ECONOMIC IMPACT OF TRANSPORT INFRASTRUCTURE, EDUCATIONAL ATTAINMENTS AND THE NUMBER OF INVENTIONS ON REGIONAL EFFICIENCY

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ABSTRACT

The endowment with region-specific production factors such as infrastructure, human capital and technological capabilities is considered highly significant for the regional economic performance. This paper aims to identify the relative importance of these factors, which we refer to as potential factors in the following, for the economic performance of 261 European NUTS2 regions and to give a first insight into the regions' efficiency in using them. It can be assumed that potential factors affect different types of regions differently. Therefore, the first step foresees a clustering of the regions according to their population density. After the clustering the correlation of the aforementioned factors with the regional economic performance is analysed. First results confirm the presumed positive (and mostly significant) correlation of all three factors for each cluster. Despite the generally positive correlation of the considered factors with the regional performance, investments to strengthen these factors will not automatically push the regional economy. First, the strict causality from investments in potential factors to regional economic performance is not always conclusive and, second, effects strongly rely on the initial situation. Investments that remove constraints for growth will entail much stronger impacts compared to other investments. Against this background, the paper intends to analyse the conditions under which investments into potential factors might generate the desired regional growth effect. Therefore, the study continues with a bottleneck analysis that compares potential production with the observed performance. Further investments into potential factors could indeed increase the competitiveness of regions that use their potential factors more efficient than average. Contrary, under-average efficient regions often suffer from the lack of directly productive capital. In this case, measures to attract this kind of capital are of higher relevance.

Keywords: regional cluster, production potential, efficiency

1. INTRODUCTION

A sufficient endowment with region-specific immobile production factors, which we refer to as potential factors in the following, can foster economic competitiveness and is widely regarded as a pre-condition for economic growth. This is true, for example, in the context of transport infrastructure and the regions' accessibility (Aschauer 1989, Prud'homme 1996), but also holds for educational attainments of the workforce and the ability to generate and absorb knowledge (Romer 1990).

In reality, regional impacts induced by public investments differ significantly. The competitiveness of the region around Frankfurt airport, for example, has been continuously increased with the extension of the airport. The investments in the East German transport infrastructure, however, had by far smaller impacts inducing little employment effects on regions lagging behind. On the contrary, in some cases they accelerated the outflow of resources (e.g. Gather 2003). Against this background, the paper intends not only to analyse the effect of region-specific immobile production factors on economic performance, but also to identify the regions' efficiency in using these factors.

Due to the heterogeneity of the regions section 2.1 starts with the clustering of the regions according to their population density. Thus, regions of similar type can be compared in the following sections. Section 2.2 continues with the definition of explained and explanatory variables. The latter include indicators for transport infrastructure and human capital as well as for the technological capabilities. Subsequently the section analyses the correlation of these factors with the regional economic performance. Finally, the regions´ production potential is compared with the observed performance in section 3. Real outputs that exceed potential output, point to an over-average efficient usage of the immobile factors and additional investments in these factors could indeed foster the economic performance. Vice versa, regions, whose potential output exceeds their real performance, are generally less efficient in utilising their region-specific factors than the average region in their cluster. In this case policies to attract directly productive capital might be more efficient, at least from an economic point of view. Section 4 concludes and gives an outlook.

2. ANALYSIS OF REGIONAL POTENTIALS

2.1. Clustering of regions

Most likely region-specific potential factors affect different types of regions in different ways. Therefore, the first step of the analysis foresees the clustering of the considered NUTS2 regions according to their population density.

1. **Cluster 1 (low density):**
   comprises all regions with a population density between 0 and 100 inhabitants per square-km.

2. **Cluster 2 (medium density):**
   comprises all regions with a population density between 100 and 300 inhabitants per square-km.

3. **Cluster 3 (high density)**
   comprises all regions with a population density above 300 inhabitants per square-km.

Following this procedure 101 regions are assigned to the first cluster, 100 regions to the second cluster and 60 regions to cluster 3. Exemplary Karlsruhe (in Germany), Wien (in Austria) and Lisboa (in Portugal) could be mentioned as high density regions, Medium density areas include for example Stockholm (in Sweden), Comunidad Valenciana (in Spain) and Veneto (in Italy). Sardegna (in Italy), Salzburg (in Austria) and Mecklenburg-Vorpommern (in Germany) are among the low density regions.

