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Transforming innovation models in European regions: Breaking out of path dependency and growing faster?

Abstract
The aim of the paper is to verify whether a change in innovation model by less-developed regions may speed up development processes and if innovativeness plays crucial role in these processes. Cluster analysis conducted for the years 1994-2014 showed that the majority of less-developed regions in 1994-2000 that experienced significant growth by 2011-2014 changed their innovation models. Logit regression confirmed that innovation factors play a crucial role in high growth rates. The findings suggest that less-developed regions can break out of path dependency by increasing their shares of high-tech industries and employment in science and technology and boosting technology transfer, which usually involves changing and improving their innovation models.

Keywords
Regional development • development path • path dependency • less-developed region • innovation model • innovativeness

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Introduction

The aim of this paper is to test whether a change in regional innovation models could speed up the development process in less-developed regions and if regional innovation potential plays a crucial role in the process. Regions develop at different rates, and a variety of endogenous and exogenous factors shape their development paths. Although Ulaşan (2012) claims that none of these factors is more significant than the others, since Schumpeter (1934) identified the role of innovative entrepreneurs in regional development, innovative activity has become the most effective way for regions to grow. Subsequent theories confirmed the role of innovativeness in speeding up the development process. The neoclassical growth theory introduced by Solow and Swan showed that exogenous technological progress is the only factor that can make growth sustainable in the long term (Solow 1988). *New growth theory* states that technological progress is endogenic; it may come from research and development carried out by firms in-house, not outside these firms. This theory stresses the role of such factors as human capital, innovation, learning by doing, and knowledge spillovers in stimulating economic growth (Lucas 1988, Romer 1990). These growth and development theories were the basis for the creation of neoclassical and endogenic regional growth theories, as well as theories that identify imbalances in the development levels that are the main sources of growth of neighbouring regions (Capello & Nijkamp 2009). Such theories include the *growth pole theory* by Perroux (1950), Hirschman's (1958) *theory of polarized development*, Myrdal's (1968) *theory of cumulative causation*, and Friedmann and Weaver's (1977) *centre-periphery theory*. The spatial dimension of regional development in which imbalances play the role of catalyst has become one of the most important areas of research.

Historical issues such as technological, institutional and social legacies and major positive and negative events that occurred within the region in the past have also become crucial, not only in understanding the endogenous potential of a region and its role in development (Garretsen & Martin 2010), but also in finding out how much a region is locked-into the existing development path (Boschma 2007). In particular, gaining an insight into path dependency has become crucial to understanding why less-developed regions are not growing faster than other, more-developed regions, as only a few have broken out of their paths (Pylak 2015). Theoretically, less-developed regions may still increase their level of innovation (Cooke 2007) and break out of path dependency through shocks and/or evolutionary processes driven by exogenous forces (Boschma 2015), leading to changes in their economic structures and innovation systems. Thus, we hypothesize that less-developed European regions have historically achieved faster growth than other regions only through factors related to innovation and the upgrading of the regional innovation system's entire innovation model.

Research methodology

To test the abovementioned hypotheses, we conducted a two-phase analysis using available statistical data for European regions at the second level of the Nomenclature of Territorial Units for Statistics (NUTS2) for the years 1994–2014. First, we implemented cluster analysis to test whether regions that were

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relatively less-developed at the beginning of the period and that had grown faster than others during the period, had changed their innovation models. We applied the concept of innovation models in a similar way to Ajmone and Maguire (2011). Different classes of innovation model reflected different generalised types of innovation systems in regions described by different values for variables referring to the following subsystems: (1) economic structure, especially the number of high and medium-high-tech manufacturing industries—with the latter sometimes characterised by a higher research and development (R&D) intensity than the high-tech industries, such as in the case of Poland (see, for example, Wojnicka-Sycz 2013)—and the share of knowledge-intensive services (KIS) and less knowledge-intensive services (LKIS); (2) inputs and resources for R&D, including the proportion of GDP spent on R&D, the proportion of business expenditures as part of total R&D outlays, the proportion of people employed in science and technology as part of the economically active population, and the proportion of the population with tertiary education; and (3) the outputs of R&D, including the number of patents and the GDP level, which is a result of innovativeness and a measure of the effectiveness of regional economies (see Markowska & Strahl 2012). Therefore, we could indicate classes of innovation models that were the most technologically advanced and that achieved high GDP growth over the period. We then determined if variables related to innovation are responsible for speeding up this development by applying logit regression to 60% of the regions that had an average gross domestic product (GDP) per capita for the year 2000. To avoid gaps in the statistical data, we chose one year from the 1994–2000 range and one year from the 2011–2014 range that had the fewest omissions of information for each variable.

