence of new industries. Not last, Todtling and Trippl (2005) classify the RIS according to the so-called ”RIS failures” – i.e. organizational thinness, fragmentation and lock-in effects – and make a distinction between metropolitan agglomerations, old industrial regions and peripheral regions.

The latter typology brings in useful assumptions to the study of RIS in emerging countries and/or in the regions with less developed innovation systems. As such, the study of RIS in Central and Eastern European (CEE) countries is somewhat hampered by the fact that ”important elements of the RIS may be missing”, as evidenced by Radosevic (2002). Trippl et al. (2015) made important steps forward for the identification of regions with less developed innovation systems: such regions may suffer from institutional thinness, organizational thinness or a combination of both dimensions of thinness. In line with this classification, large cities in Eastern Europe have organizationally thick, but institutionally thin RIS: they are characterized by the existence of a critical mass of knowledge creation organizations, but they lack the cooperation culture and exhibit a low quality of government institutions. In contrast, the other regions in Eastern Europe are simultaneously organizationally and institutionally thin, as they suffer from the lack of innovation-related organizations and from an institutional set-up that is not conducive to innovation. According to Blazek et al. (2014), the regions located in Central Eastern Europe, with a post-communist heritage, are by far the most lagging behind with respect to the research and innovation systems. Further research focusing on the case of the CEE countries is expected to give attention to the determinants of the transformative capacity of their regional innovation systems and to gain deeper insights into the heterogeneity of less-developed regions.

Our paper acknowledges the research questions raised by Blazek et al. (2014) and aims to revisit some of the typologies of the European regional innovation systems and to shed light on the features of the Central and Eastern European regions.

The purpose is to put in a comparative perspective the existing classification so that to reveal the heterogeneity of the less developed regions in Central and Eastern Europe and to identify the recommended paths for regional transformation. We consider 11 Central and Eastern European countries that were part of the communist bloc before 1990 and are now members of the European Union, i.e. Bulgaria (BG), Croatia (HR), Czech Republic (CZ), Estonia (EE), Hungary (HU), Lithuania (LT), Latvia (LV), Poland (PL), Romania (RO), Slovakia (SK) and Slovenia (SI). NUTS2 level regions have been chosen as of reference for the analysis, as they have proven to be meaningful levels for regional policy analysis.

The reminder of the paper is organized as follows: Section 2 outlines the research method and presents the categorization of CEE regions using economic and innovation-related variables; in Section 3, the research results are discussed separately for three types of regions: the lagging-behind, the intermediate and the most advanced regions; Section 4 concludes the study and reveals different specific policy recommendations that reside from the proposed typologies.

## 2. Research method

The literature uses two dominant approaches to obtain RIS typologies: the first one deals with case study designs, very few of them being focused on the case of the less developed regions, especially on those with a post state socialism heritage (Blazek et al., 2014). The second approach uses statistical analysis for clustering of regions with similar characteristics or creates innovation scoreboards that measure the innovation performance at different points in time. Our study is centered on this second approach and puts in a comparative perspective seven classifications of European regions based on statistical sources (Table no. 1).