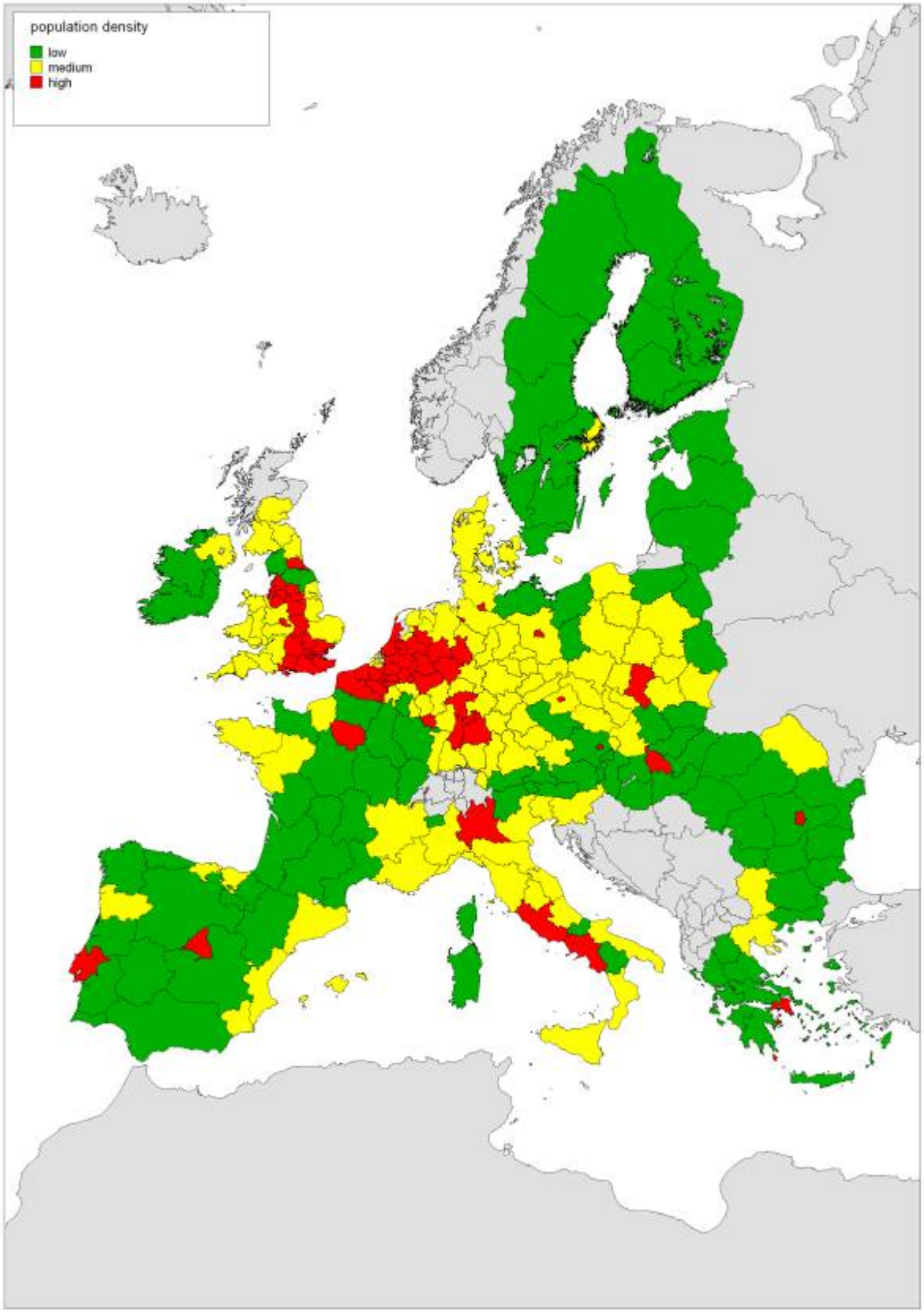

Figure 1 – Cluster of European NUTS2 regions

2.2. Selection of regional potential factors

The regional production is defined as the outcome under the condition of a region-specific allocation of production factors. These factors can be subdivided into two categories. The first category includes indirectly productive, mostly immobile, factors. The second category comprises the directly productive, mostly mobile, factors.

With regard to the regions' production potential, immobile factors are of particular relevance, as a sufficient endowment with these factors can be considered a necessary condition to attract mobile factors. Following this argument Biehl (1991) and Blum (1982) suggest to explain the production potential by the endowment with specific potential factors.

Though this argument is often found in the literature (e.g. Aschauer 1989, Conrad and Seitz 1994, Prud'homme 1996) results are not always conclusive. Some studies even doubt the strict causality from investments in potential factors to regional development and would argue that wealthy regions are able to invest more in infrastructure or the educational system (e.g. Nijkamp 2000).

In order to calculate the regions' production potential, production elasticities have to be estimated in a first step. If the observed output is above the calculated potential, the considered potential factor is used quite efficiently and the existing endowment might limit further economic growth. Investments into this factor could then alleviate bottlenecks and further stimulate the economic performance. In contrast, the same investments might fail to have any major effects, if mobile but not immobile factors are identified as the main limiting determinants.

2.2.1. Explained variable

Based on the System of National Accounting many studies aim to explain Gross Domestic Product (GDP) or the Gross Regional Product (GRP) respectively as the most popular indicator for economic performance. However, due to the different size of the considered regions (in terms of area and population), the significance of this indicator is relatively low. Instead the growth of the regional product, employment generation (Bröcker et al. 1983), regional trade volumes (Krugman 1981, Johansson 2000) or knowledge-based indicators (Kramar 2005) could be explained. Alternatively, the indicator could be a personalised one. Cutanda and Joaquina (1994), for example, suggest explaining the GRP per capita. The presented study follows this suggestion and denotes the GRP per capita of the year 2005 with Y and the potential GRP per capita with Y^{pot}.

2.2.2. Explanatory variables

For the study at hand Y^{pot} shall be explained by transport infrastructure, human capital and technological capabilities respectively. We assume a positive correlation between each of these factors and the regions' potential output.

All factors are considered highly immobile and region-specific. Considering that Europe aims to become the most dynamic and competitive knowledge-based economy in the world, the regions ability to generate knowledge can doubtless be considered a key to economic growth. However, the question arises, whether knowledge generation is indeed immobile. For example, technological capabilities (defined as number of patents based on the residence of inventors) are often specific and highly dependent on the degree of (rather mobile) public and private R&D investments. This clearly conflicts with immobility. On the other hand, the regions' ability to generate knowledge hardly changes over time, which, in turn, suggests that the patents reflect a certain region-specific structure that is rather constant in the medium term.

Transport infrastructure

Infrastructure capital is described by the intra-regional equipment with road infrastructure (R) and is defined as the sum of the weighted road density. The road density reflects the total length of roads (in km) (weighted according to the road category[1]) divided by the regions' area (in sqkm).

$$R_i = \frac{r_{\omega,i}}{a_i}$$

R_i road infrastructure indicator for (NUTS2) region i,
$r_{\omega,i}$ weighted length of roads in region i (in km) for the year 2005,
a_i area of region i (in sqkm) for the year 2005.