A significant amount of missing data concerning the above variables made it necessary to remove several regions from the analysis, including at least one region from each country and all the Greek regions. The total number of regions analysed was 173. Variables expressed in relative terms were included in our analysis as they were, while variables expressed in absolute terms were standardised to make them comparable using formula (1):

$$x_i = 1 - \frac{(-1)(z_i - max_z)}{(max_z - min_z)} \qquad (1)$$

where x_i is the standardised variable, z_i is the original value of the variable *z* for region *i*, and max_z/min_z is the maximum/minimum value of the variable *z* for all analysed regions.

Groups of regions with similar regional innovation models and their transitions

We conducted cluster analysis, using k-means with the Euclidean distance measure and six clusters indicated, to categorise regions with similar innovation models (described by the abovementioned variables) at both the beginning (1994–2000) and the end (2011–2014) of the analysed period as well as to find regions that had developed by changing their innovation models.

We assumed that more-developed regional innovation models would be reflected mainly in higher values of the variables related to the three abovementioned areas: economic structure; inputs and resources for R&D; and R&D outputs, particularly high proportions of high-tech industries and KIS, and, to a lesser extent, high proportions of medium-high-tech industries and LKIS market services. We labelled innovation models from 1 (the most developed) to 6 (the least developed). We also determined that the six innovation models identified in our research formed four classes of innovation models (A–D, with A being the most developed) at the beginning of the analysed period (1994–2000) and three at the end of the period (2011–2014). The clusters were grouped into classes of innovation models that were similar according to R&D outputs, but with different economic structures and R&D inputs, and resources that contributed to these outputs. The C and D classes of innovation model for the years 1994–2000 were combined to make the C/D class for 2011–2014. The transition of a few regions from class C to class B in 2011–2014 caused the merging of these two classes, as this lowered the average value of the variables for the remaining regions in class C and necessitated their assimilation into class D (see Appendix).

The innovation models in class A consist of two clusters of regions (Nos. 1 and 2). Cluster no. 1 consisted of 30 regions in 1994–2000 and 26 regions in 2011–2014. These regions are wealthy regions with the highest GDPs per capita thanks to their modern market services and high-tech manufacturing, qualified and highly educated people who are employed in the science and technology fields, high R&D outlays in relation to GDP, and average proportions of business expenditures in total R&D, with average activity in patenting. This cluster includes capitals of the old European Union (EU) member countries, a few capital regions from the new EU member countries (Prague, Budapest and Bratislava), and the French region Rhône-Alpes—one of the most innovative regions in the world (Voyer 1998).

Cluster no. 2 included 12 regions in 1994–2000 and 13 regions in 2011–2014, wealthy regions with high GDPs per capita and modern industries, standing out in terms of high proportions of employment in high and medium-high technology, with strong patent activity and the highest intensity of R&D in relation to GDP, high endowments of qualified human resources, and the highest proportion of business outlay as part of total R&D spending.

Class B innovation models also consist of two clusters (Nos. 3 and 4). Cluster no. 3 consisted of 20 German regions in 1994–2000 that were moderately wealthy regions with low proportions of market services in employment and moderate proportions of advanced industry but quite strong patent activities and high endowments in human resources. In turn, the second cluster in this class, cluster No. 4, consisted of 46 moderately rich regions in 1994–2000. The regions were characterised by high proportions of market services, modern industry, moderate endowments in human resources and moderate R&D outlays in relation to GDP, with high proportions of business outlay as part of total R&D spending as well as moderate patent activity.

These two clusters constituting class B innovation models were more like each other in 2011–2014 than in 1994–2000. Cluster no. 3 had a higher proportion of business R&D as part of total R&D outlays, and patent activity than cluster no. 4, which may suggest a predomination of applied research in regions of this cluster. However, cluster no. 3 was also characterised by lower proportions of high and medium-high-tech manufacturing, proportions of people with tertiary education, and proportion of R&D outlays as a percentage of GDP, than cluster no. 4. Both clusters had high proportions of KIS and LKIS market services, high proportions of people employed in science and technology as a percentage of the active population, and medium-high intensity of R&D outlay in relation to GDP.