**Table no. 1. Regional innovation system typologies using statistical sources**

| Author (s) | Aim | Conceptual framework | Classification method | Typologies (No) | CEE Regions (N=56) |
|---|---|---|---|---|---|
| Muller et al. (2006) | - to develop a regional typology of innovation capacities in the New Member States and Candidate Countries; | i) knowledge creation,<br>ii) absorptive capacity<br>iii) diffusion capacity<br>iv) demand<br>v) governance capacity | 25 variables; principal components analysis; | 5 | 53 CEE regions<br><br>Not classified: 3 CEE regions |
| Dory (2008) | - to produce a categorisation of the EU25 regions according to their long-term, structural techno-economic characteristics; | i) knowledge creation and absorption capacities;<br>ii) economic structure and industrial specialisation | 13 variables; hierarchical cluster analysis; | 10 | 54 CEE regions<br><br>Not classified: 2 CEE regions |
| Navarro et al. (2009) | - to depict a typology of regions, capturing the diversity of regional innovation systems (RISs) across the EU-25; | i) knowledge generation inputs;<br>ii) structural characteristics of the region (agglomeration economies &social filters);<br>iii) innovation output;<br>iv) economic output | 21 variables; principal components analysis; cluster analysis | 8 | 40 CEE regions<br><br>Not classified: 16 CEE regions |
| Wintjes and Hollanders (2010) | - to highlight the great diversity in development pathways and trajectories of innovation across European regions; | i) the accessibility to knowledge;<br>ii) the capacity to absorb knowledge;<br>iii) the capability to diffuse knowledge and technology | 20 variables; factor analysis; hierarchical clustering analysis | 7 | 54 CEE regions<br><br>Not classified: 2 CEE regions |
| Marsan and Maguire (2011); OECD (2011) | - to highlight the diversity of regional profiles across OECD regions on the purpose of the peer group comparisons; | i) Inputs (financial, capital & human capital);<br>ii) Linkages<br>iii) Outputs: tacit outputs, innovation outputs, economic outcomes | 12 variables; Ward cluster method | 8 | 35 CEE regions<br><br>Not classified: 21 CEE regions |
| Camagni and Capello (2012) | - to identify different territorial patterns of innovation and empirically test their existence in Europe | i) Knowledge and innovation creation;<br>ii) Regional pre-conditions for i);<br>iii) Inter-regional knowledge and innovation flows;<br>IV) Regional preconditions to acquire external knowledge and innovation. | 26 variables; cluster analysis; multinomial logistic regression | 5 | 56 CEE regions |
| Hollanders and Es-Sadki (2017) | - to provide a comparative assessment of performance of innovation systems across 220 regions of EU Member States, Norway, Serbia and Switzerland. | i) Framework conditions<br>ii) Investments<br>iii) Innovation activities<br>(iv) Impacts | 18 variables; aggregated in a composite indicator | 12 | 56 CEE regions |

*Source*: authors' elaboration

As reveled in the Table no. 1, most of the proposed typologies aim to capture the diversity in territorial innovation patterns across Europe (and OECD regions) using indicators that are related to both the regional conditions and the innovation inputs, processes and outputs. There is a large consensus in the literature that the regional

economic conditions (regional GDP, unemployment, agglomeration, accessibility etc.), the sectoral structure of the economy and the so-called ”social filters” (i.e. educational achievements, human resources in science and technology etc.) have a pivotal role in spurring innovation and growth at the regional level. Almost all typologies consider the investments in research and development (R&D) as proxies for the knowledge creation capacity and use patents and knowledge flows to measure the innovation outputs and linkages. Not last, the economic effects usually are proxied by the growth rates in GDP, exports, new firm formation in fast-growing industries etc. In order to shed light on the features of the CEE regions, we examine the proposed typologies and place each of the 56 NUTS2 regions into a specific category (from A – K, were A is the least developed category). To make the results comparable, we assign each category into one of the three main classes, i.e. ”lagging-regions”, ”intermediate regions” and ”advanced regions” (Table no. 2).

**Table no. 2. Categorisation of CEE regions using economic and innovation-related variables**

| Authors | Lagging-behind regions | No. | Intermediate regions | No. | Advanced regions | No. |
|---|---|---|---|---|---|---|
| Muller et al. 2006 | Lagging-behind agricultural regions (A) | 10 | Skilled manufacturing platforms regions (C) | 10 | Regions with tertiary growth potential (D) | 9 |
| | Industrially challenged regions (group B) | 17 | | | Capital regions (E) | 7 |
| Dory, 2008 | Predominantly agricultural (A) | 26 | Re-industrialising (D) | 22 | High-income industrial leaders (G) | - |
| | Diversified agro-industrial (B) | - | Newly industrialised (E) and diversified (F) | - | Diversified high- income economies (H) | - |
| | Tourism- based (C) | - | Restructuring industrial (G) | 6 | Service-based high income economies (I) | - |
| Navarro et al. (2009) | Peripheral agricultural regions with a strong economic and technological lag (A) | 20 | Central regions with an intermediate economic and technological capacity (D) | 1 | Service-oriented regions with a certain economic and techno-logical capacity (F) | 1 |
| | Restructuring industrial regions with strong weaknesses (B) | 12 | Industrially restructured regions with a certain economic and techno-logical capacity (E) | - | Technologically advanced region with an industrial specialization (G) | - |
| | Peripheral regions with an economic and technological lag (C) | 5 | - | - | Service-oriented innovative and capital regions (H) | 1 |
| Wintjes and Hollanders (2010) | Traditional Southern EU regions (A) | - | Knowledge absorbing regions (C) | - | Metropolitan knowledge-intensive services regions (F) | - |
| | Skilled industrial Eastern EU regions (B) | 44 | Skilled technology regions (D) | 2 | High-tech regions (G) | - |
| | | | Public knowledge centres (E) | 8 | | |
| Marsan and Maguire (2011); OECD, 2011 | Primary-sector-intensive regions (A) | 13 | Medium-tech manufacturing and service providers (D) | 1 | US states with average S&T performance (F) | - |
| | Structural inertia or de-industrialising regions (B) | 9 | Service and natural resource regions in knowledge-intensive countries (E) | 1 | Knowledge and technology hubs (G) | 1 |
| | Traditional manufacturing regions (C) | 10 | | | Knowledge- intensive city/capital districts(H) | - |
| Camagni and Capello (2012) | The imitative innovation area (A) | 29 | The smart technological application area (C) | 7 | The applied science area (D) | 2 |
| | The smart and creative diversification area (B) | 18 | | | The European science-based area (E) | - |
| Hollan-ders and Es-Sadki (2017) | Regional Modest Innovators – (A) | 8 | Regional Moderate Innovators (E) | 9 | Regional Strong Innovators + (I) | - |
| | Regional Modest Innovators (B) | 9 | Regional Moderate Innovators + (F) | 9 | Regional Innovation Leaders – (J) | - |
| | Regional Modest Innovators + (C) | 4 | Regional Strong Innovators – (G) | 2 | Regional Innovation Leaders (K) | - |
| | Regional Moderate Innovators – (D) | 14 | Regional Strong Innovators (H) | 1 | Regional Innovation Leaders + (L) | - |