Human capital

The regions' endowment with human capital is represented by the employees in 'Research and Development'. It is assumed that regions with a high share of R&D-employees tend to have a comparably high qualification level. The qualification level (Q) is defined as follows:

$$Q_i = \frac{Empl_{i,R\&D}}{Empl_i}$$

[1] Motorways are weighted by factor 5 and other roads by factor 1. The weighting factors, which reflect the differences of construction and maintenance cost, are oriented at recommendations of the European Commission (e.g. Reynaud and Braun 2001, EC 2002).

Q_i qualification level indicator for (NUTS2) region i,
$Empl_{i,R\&D}$ average number of employees in Research and Development (R&D) between 2004 and 2007 in region i,
$Empl_i$ average number of employees between 2004 and 2007 in region i.

Technological capabilities

The technological capabilities of a region can be explained by the number of patent applications of the region's inventors. Therefore the region's innovative potential is represented by the patent indicator (P).

$$P_i = \frac{p_i}{pop_i}$$

P_i patent indicator for (NUTS2) region i,
p_i number of patent applications (by residence of inventor) in region i for the year 2005,
pop_i total number of inhabitants in region i for the year 2005.

Our intuition is that each of the chosen indicators is positively correlated with the economic performance – this means regions with more transport infrastructure, better human capital and higher technological capabilities should, in general, experience higher income per capita. In order to test this assumption, a correlation analysis is performed for each of the factors and the GRP per capita in the next section.

2.3. Correlation Analysis

Following the definition of explained and explanatory variables above, the applied functions are derived as follows:

$$Y_i = c \cdot R_i^{\alpha}$$
$$Y_i = c \cdot Q_i^{\beta}$$
$$Y_i = c \cdot P_i^{\gamma}$$

Y_i: Gross Regional Product per head,
c: levelling factor,
α, β, γ: production elasticities.

For the estimation of the production elasticities the variables are standardised and logarithmised.[2] The results for the estimation of the production elasticities are summarised in Table 1.

Table 1 - Correlation of the explanatory variables with the GRP per capita

	Cluster 1 Low density	**Cluster 2 Medium Density**	**Cluster 3 High Density**
R (Transport Infrastructure)	0.299**	0.151*	0.453**
Q (Human capital)	0.574**	0.452**	0.387**
P (Technological capabilities)	0.677**	0.578**	0.264**

** The correlation is significant at the level of 0.05.
* The correlation is significant at the level of 0.1.

The (Pearson) correlation coefficients with the Gross Regional Product per head vary in the different clusters in the following way:

- In Cluster 1 (low density regions) transport infrastructure capital holds a value of about 0.3, whereas human capital (with a value of 0.57) and technological capabilities (with a value of 0.68) show clearly higher correlations with the GRP per capita.

- In Cluster 2 (medium density regions) human capital (with a value of 0.45) and technological capabilities (with a value of 0.58) show lower correlation coefficients with the GRP per capita than in Cluster 1. There is a significant correlation between the transport infrastructure and the per capita income only (at the 0.1 level).

- Cluster 3 (high density regions) represents, compared to the correlations for all regions and for Clusters 1 and 2, the highest value (0.45) for transport infrastructure and the lowest values for technological capabilities (with a value of 0.26) and human capital (with a value of 0.39).

3. Efficiency Analysis

In order to calculate the efficiency in the sample regions a data envelopment analysis (DEA) is applied for each of the three clusters. The DEA deals with a deterministic production frontier. According to this approach, all observations lie on or below of the frontier. Every deviation from the frontier is interpreted as inefficiency (Charnes et al. 1978). The DEA evaluates the efficiency of a number of so-called ‘decision making units’ (DMU) which can be industries, individual firms, products or regions as in the approach presented here. The DEA has two main advantages (Cantner et al. 2007):

[2] When the standardisation is applied, the logarithmised explained and explanatory variables take an average value of 0. The advantage thereof is that different dimensions of the variables do not matter. Hence simultaneously also the constants amount to 0.

- The DEA is an extreme point method and compares each DMU with the most-efficient DMU in the sample. Therefore the DEA does not require a specific functional form that relates to inputs and outputs.

- The DEA does not assume any linear combination of inputs or outputs, i.e. a DMU is efficient if there is no other DMU that can improve one input or output factor, without worsening the value of at least another one.

Now every region in each of the three clusters is analysed regarding the efficient use of the three potential factors technological capabilities, human capital and transport infrastructure. In a first step, the respective potential factors are plotted on the x-axis and the per capita income on the y-axis. Afterwards a frontier is calculated in the way, that all efficient points build a convex envelope (see red lines in Figure 2 and Figure 3). The illustrations for all clusters and all potential factors are reported in Appendix 1. Two interesting cases are discussed in the following.

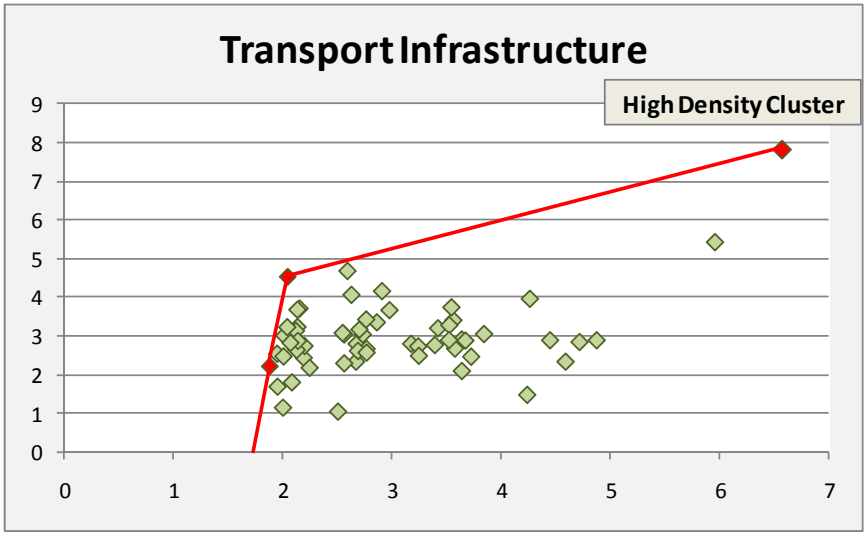

Figure 2 - Efficiency values for Transport Infrastructure in the high density cluster