Cluster no. 5 in the class C innovation model consisted of 49 regions in 1994–2000. The cluster includes medium-poor regions with low R&D expenditure and patent activity, low proportions of business R&D as part of total R&D outlays, moderate qualities of human resources, quite high proportions of high-tech industry and services in employment, and strong market services. At the end of the analysed period, the cluster consisted of 26 regions, as 13 regions had moved to clusters 3 and 4.

Cluster no. 6 in the class D innovation model in 1994–2000 included 16 poor regions characterised by very weak R&D

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activity in relation to GDP and patent applications, with very high proportions of business in total R&D, a lack of public support for R&D, and low overall R&D activity. Regions in this cluster were also characterised by very weak endowments in qualified human resources and the weak development of high-tech industries but high proportions of medium-high-tech industries, and high proportions of employment in LKIS market services. Interestingly, the average GDP per capita in this cluster increased slightly during 2011–2014 and exceeded the GDP per capita of cluster no. 5 because 13 more-developed regions moved from cluster no. 5 to clusters 3 and 4.

Regions that made development leaps to better innovation models in 1994–2014

The most significant development leap was observed in the Bucuresti-Ilfov region, which moved from class C to class A and achieved the greatest improvement in the regions' rankings in terms of GDP per capita in 2011 compared to 2000. We also observed less spectacular development leaps from class C to class B innovation models in the case of the more- and less-developed regions experiencing different growth dynamics, as follows:

- Among the weak regions, with a GDP per capita below the median in 1994–2000, that had a strong increase in GDP (at least a 10-position increase in the ranking of EU regions in terms of GDP per capita) were Brandenburg, Eesti (Estonia), Galicia, Principado de Asturias, Mazowieckie, Dolnoslaskie, and Nord-Pas-de-Calais.
- Among the weak regions, with GDP per capita below the median in 1994–2000, that had no significant increase in position in terms of GDP were Lorraine, Poitou-Charentes, Languedoc-Roussillon, Pomorskie, Northumberland, Tyne and Wear, Devon, West Wales, and The Valleys.
- Among the strong regions, with GDP per capita above the median in 1994–2000, that had no significant increase in position in terms of GDP were Tirol, Champagne-Ardenne, Liguria, Veneto, Friuli-Venezia Giulia, and Lazio.

The more-developed regions (with GDP per capita higher than the median in 1994–2000) that made development leaps from class B to class A innovation models were as follows:

- Those with significant increases in position in terms of GDP per capita were Mittelfranken, Unterfranken, Schwaben and Gießen (Giessen).
- Those without significant increases in position in terms of GDP per capita were Vorarlberg, and Prov. Antwerpen (Province of Antwerp).

Finally, to test the stated hypothesis, we needed to analyse the less-developed regions that had strong increases in their positions in terms of GDP per capita. Out of 12 such regions, 7 regions upgraded their innovation models to a higher class, 4 remained in the same class and only 1 region fell to a lower class. This finding suggests that upgrading the innovation model, which involves increasing different variables related to R&D activity and modernising the economic structure, might cause significant growth in GDP per capita in less-developed regions. This finding is also in line with theories indicating that innovation and technical progress are crucial factors in the growth and development of countries and regions (cf. Lucas 1988, Romer 1990, Schumpeter 1939, Solow 1988). It also contradicts some recent analysis, especially connected with the smart specialization phenomenon, that less developed regions should not try to invest in high-tech industries and the research connected with them but rather try to use high technology in traditional industries (see Camagni, Capello 2013). Our findings suggest that in some less-developed regions efforts in economic renewal may cause huge growth. Moreover, the direct impact of technology and R&D expenditure on the rate of GDP growth is not always noticeable, especially at the level of countries (as in the case of Sweden, which experienced very slow GDP growth while expenditures on R&D were very intense in terms of GDP over a long period). Conversely, Poland has experienced low innovation activity and relatively high rates of GDP growth in previous years. Hence, deliberation on the connection between technology and innovation activity, and the possibility of changing the development path to achieve high growth, is still important.

The testing of innovation factors' impact on development leaps

To test the hypothesis concerning the impact of innovation factors on regions' developmental leaps, we conducted a logit regression for 60% of the regions that had an average GDP per capita in 1994–2000 because Pylak (2015) observed that changes in innovation models happen primarily in average regions. In accordance with Greene (2003), we used logit regression with a binary explained variable where '1' indicated that a region increased its position in the ranking of EU regions from 1994 to 2014 by at least 10 places and '0' indicated a change of fewer than 10 positions or a decrease in position. In the analysis, we compared the average values of variables in two groups of regions: (1) regions that increased their positions in the ranking of GDP per capita by at least 10 places for the period 1994–2014, and (2) regions that experienced a decrease in position or lacked significant change.