*Source*: authors’ elaboration

Three other classifications were used only partially in our analysis as they reflect exclusively the economic component (EC, 2014/99/EU; EC SWD, 2017) or the innovation component (Blazek and Kadlec, 2018) and not a combination of the two. The EU Regulation No 2303/2013 laying down the common provisions for the European Structural and Investments Funds 2014 – 2020 delimitates three categories of regions (NUTS2) based on their GDP per capita measured in purchasing power parities (PPS), namely: the ”less developed regions”, whose GDP per capita is less than 75% of the average GDP of the EU-27, the ”transition regions”, whose GDP per capita is between 75% and 90% of the average GDP of the EU27 and ”more developed regions”, whose GDP per capita is above 90% of the average GDP of the EU-27 (Article 90). 50 out of the 56 regions in Central and Eastern Europe are classified as ”less developed regions”, while six of them – the capital regions of the Czech Republic, Hungary, Poland, Romania, Slovenia and Slovakia fall within the ”more developed regions” category. It should be noted here the fact that the Baltic countries – Estonia, Latvia and Lithuania – are assimilated to NUT2 regions (EC 2014/99/E). More recently, ”The lagging regions” report launched in June 2015 by the European Commission to examine the factors that hold back growth and investments in Europe defines, for analytical purposes, two types of lagging regions. The ”low-growth regions” are those regions with GDP per capita up to 90% of the EU regions that did not converge to the EU average between 2000 and 2013, while the ”low-income regions” cover all the regions with a GDP per head in PPS below 50% of the EU average in 2013. 19 regions in Central and Eastern Europe are classified as ”low-income regions”, most of them being located in Bulgaria, Hungary, Poland and Romania (EC SWD, 2017). Another typology which is useful to our analysis is the one proposed by Blazek and Kadlec (2018), who classify the European regions based on their prevailing knowledge bases and the key segments of R&D systems into three categories: ”public R&D”, ”private R&D” or ”mixed R&D” (no dominance of the public or private sector). Out of the 56 CEE regions, R&D systems in 26 regions are dominated by the public sector, eight regions are dominated by the private sector and 10 regions combine public and private R&D (12 regions are not classified).

Annex 1 presents the economic status (EC, 2014/99/EU; EC SWD, 2017) and the R&D status of each NUTS2 region at the CEE level (Blazek and Kadlec, 2018); in addition, it reveals the categories assigned to each region in the proposed typologies (Table no. 2) and provides a general score for research, development and innovation (RDI score) that was computed as follows: we assigned a score of 1 to each A, a score of 2 to each B etc. and computed the average RDI score for each region. The RDI scores range from 1,14 (PL33/72) to 6,14 (CZ01), with large variations both between countries and the regions within the countries, which are detailed in the following sections.

**3. Research results**

Table no. 2 and Annex 1 give a synthetic overview of the performance of the regional innovation systems in Central and Eastern Europe. Most of the regions fall within the first categories two or three categories in all the proposed typologies and are characterized as being ”lagging-behind”, ”peripheral” or ”modest” innovators. At the other end of the spectrum, the number of regions classified as ”advanced” ranges from zero to two, except for the typology proposed by Muller et al. (2006), which is to some extent biased by the fact that considers exclusively the CEE regions and not all the European regions. The number of ”intermediate” regions is highly variable, and the boundary between the lagging-behind regions and the intermediate ones is very blurred.