In the high density cluster three regions define the envelope concerning the output factor ‘Gross Regional Product per head’ and the input factor ‘transport infrastructure’: Praha, Hamburg and Inner London. For these three regions it is neither possible, that a region with less input can reach the same output nor, that a region with the same input can reach a higher output.

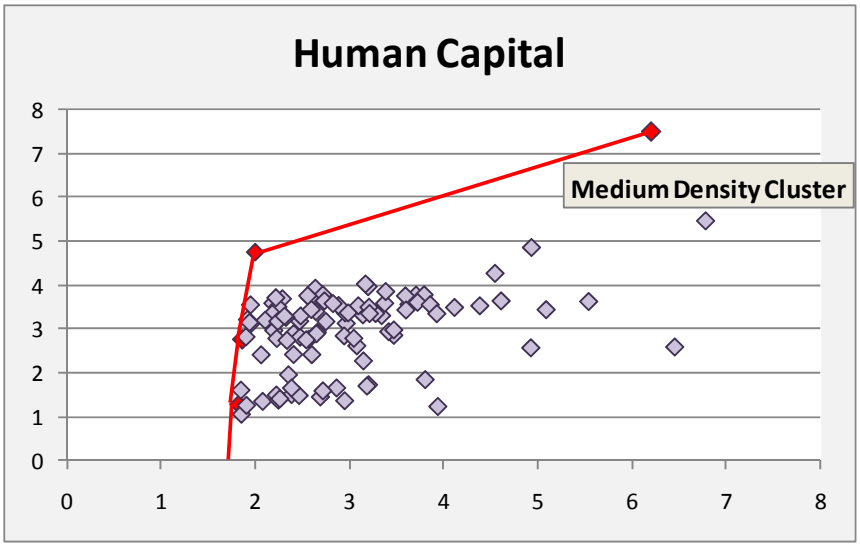

Figure 3 - Efficiency values for Human Capital in the medium density cluster

In the medium density cluster four regions define the envelope regarding the output factor 'Gross Regional Product per head' and the input factor 'human capital': Swietokrzyskie (in Poland), Cornwall and Isles of Scilly (in the United Kingdom), Groningen (in the Netherlands) and Luxembourg. Also for these regions it is neither possible, that a region with the same input can reach a higher output nor, that a region with less input can reach the same output.

Finally, all regions are classified according to their efficiency score. This is performed in the way that the average efficiency value of the respective potential factor is used as threshold for every cluster. Regions with an efficiency value above the threshold are categorized as over-average efficient ('O') whereas the categorisation under-average efficient ('U') is used for regions with an efficiency score below the threshold. The results are presented in Appendix 2.

4. Final remarks

The presented paper provides an insight into the correlation of human capital, technological capabilities and transport infrastructure with the Gross Regional Product per capita for European NUTS2 regions. It can be shown that an increasing endowment of these factors is positively correlated with the regions´ economic performance. This issue is confirmed by our regression analysis, which is performed for the regional clusters that differentiate regions with high, medium or low density. Despite the positive correlation of the factors human capital, technological capabilities and transport infrastructure with the per capita income, investments in these fields will not automatically lead to an improvement of the economic performance. This is only the case, if the endowment with one or more of these factors is limiting further growth. Regions, which use one or more immobile factors in an over-average efficient way, most likely benefit by further investments into the endowment with the respective factor. Under-average efficient utilisation, in contrast, points to the fact that the

region's economic performance is below its potential. In this case, start-up financing and other measures to attract mobile capital are, compared to e.g. infrastructure investments, of even higher relevance. This is particularly true if the endowment with immobile factors has already reached a certain level.