Table 1. Logit regression analysis with the explained variable of an increase of at least ten positions in the ranking of regions according to GDP per capita in 2011 compared to 2000

Explanatory variables	Coefficient
Constant	–25.50***
Change in gross capital formation per person employed 2011/2004	23.20***
Dynamics of proportion of high-tech industries in employment 2013/1994	0.05***
Dynamics of proportion of knowledge-intensive market services 2013/1994	–0.04***
Dynamics of proportion of people with tertiary education and employed in science and technology as part of the active population 2013/1999	0.08***
Dynamics of female activity rate (the percentage of active females in relation to the total female population) 2014/1999	0.16***
McFadden's pseudo R2	0.58

Source: Authors' calculations using Gretl software.
*Note: *** indicates significance level of $p < 0.005$.*

The analysis (see Table 1) showed that the first group of regions had modern industries with more value added per person employed in the manufacturing sector, better quality human resources and stronger R&D and innovation activity (which created stronger innovation systems) than the second group of regions. In particular, the first group was characterized by greater

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industrialisation, a higher proportion of employment in high-tech and medium-high-tech industries, greater R&D and patent activity due to higher R&D spending, a higher proportion of employment in science and technology, a higher proportion of residents with at least secondary education, a greater increase in the number of business units per inhabitant, and a better labour market, than the second group.

Our analysis showed that regions had better chances of experiencing a significant increase in GDP per capita during the analysed period if they increased the following, ceteris paribus:

- gross fixed capital formation per person employed
- the proportion of employment in high-tech industry
- the proportion of persons with tertiary education and employed in science and technology as a percentage of the active population
- the employment rates for females aged 15–64

Because an increase in gross capital formation may reflect technology transfer, we may conclude that the following variables related to innovation caused the significant growth in GDP per capita: an increase in technology transfer volume, an increase in the high-tech industry's share in the economy, and the proportion of people employed in science and technology in the active population.

An increase in the proportion of knowledge-intensive market services in employment lowered a region's chances of experiencing a significant increase in GDP per capita, ceteris paribus. Changes in the number of business units per inhabitant, changes in the proportion of employment in medium-high-technology industries, and changes in the proportion of R&D as part of GDP were not statistically significant in regard to changes in a region's position in the GDP per capita ranking.

Conclusions

The aim of this paper was to test if a change in innovation model by less-developed regions may speed up a region's development processes. Cluster analysis conducted for two periods, 1994–2000 and 2011–2014, showed that many more-developed and less-developed regions with high and low growth rates changed their innovation models. In particular, the majority of regions that were less-developed in 1994–2000, which then experienced significantly high growth rates in 2011–2014, changed their innovation models to a better class. Thus, changing the innovation model increased a region's chances of experiencing faster development. The hypothesis is partly confirmed because there are examples of regions that did not change their models but did experience growth. Interviews carried out in Pomorskie in Poland and Friuli Venezia Giulia in Italy-two of the regions that upgraded their innovation models (Wojnicka-Sycz 2016)-showed that the transformation of the innovation models in these regions was caused by the renewal of the regional innovation policy, including providing a suitable base for innovation and R&D such as academic and R&D centres and qualified human resources, and increasing the propensity to cooperate inside and outside these regions. Moreover, especially in the case of the Pomorskie region, the transformation of the innovation model was complemented by the transformation of the Polish economy as a whole from a centrally controlled system to a market economy, and EU integration, which created a 'window of opportunity' for breaking out of path dependency (Boschma & Frenken 2011).

Additionally, enhancing innovation through the following factors caused significant growth in GDP per capita, confirming the hypothesis regarding the importance of innovation-related factors: an increase in technology transfer volume indicated by gross fixed capital formation per person employed, an increase in high-tech industries' share in the economy, and an increase in the proportion of human resources employed in science and technology. In contrast, increasing the proportion of knowledge-intensive market services lowered the chances that a region would experience significant growth in GDP, while changing the number of business units per inhabitant, changing the proportion of employment in medium-high-technology industries, and changing the proportion of R&D as part of GDP, were not statistically significant in increasing the GDP per capita. Thus, not all aspects of innovation were crucial for rapid GDP growth. Therefore, the precise role of each innovation factor in the development of less-developed regions needs to be analysed in further research.