Figure no. 1 illustrates the aggregated scores resulted from the proposed typologies (Annex 1), which are grouped into three categories, using a natural breaks algorithm: the

lagging-behind regions (1,14 – 2,43), the intermediate regions (2,44 – 3,99) and the advanced regions (4 – 6,14).

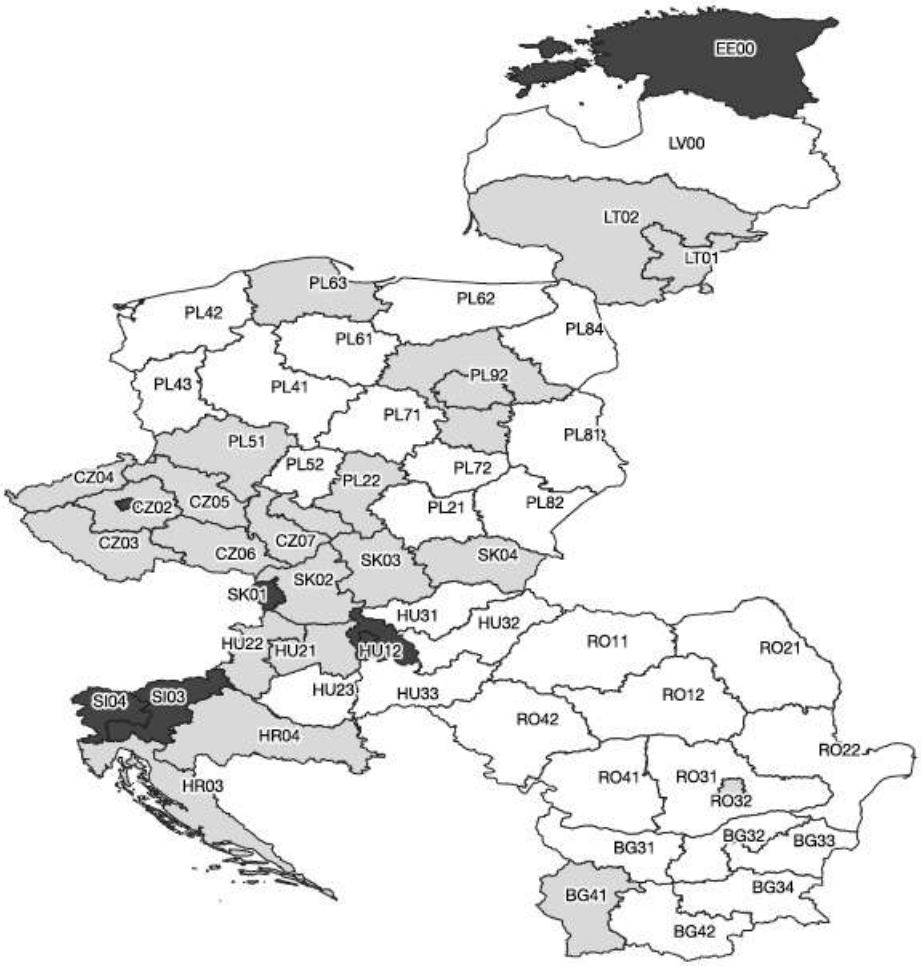


Figure no. 1
**RDI performance in Central and Eastern European regions***

*Own computation based on the scores provided in Annex 1; the darker the color, the higher the RDI performance

**The lagging-behind regions**

The regions with the lowest performances in innovation at the CEE level can be found in Bulgaria, Romania, Latvia, Hungary and Poland. These regions are characterized by the lowest values on most variables, especially with regard to the economic output (GDP/capita) and productivity (Muller et al., 2006; Dory, 2008; Navarro et al., 2009; OECD, 2011); in fact, all the low-income regions identified by the European Commission as ”low-income regions” fall within this category (EC SWD, 2017). The lagging-behind regions appear to suffer from structural problems caused by the weakness of links to both national and global economies (Muller et al., 2006), structural deficiencies in terms of infrastructure and accessibility (Navarro et al., 2009) and the lack of a diversified economic structure. Most of the regions in this group have a very high share of employment in agriculture and are labeled as ”predominantly agricultural” (Dory, 2008),