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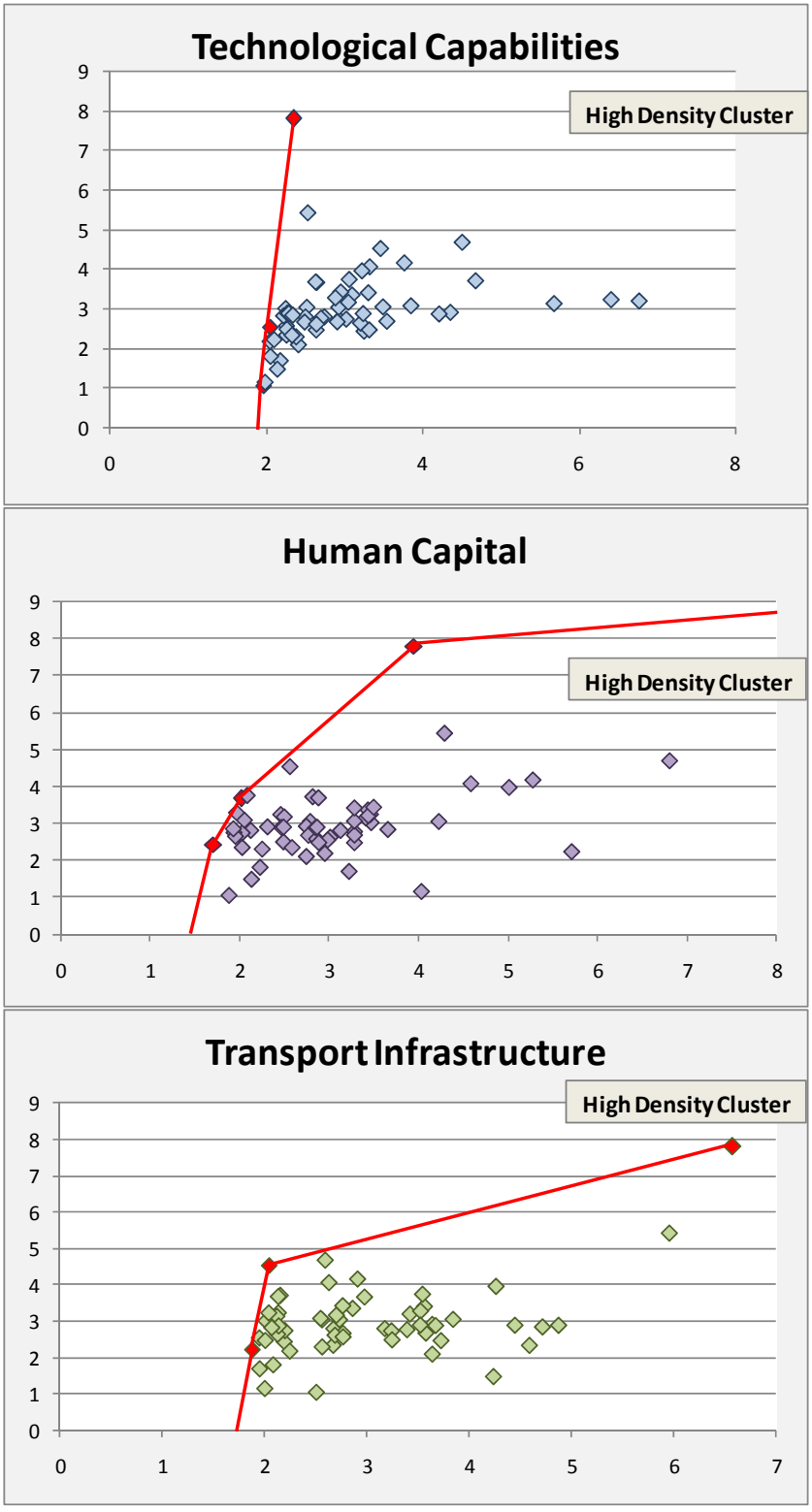
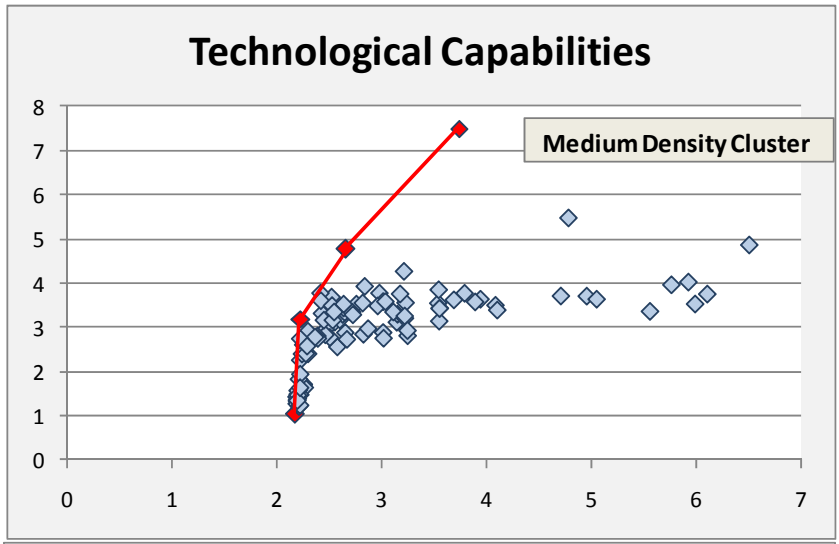
APPENDIX

Appendix 1 – Regional efficiency values differentiated by potential factor and cluster