Acknowledgements

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Appendix

Table 2. The innovation model classes and clusters for regions in 1994–2000 and 2011–2014

Country	Years	1994–2000						2011–2014					
	Class	A		B		C/D		A		B		C/D	
	Cluster no.	1	2	3	4	5	6	1	2	3	4	5	6
Austria	Burgenland (AT)				■						■		
	Niederösterreich (Lower Austria)				■						■		
	Wien (Vienna)	■						■					
	Kärnten (Carinthia)				■						■		
	Steiermark (Styria)				■						■		
	Oberösterreich (Upper Austria)				■						■		
	Salzburg					■						■	
	Tirol (Tyrol)					■ (green)					■ (green)		
	Vorarlberg				■ (green)			■ (green)					

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	Class	A		B		C/D		A		B		C/D	
	Cluster no.	1	2	3	4	5	6	1	2	3	4	5	6
Belgium	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	grey						grey					
	Prov. Antwerpen (Antwerp)				green			green					
	Prov. Limburg (BE)				grey						grey		
	Prov. Oost-Vlaanderen (East Flanders)	grey						grey					
	Prov. Vlaams-Brabant (Flemish Brabant)	grey						grey					
	Prov. West-Vlaanderen (West Flanders)				grey						grey		
Czech Republic	Praha (Prague)	grey						grey					
	Strední Cechy (Central Bohemia)				grey						grey		
	Jihozápad (Southwest)					grey						grey	
	Severozápad (Northwest)						grey						grey
	Severovýchod (Northeast)						grey						grey
	Jihovýchod (Southeast)					grey						grey	
	Strední Morava (Central Moravia)						grey						grey
	Moravskoslezsko (Moravian-Silesian)						grey						grey
Germany	Stuttgart		grey						grey				
	Karlsruhe		grey						grey				
	Freiburg			grey						grey			
	Tübingen		grey										
	Oberbayern		grey						grey				
	Oberfranken			grey						grey			
	Mittelfranken			green				green					
	Unterfranken			green				green					
	Schwaben			green				green					
	Berlin	grey						grey					
	Brandenburg					green				green			
	Hamburg			grey						grey			
	Darmstadt		grey						grey				
	Gießen			green				green					
	Kassel			grey						grey			
	Braunschweig		grey						grey				
	Hannover			grey						grey			
	Lüneburg			grey						grey			
	Weser-Ems			grey						grey			
	Düsseldorf			grey						grey			
	Köln		grey						grey				
	Münster			grey						grey			
	Detmold			grey						grey			
	Arnsberg			grey						grey			
	Koblenz			grey						grey			
	Rheinhessen-Pfalz		grey						grey				
	Dresden			grey						grey			
	Sachsen-Anhalt			grey						grey			
	Schleswig-Holstein			grey						grey			
	Thüringen			grey						grey			
Estonia	Eesti					green				green			
Spain	Galicia					green				green			
	Principado de Asturias (Asturias)					green				green			
	País Vasco (Basque Community)				grey						grey		
	Aragón (Aragon)				grey						grey		

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Country	Years	1994–2000						2011–2014					
	Class	A		B		C/D		A		B		C/D	
	Cluster no.	1	2	3	4	5	6	1	2	3	4	5	6
Spain	Comunidad de Madrid (Madrid)	■						■					
	Castilla-la Mancha (Castile-La Mancha)					■						■	
	Cataluna (Catalonia)				■						■		
	Comunidad Valenciana (Valencian Community)					■						■	
	Andalucía (Andalusia)					■						■	
Finland	Länsi-Suomi (Western Finland)		■						■				
France	Île de France (Parisian Region)	■						■					
	Champagne-Ardenne					▣					▣		
	Picardie (Picardy)				■						■		
	Haute-Normandie (Upper Normandy)				■						■		
	Centre (FR)				■						■		
	Basse-Normandie (Lower Normandy)				■						■		
	Bourgogne (Burgundy)				■						■		
	Nord-Pas-de-Calais					▣				▣			
	Lorraine					▣				▣			
	Alsace				■						■		
	Franche-Comté				■						■		
	Pays de la Loire				■						■		
	Bretagne (Brittany)				■						■		
	Poitou-Charentes					▣				▣			
	Aquitaine				■						■		
	Midi-Pyrénées	■						■					
	Rhône-Alpes	■						■					
	Auvergne				■						■		
	Languedoc-Roussillon					▣				▣			
	Provence-Alpes-Côte d'Azur	■						■					
Hungary	Közép-Magyarország (Central Hungary)	■						■					
	Közép-Dunántúl (Central Transdanubia)				■						■		
	Nyugat-Dunántúl (Western Transdanubia)					■						■	
	Dél-Dunántúl (Southern Transdanubia)					■						■	
	Észak-Magyarország (Northern Hungary)					■						■	
	Észak-Alföld (Northern Great Plain)					■						■	
	Dél-Alföld (Southern Great Plain)					■						■	
Ireland	Border, Midland and Western				■						■		
	Southern and Eastern	■						■					
Italy	Piemonte				■						■		
	Liguria					▣					▣		
	Lombardy				■						■		
	Abruzzo					■						■	
	Campania					■						■	
	Puglia					■						■	
	Sicilia					■						■	
	Sardegna					■						■	
	Veneto					▣					▣		
	Friuli-Venezia Giulia					▣					▣		
	Emilia-Romagna				■						■		
	Toscana					■						■	
	Umbria					■						■	
	Marche					■						■	
	Lazio					▣					▣		