”lagging-behind agricultural regions” (Muller et al., 2006), ”peripheral agricultural regions with a strong economic and technological lag” (Navarro et al., 2009) or ”primary-sector-intensive regions” (OECD, 2011). At the same time, there are regions in this group with high employment in industry, but with major structural challenges related to this sector, i.e. ”industrially challenged regions” (Muller et al., 2006), ”restructuring industrial regions with strong weaknesses” (Navarro et al., 2009), ”structural inertia or de-industrializing regions”, ”traditional manufacturing regions” (OECD, 2011) etc. Educational attainment and long-life learning appear to be weak or mixed and the regional knowledge absorption capacity is usually insufficiently developed (Muller et al., 2006; Dory, 2008; Navarro et al., 2009; Wintjes and Hollanders, 2010; Hollanders and Es-Sadki, 2017). Meanwhile, the knowledge creation capacity is limited and these ”modest innovators” perform much below the EU average in terms of R&D expenditures (especially in the business sector), linkages between the innovation actors or patenting intensity (Hollanders and Es-Sadki, 2017). In only two regions in this group (PL32 and RO31) there is a dominance of the private R&D over the public R&D, according to typology created by Blazek and Kadlec (2018). Very few positive features are associated to the lagging-behind regions, which should be further considered in policy-making: according to Wintjes and Hollanders (2010), most of the regions in this group are ”skilled” industrial regions, which are rapidly catching up from the low levels of economic performance. In addition, Camagni and Capello (2012) point to the fact that the ”imitative innovation area” (i.e. the regions in Bulgaria, Latvia, Hungary, Poland, Romania and Slovakia) has a high attractiveness of foreign direct investments, while few agglomerated regions in Poland and Slovakia (”the smart and creative diversification”) are strongly endowed with creativity and attractiveness that help to absorb knowledge and to adapt it to local innovation needs.

**The intermediate regions**

The intermediate regions can be found in the Czech Republic, Croatia, Hungary and Lithuania, but also in the capital regions of Bulgaria, Romania and Poland. The regions in this group are characterized as being ”low-to-medium” income economies (Dory, 2008), whose model of integration was based on ”static” relative advantages, i.e. lower costs in all production factors (Muller et al., 2006). They benefit highly from the relocation of European industries (Dory, 2008) or from the above average accessibility to knowledge in the case of metropolitan areas; as such, they are undergoing a strong structural change, thus being labeled as ”re-industrializing regions”, ”restructuring industrial regions” (Dory, 2008), ”skilled manufacturing platforms” (Muller et al., 2006), ”smart technological application areas” (Camagni and Capello, 2012) or ”public knowledge centres” (Wintjes and Hollanders, 2010) in the case of capital regions. Intermediate regions have moderate knowledge creation capacities (Muller et al., 2006) – they are ”modest innovators” according to Hollanders and Es-Sadki (2017). The public knowledge base is fairly strong, the medium – to – high manufacturing sectors have taken a larger role in the economy and the quality of human resources is substantially higher than in the case of the lagging-behind regions (Dory, 2008). Even if the R&D performance is still modest when compared to the European strong innovators, intermediate regions (”moderate innovators”) have well-above the EU average performances across a number of indicators – i.e. non-R&D innovation expenditures, trademark applications and sales due to new-to-market and new-to-firm innovations (Hollanders and Es-Sadki, 2017), which is pivotal in explaining their relatively high non-R&D innovation performances. Moreover, according to Camagni and Capello (2012), such regions have a high creativity, which could allow translate external knowledge into innovation.

**Advanced regions**

Estonia, Slovenia and the capital regions of the Czech Republic (Prague), Hungary (Budapest) and Slovakia (Bratislava) are the sole regional ”pockets of excellence” that can be identified at the CEE level. By far, the Prague region is ranked the highest in almost all the proposed typologies and the Regional Innovation Scoreboard 2017 highlights the fact that its innovative performance is 75% higher than of the lowest performing region in the Czech Republic (CZ04) (Hollanders and Es-Sadki, 2017). According to Camagni and Capello (2012), Prague and Estonia are ”the notable exceptions” at East that belong to the ”Applied science area”, which is made of strong knowledge production regions, with a high degree of knowledge coming from regions with a similar knowledge base. At the same time, the capital regions of Slovenia and Slovakia are classified as ”regional strong innovators”, while Budapest, the capital region of Hungary is a ”regional moderate innovator+” (Hollanders and Es-Sadki, 2017). According to Muller et al. (2006), the capital regions can be seen as ”service centres” of other regions and the ”elements for future knowledge-based Europe”, as they have a higher proportion of high-tech services and a higher share o population with tertiary education; yet, they have not developed so far as knowledge providers to the global economy.