Technological Capabilities
Medium Density Cluster
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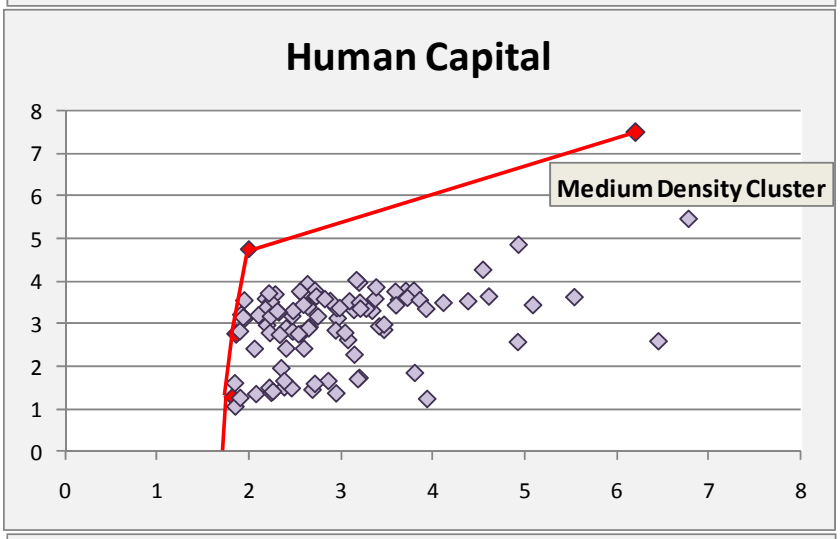
Human Capital
Medium Density Cluster
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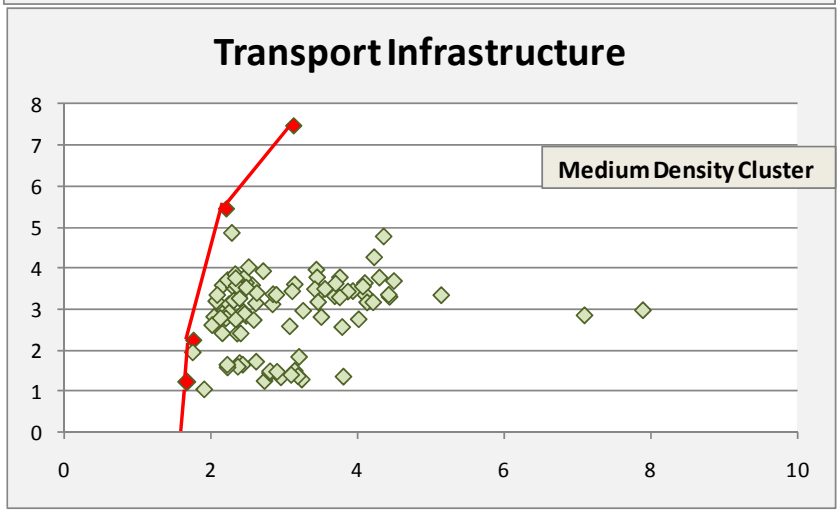
Transport Infrastructure
Medium Density Cluster
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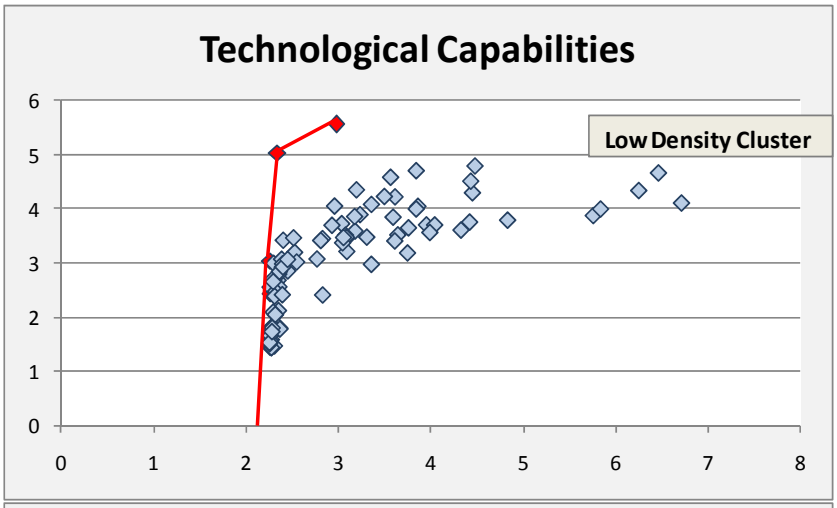
Technological Capabilities
Low Density Cluster
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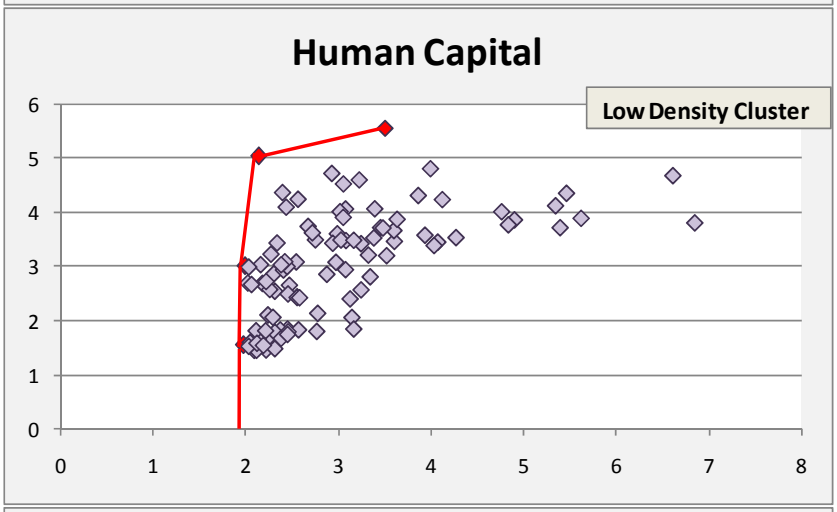
Human Capital
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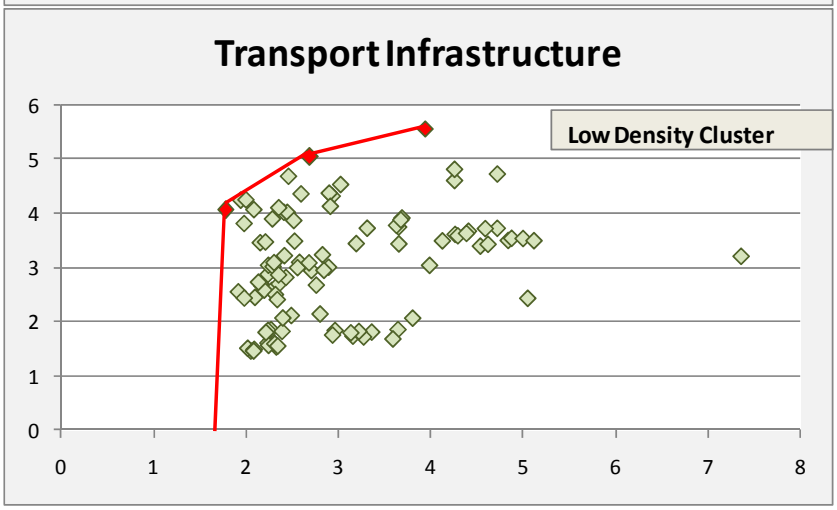
Transport Infrastructure
Low Density Cluster
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Appendix 2 - Utilisation of technological capabilities, human capital and transport infrastructure