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Country	Years	1994–2000						2011–2014					
	Class	A		B		C/D		A		B		C/D	
	Cluster no.	1	2	3	4	5	6	1	2	3	4	5	6
Luxembourg	Luxembourg	■						■					
Netherlands	Groningen	■						■					
	Friesland (NL)				■						■		
	Drenthe				■						■		
	Overijssel				■						■		
	Gelderland	■						■					
	Utrecht	■						■					
	Noord-Holland (North Holland)	■						■					
	Zuid-Holland (South Holland)	■						■					
	Noord-Brabant (North Brabant)		■						■				
	Limburg (NL)				■						■		
Poland	Lódzkie					■						■	
	Mazowieckie					●				●			
	Malopolskie					■						■	
	Slaskie					■						■	
	Wielkopolskie					■						■	
	Lubuskie					■						■	
	Dolnoslaskie					●				●			
	Kujawsko-Pomorskie					■						■	
	Pomorskie					●				●			
Portugal	Norte						■						■
	Área Metropolitana de Lisboa (Lisbon Metropolitan Area)					■						■	
Romania	Nord-Vest						■						■
	Centru						■						■
	Nord-Est						■						■
	Sud-Est						■						■
	Sud - Muntenia						■						■
	Bucuresti - Ilfov					●		●					
	Sud-Vest Oltenia						■						■
	Vest						■						■
Sweden	Stockholm	■						■					
	Östra Mellansverige (East Middle Sweden)		■						■				
	Smaland med öarna (Småland and the islands)				■						■		
	Sydsverige (South Sweden)	■						■					
	Västsverige (West Sweden)		■						■				
	Norra Mellansverige (North Middle Sweden)				■						■		
Slovenia	Vzhodna Slovenija (NUTS 2010) (Eastern Slovenia)						■						■
	Zahodna Slovenija (NUTS 2010) (Western Slovenia)				■						■		
Slovakia	Bratislavský kraj (Bratislava Region)	■						■					
	Západné Slovensko (Western Slovakia)						■						■
	Stredné Slovensko (Central Slovakia)						■						■
	Východné Slovensko (Eastern Slovakia)						■						■
United Kingdom	Northumberland, Tyne and Wear					●				●			
	Greater Manchester					■						■	
	Lancashire				■						■		
	West Yorkshire					■						■	
	Derbyshire and Nottinghamshire				■						■		
	Leicestershire, Rutland and Northamptonshire				■						■		
	Herefordshire, Worcestershire and Warwickshire				■						■		
	Shropshire and Staffordshire				■						■		

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Continued *Table 2. The innovation model classes and clusters for regions in 1994–2000 and 2011–2014*

Country	Years	1994–2000						2011–2014					
	Class	A		B		C/D		A		B		C/D	
	Cluster no.	1	2	3	4	5	6	1	2	3	4	5	6
United Kingdom	West Midlands				■						■		
	East Anglia				■						■		
	Bedfordshire and Hertfordshire	■						■					
	Essex				■						■		
	Outer London (NUTS 2010)	■						■					
	Berkshire, Buckinghamshire and Oxfordshire	■						■					
	Surrey, East and West Sussex	■						■					
	Hampshire and Isle of Wight	■						■					
	Kent				■						■		
	Gloucestershire, Wiltshire and Bristol/Bath area	■						■					
	Devon					■						■	
	West Wales and The Valleys					▣				▣			
	East Wales				■						■		
	Eastern Scotland	■						■					
	South Western Scotland	■						■					

Note: A grey box indicates the region was assigned to a given cluster; a green box indicates the region changed its cluster in 2011–2014.

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