**4. Discussions and conclusions**

Developing regional typologies of innovation is not a purpose in itself, but a mean to identify differentiated policy responses and to abandon the ”one-size-fits-all” solutions, which are proved to fail to yield the anticipated results (Todtling and Trippl, 2005). There is a large consensus in the literature that the factors shaping the economic performance of regions with variable levels of development differ considerably (Rodriguez-Pose and Ketterer, 2018). As such, different specific policy recommendations reside from the proposed typologies, all acknowledging the fact that ”strong growth is possible in all types of regions” (OECD, 2012).

**Address first the macro-structural weaknesses.**

Most of the proposed typologies agree with the idea that the lagging-behind regions need to achieve ”a certain degree of maturity” to be able to put in place innovation-based regional development strategies (Dory, 2008). Such regions ”appear as requiring cohesion policy efforts rather than scientific excellence” (Muller et al., 2006), so they need to reduce first gaps in physical and digital infrastructure (EC SWD, 2017). As among the less developed regions, those growing faster than the national average appear to have more infrastructure (OECD, 2012), tackling the infrastructure deficit should be addressed in the early stage of any development strategy, on condition that the aid is limited in time and is matched to similar efforts to enhance human resources (Rodriguez-Pose and Ketterer, 2018). Non-science and technology driven regions need also support the socio-economic transformations (OECD, 2011), restructure ”the obsolete industrial structure” and bring a change into the local economy (Navarro et al., 2009). Developing ”niche strategies” for industrial development and finding general schemes of development – e.g. a shift to organic-food sectors, manufacturing-based upgrading, improvement of service-related technologies etc. – are among the recommended actions for the lagging-behind agricultural regions and for the industrially challenged regions (Muller et al., 2006). Not last, improving the regional business environment should be considered, to stimulate the smaller and less productive firms in the lagging-regions (Farole et al., 2018).

**Invest in human capital and skills and improve the regional absorption capacity.**

Evidence on long-term economic dynamics of the EU regions shows that human capital is one of the strongest predictors of regional growth for any type of region. Yet, the

positive effect on economic growth of highly educated people is found to be stronger in the less developed regions of EU13 (Central and Eastern European countries plus Cyprus and Malta) than in the rest of Europe (Annoni and Rubianes, 2016). The skilling of the workforce should therefore be a preeminent element of any development strategy; otherwise, as stated by Rodriguez-Pose and Ketterer (2018), ”without a properly trained workforce, many low-income regions in many Europe may remain stuck among the innovation averse and even become low-growth in time”. Investing in skills should therefore be ”a no-regrets policy” for the lagging regions (Farole et al., 2018), which should reinforce access to know-how and long-life learning (Muller et al., 2006), reverse the trend of out-migration of the younger and more educate population (EC SWD, 2017) and acknowledge the crucial roles of universities and providers of vocational education and training in the less developed innovation ecosystems (EC COM, 2017). What is also important to note is the fact that in the case of lagging regions, reducing the proportion of persons with very low skills seems more important than increasing the share of high skills levels (OECD, 2012) because, as explained by Annoni and Rubianes (2016), a high share of the labour force without an upper secondary education has a negative impact on regional economic growth. Meanwhile, according to Camagni and Capello (2012), it is also important to orient the investments towards the knowledge domains in which the region hopes to excel and not towards general education and training policies.

**Adopt the broader view of innovation and focus on technology adoption and absorption.**

There is a large consensus in the literature that ”R&D support is not the most natural goal” for peripheral, lagging regions (Dory, 2008), as R&D proves to matter more in regions close to the productivity frontier (OECD, 2012). Such regions are highly recommended to ”target the broader process of knowledge generation” (Blazek and Kadlec, 2018) and to focus more on technology adoption and absorption, which are more important than R&D (Annoni and Rubianes, 2016). For example, the imitative innovation regions are expected to gain maximum return to innovation from providing incentives to attract multinational corporations and to encourage them to develop creative projects with local firms (Camagni and Capello, 2012); similarly, non-science and technology regions are recommended to focus on innovation diffusion and attract branches of national research organizations, while trying to develop a latent demand for innovation (OECD, 2011). Enhancing the private technology and improving the system of technology intermediaries (i.e. technology centers) are also included among the desirable policy options (Wintjes and Hollanders, 2010). Other crucial factors for such regions are to reach a critical mass of activities and concentrate on endogenous strengths (Dory, 2008), to improve the interactions among businesses and between the productive sector (EC SWD, 2017) and to capitalize more from involvement in EU learning networks (Navarro et al., 2009). To this end, strengthening the ability to ensure access to national and supranational funding (Muller et al., 2006) is of a crucial importance.