Utilisation of technological capabilities/human capital/transport infrastructure
O = over-average efficient; U = under-average efficient

Code	Region	Cluster	Efficiency		
AT11	Burgenland (A)	1	U	O	O
AT12	Niederösterreich	1	O	O	O
AT21	Kärnten	1	O	O	O
AT22	Steiermark	1	O	O	O
AT32	Salzburg	1	O	O	O
AT33	Tirol	1	O	O	O
BE34	Prov, Luxembourg (B)	1	U	U	U
BG31	Severozapaden	1	U	U	U
BG32	Severen tsentralen	1	U	U	U
BG33	Severoiztochen	1	U	U	U
BG34	Yugoiztochen	1	U	U	U
BG42	Yuzhen tsentralen	1	U	U	U
CY00	Cyprus	1	U	O	U
CZ03	Jihozápad	1	U	U	U
DE41	Brandenburg - Nordost	1	U	O	O
DE80	Mecklenburg-Vorpommern	1	U	O	O
DK03	Syddanmark	1	O	O	O
DK04	Midtjylland	1	O	O	O
DK05	Nordjylland	1	O	O	O
EE00	Estonia	1	U	U	U
ES11	Galicia	1	U	U	U
ES12	Principado de Asturias	1	U	U	O
ES22	Comunidad Foral de Navarra	1	O	O	O
ES23	La Rioja	1	O	O	O
ES24	Aragón	1	U	O	O
ES41	Castilla y León	1	U	O	O
ES42	Castilla-la Mancha	1	U	U	O
ES43	Extremadura	1	U	U	U
ES61	Andalucia	1	U	U	O
FI13	Itä-Suomi	1	U	O	O
FI18	Etelä-Suomi	1	O	O	O
FI19	Länsi-Suomi	1	O	O	O
FI1A	Pohjois-Suomi	1	O	O	O
FI20	Åland	1	O	O	O
FR21	Champagne-Ardenne	1	O	O	O
FR22	Picardie	1	U	O	O
FR24	Centre	1	O	O	O
FR25	Basse-Normandie	1	U	O	O
FR26	Bourgogne	1	O	O	O
FR41	Lorraine	1	U	O	O
FR43	Franche-Comté	1	U	O	O
FR53	Poitou-Charentes	1	U	O	O
FR61	Aquitaine	1	O	O	O
FR62	Midi-Pyrénées	1	O	O	O
FR63	Limousin	1	U	O	O
FR72	Auvergne	1	U	O	O
FR81	Languedoc-Roussillon	1	U	O	O
FR83	Corse	1	O	O	O
GR11	Anatoliki Makedonia, Thraki	1	O	U	U

Utilisation of technological capabilities/human capital/transport infrastructure
O = over-average efficient; U = under-average efficient

Code	Region	Cluster	Efficiency		
GR13	Dytiki Makedonia	1	U	O	U
GR14	Thessalia	1	U	U	U
GR21	Ipeiros	1	O	U	U
GR22	Ionia Nisia	1	O	O	U
GR23	Dytiki Ellada	1	U	U	U
GR24	Sterea Ellada	1	O	O	O
GR25	Peloponnisos	1	O	U	U
GR41	Voreio Aigaio	1	U	U	U
GR42	Notio Aigaio	1	O	O	O
GR43	Kriti	1	U	U	U
HU21	Közép-Dunántúl	1	U	U	U
HU22	Nyugat-Dunántúl	1	U	U	U
HU23	Dél-Dunántúl	1	U	U	U
HU31	Észak-Magyarország	1	U	U	U
HU32	Észak-Alföld	1	U	U	U
HU33	Dél-Alföld	1	U	U	U
IE01	Border, Midlands and Western	1	O	O	O
IE02	Southern and Eastern	1	O	O	O
ITC2	Valle d'Aosta/Vallée d'Aoste	1	O	O	O
ITD1	Provincia Autonoma Bolzano-Bozen	1	O	O	O
ITD2	Provincia Autonoma Trento	1	O	O	O
ITF2	Molise	1	U	U	U
ITF5	Basilicata	1	U	U	U
ITG2	Sardegna	1	U	O	O
LT00	Lithuania	1	U	U	U
LV00	Latvia	1	U	U	U
PL31	Lubelskie	1	U	U	U
PL34	Podlaskie	1	U	U	U
PL42	Zachodniopomorskie	1	U	U	U
PL43	Lubuskie	1	U	U	U
PL62	Warminsko-Mazurskie	1	O	U	U
PT15	Algarve	1	O	U	O
PT16	Centro (PT)	1	U	U	U
PT18	Alentejo	1	O	U	U
RO11	Nord-Vest	1	U	U	U
RO12	Centru	1	U	U	U
RO22	Sud-Est	1	U	O	U
RO31	Sud - Muntenia	1	O	U	U
RO41	Sud-Vest Oltenia	1	O	U	U
RO42	Vest	1	O	U	U
SE12	Östra Mellansverige	1	O	O	O
SE21	Småland med öarna	1	O	O	O
SE22	Sydsverige	1	O	O	O
SE23	Västsverige	1	O	O	O
SE31	Norra Mellansverige	1	O	O	O
SE32	Mellersta Norrland	1	O	O	O
SE33	Övre Norrland	1	O	O	O
SI01	Vzhodna Slovenija	1	U	U	U
SK03	Stredné Slovensko	1	U	U	U
SK04	Východné Slovensko	1	U	U	U

Utilisation of technological capabilities/human capital/transport infrastructure
O = over-average efficient; U = under-average efficient