**Improve institutions and governance and implement smart specialization strategies.**

Smart specialization emerges as the new innovation policy paradigm at the European level, whose main purpose is to ensure that ”public resources are targeted at areas which are likely to bring the best returns in terms of raising the innovation level in all parts of Europe” (EC COM, 2017). Smart specialization is particularly relevant for the less developed regions, as its purpose is to address the weaknesses in innovation systems, i.e. the weak governance, the insufficient levels of information flows, inter-regional collaboration, integration in global value chains etc. Strengthening institutional endowments and the regional administrative capacity is seen as ”fundamental to expanding

regional potential" (Farole et al., 2018) and to establishing an environment that "is conducive to growth and investments" (EC SWD, 2017). Such regions are strongly encouraged to take a collective effort of self-assessment using participative approaches (Muller et al., 2006), to establish new institutions - e.g. consultancy services and innovation management for small and medium enterprises (Navarro et al., 2009) and to launch "a gradual process of policy learning" (Blazek and Kadlec, 2018).

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**Annex I**
**Categorisation of CEE regions by economic status and RDI score & status**

| NUTS 2 2013* | NUTS 2 2016* | Economic status** EC 2014, EC SWD 2017 | Dory 2008 | Muller et al. 2006 | Navarro et al. 2009 | Wintjes & Hollanders 2010 | Marsan &Maguire 2011 | Camagni & Capello 2012 | Hollanders & Es-Sadki 2017 | RDI Status Blazek & Kadlec, 2018 | RDI Score *** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **(BG) Bulgaria** | | | | | | | | | | | |
| BG31 | BG31 | LDR-LI | A | B | N/A | E | N/A | A | B | N/A | 2,20 |
| BG32 | BG32 | LDR-LI | A | B | N/A | B | N/A | A | B | N/A | 1,60 |
| BG33 | BG33 | LDR-LI | A | B | N/A | E | N/A | A | B | N/A | 2,20 |
| BG34 | BG34 | LDR-LI | A | E | N/A | B | N/A | A | B | N/A | 2,20 |
| BG41 | BG41 | LDR | A | B | N/A | E | N/A | A | D | N/A | 2,60 |
| BG42 | BG42 | LDR-LI | A | B | N/A | B | N/A | A | D | Public | 2,00 |
| **(CZ) Czech Republic** | | | | | | | | | | | |
| CZ01 | CZ01 | MDR | G | E | H | E | G | D | G | Public | 6,14 |
| CZ02 | CZ02 | LDR | D | C | B | B | C | B | F | Private | 3,14 |
| CZ03 | CZ03 | LDR | D | C | B | B | C | C | F | Mixed | 3,29 |
| CZ04 | CZ04 | LDR | D | B | B | B | C | B | F | Private | 3,00 |
| CZ05 | CZ05 | LDR | D | C | B | B | C | C | F | Private | 3,29 |
| CZ06 | CZ06 | LDR | D | C | C | B | C | C | F | Mixed | 3,43 |
| CZ07 | CZ07 | LDR | D | C | B | B | C | C | F | Mixed | 3,29 |
| CZ08 | CZ08 | LDR | D | B | B | B | C | C | E | Private | 3,00 |
| **(EE) Estonia** | | | | | | | | | | | |
| EE00 | EE00 | LDR | G | D | C | B | N/A | D | E | Public | 4,17 |
| **(HR) Croatia** | | | | | | | | | | | |
| HR03 | HR03 | LDR | N/A | N/A | N/A | N/A | N/A | B | D | N/A | 3,00 |
| HR04 | HR04 | LDR | N/A | N/A | N/A | N/A | N/A | B | D | N/A | 3,00 |
| **(LV) Latvia** | | | | | | | | | | | |
| LV00 | LV00 | LDR | A | D | A | B | N/A | A | E | Public | 2,33 |
| **(LT) Lithuania** | | | | | | | | | | | |
| LT00 | LT01 LT02 | LDR | A | D | A | B | N/A | B | E | Public | 2,50 |
| **(HU) Hungary** | | | | | | | | | | | |
| HU10 | HU11 HU12 | MDR | G | E | D | E | D | A | F | Mixed | 4,57 |
| HU21 | HU21 | LDR | D | B | B | B | C | A | E | Private | 2,71 |
| HU22 | HU22 | LDR | D | B | B | B | C | A | D | Mixed | 2,57 |
| HU23 | HU23 | LDR-LI | D | C | A | B | B | A | D | Mixed | 2,43 |
| HU31 | HU31 | LDR-LI | D | B | B | B | B | A | D | Private | 2,43 |
| HU32 | HU32 | LDR-LI | D | C | A | B | B | A | D | Mixed | 2,43 |
| HU33 | HU33 | LDR-LI | D | C | A | B | A | A | E | Mixed | 2,43 |
| **(PL) Poland** | | | | | | | | | | | |
| PL11 | PL71 | LDR | A | D | A | B | A | B | D | Public | 2,14 |
| PL12 | PL91 PL92 | MDR | A | E | C | E | A | B | E | Pubic | 3,14 |
| PL21 | PL21 | LDR | A | D | A | B | A | B | D | Public | 2,14 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PL22 | PL22 | LDR | D | C | A | B | B | B | D | Public | 2,57 |
| PL31 | PL81 | LDR-LI | A | D | A | B | A | A | C | N/A | 1,86 |
| PL32 | PL82 | LDR-LI | A | A | A | B | A | A | D | Private | 1,57 |
| PL33 | PL72 | LDR-LI | A | A | A | B | A | A | A | Public | 1,14 |
| PL34 | PL84 | LDR-LI | A | A | A | B | A | A | B | Public | 1,29 |
| PL41 | PL41 | LDR | A | D | A | B | A | B | C | Public | 2,00 |
| PL42 | PL42 | LDR | D | B | A | B | B | B | C | N/A | 2,29 |
| PL43 | PL43 | LDR | D | B | A | B | A | B | B | Public | 2,00 |
| PL51 | PL51 | LDR | D | D | A | B | B | B | D | Public | 2,71 |
| PL52 | PL52 | LDR | A | B | A | B | A | A | B | Public | 1,43 |
| PL61 | PL61 | LDR | A | B | A | B | A | A | B | Public | 1,43 |
| PL62 | PL62 | LDR-LI | A | B | A | B | A | A | B | N/A | 1,43 |
| PL63 | PL63 | LDR | D | D | A | B | B | B | D | Public | 2,71 |
| (RO) Romania | | | | | | | | | | | |
| RO11 | RO11 | LDR-LI | A | A | N/A | B | N/A | A | A | Public | 1,20 |
| RO12 | RO12 | LDR | A | A | N/A | B | N/A | B | A | Public | 1,40 |
| RO21 | RO21 | LDR-LI | A | A | N/A | B | N/A | A | A | Mixed | 1,20 |
| RO22 | RO22 | LDR-LI | A | A | N/A | B | N/A | A | A | N/A | 1,20 |
| RO31 | RO31 | LDR-LI | A | A | N/A | B | N/A | A | A | Private | 1,20 |
| RO32 | RO32 | MDR | D | E | N/A | E | N/A | B | C | Public | 3,80 |
| RO41 | RO41 | LDR-LI | A | A | N/A | B | N/A | A | A | N/A | 1,20 |
| RO42 | RO42 | LDR | A | A | N/A | B | N/A | B | A | Public | 1,40 |
| **(SI) Slovenia** | | | | | | | | | | | |
| SI03 | SI03 | LDR | G | N/A | C | D | N/A | C | F | Public | 4,60 |
| SI04 | SI04 | MDR | G | E | C | D | N/A | C | G | Mixed | 5 |
| **(SK) Slovakia** | | | | | | | | | | | |
| SK01 | SK01 | MDR | G | E | F | E | E | B | H | Public | 5,57 |
| SK02 | SK02 | LDR | D | B | B | B | C | A | E | Public | 2,71 |
| SK03 | SK03 | LDR | D | B | B | B | B | A | E | Public | 2,57 |
| SK04 | SK04 | LDR | D | C | B | B | B | A | F | Public | 2,86 |

Source: authors' elaboration

* NUTS2 (2013) are used in all the classifications presented in this paper; NUTS2 (2016) are used to configure Map 1 and Map 2;
** LDR = less developed region; LDR-LI = less developed, low-income regions; MDR = most developed regions
*** The RDI score represents the average values resulted from all the classifications, where A=1, B=2, C=3, D=4, E=5, F=6, G=7, H=8