Code	Region	Cluster	Efficiency		
UKD1	Cumbria	1	U	O	O
UKE2	North Yorkshire	1	O	O	O
AT31	Oberösterreich	2	U	O	O
AT34	Vorarlberg	2	U	O	O
BE33	Prov, Liège	2	U	U	U
BE35	Prov, Namur	2	U	U	U
BG41	Yugozapaden	2	U	U	O
CZ02	Střední Cechy	2	U	U	U
CZ04	Severozápad	2	U	O	U
CZ05	Severovýchod	2	U	U	U
CZ06	Jihovýchod	2	U	U	U
CZ07	Střední Morava	2	O	U	U
CZ08	Moravskoslezsko	2	U	U	U
DE13	Freiburg	2	U	O	O
DE14	Tübingen	2	U	O	O
DE21	Oberbayern	2	U	O	O
DE22	Niederbayern	2	U	O	O
DE23	Oberpfalz	2	U	O	O
DE24	Oberfranken	2	U	O	O
DE25	Mittelfranken	2	U	O	O
DE26	Unterfranken	2	U	O	O
DE27	Schwaben	2	U	O	O
DE42	Brandenburg - Südwest	2	U	U	O
DE72	Gießen	2	U	O	O
DE73	Kassel	2	U	O	O
DE91	Braunschweig	2	U	U	U
DE92	Hannover	2	U	O	O
DE93	Lüneburg	2	U	O	O
DE94	Weser-Ems	2	U	O	O
DEB1	Koblenz	2	U	O	O
DEB2	Trier	2	U	O	U
DEB3	Rheinhessen-Pfalz	2	U	O	U
DED1	Chemnitz	2	U	U	U
DED2	Dresden	2	U	U	U
DED3	Leipzig	2	U	U	U
DEE0	Sachsen-Anhalt	2	U	U	O
DEF0	Schleswig-Holstein	2	U	O	O
DEG0	Thüringen	2	U	U	U
DK02	Sjælland	2	O	O	O
ES13	Cantabria	2	O	U	O
ES21	Pais Vasco	2	O	U	O
ES51	Cataluña	2	O	U	O
ES52	Comunidad Valenciana	2	O	U	O
ES53	Illes Balears	2	O	O	O
ES62	Región de Murcia	2	O	U	O
ES70	Canarias (ES)	2	O	U	U
FR23	Haute-Normandie	2	U	O	U
FR42	Alsace	2	U	O	U
FR51	Pays de la Loire	2	O	O	U
FR52	Bretagne	2	U	O	U

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FR71	Rhône-Alpes	2	U	U	U
FR82	Provence-Alpes-Côte d'Azur	2	U	U	U
GR12	Kentriki Makedonia	2	O	U	O
ITC1	Piemonte	2	U	O	O
ITC3	Liguria	2	O	O	U
ITD3	Veneto	2	U	O	O
ITD4	Friuli-Venezia Giulia	2	U	O	O
ITD5	Emilia-Romagna	2	U	O	O
ITE1	Toscana	2	O	O	O
ITE2	Umbria	2	O	U	O
ITE3	Marche	2	O	O	O
ITF1	Abruzzo	2	O	U	U
ITF4	Puglia	2	O	U	U
ITF6	Calabria	2	O	U	U
ITG1	Sicilia	2	O	U	U
LU00	Luxembourg (Grand-Duché)	2	O	O	O
NL11	Groningen	2	O	O	O
NL12	Friesland (NL)	2	O	O	U
NL13	Drenthe	2	O	O	U
NL23	Flevoland	2	O	O	U
NL34	Zeeland	2	O	O	O
PL11	Lódzkie	2	O	U	U
PL12	Mazowieckie	2	O	U	U
PL21	Malopolskie	2	O	U	U
PL32	Podkarpackie	2	U	U	U
PL33	Swietokrzyskie	2	O	O	U
PL41	Wielkopolskie	2	O	U	U
PL51	Dolnoslaskie	2	O	U	U
PL52	Opolskie	2	O	U	U
PL61	Kujawsko-Pomorskie	2	O	U	U
PL63	Pomorskie	2	O	U	U
PT11	Norte	2	O	U	O
RO21	Nord-Est	2	O	U	U
SE11	Stockholm	2	O	O	O
SI02	Zahodna Slovenija	2	U	U	U
SK01	Bratislavský kraj	2	O	U	U
SK02	Západné Slovensko	2	U	U	U
UKC2	Northumberland, Tyne and Wear	2	O	O	U
UKE1	East Yorkshire and Northern Lincolnshire	2	O	O	U
UKF3	Lincolnshire	2	O	O	U
UKG1	Herefordshire, Worcestershire and Warks	2	O	O	U
UKG2	Shropshire and Staffordshire	2	O	O	U
UKH1	East Anglia	2	U	U	U
UKK1	Gloucestershire, Wiltshire and Bristol/Bath area	2	O	O	O
UKK2	Dorset and Somerset	2	O	O	U
UKK3	Cornwall and Isles of Scilly	2	O	O	U
UKK4	Devon	2	O	O	U
UKL1	West Wales and The Valleys	2	O	U	U
UKL2	East Wales	2	O	O	O
UKM2	Eastern Scotland	2	O	O	O

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Code	Region	Cluster	Efficiency		
UKM3	South Western Scotland	2	O	O	U
UKN0	Northern Ireland	2	O	O	U
AT13	Wien	3	O	U	O
BE10	Région de Bruxelles-Capitale/Brussels	3	O	O	O
BE21	Prov, Antwerpen	3	U	U	O
BE22	Prov, Limburg (B)	3	U	U	U
BE23	Prov, Oost-Vlaanderen	3	U	U	U
BE24	Prov, Vlaams Brabant	3	U	U	U
BE25	Prov, West-Vlaanderen	3	U	U	U
BE31	Prov, Brabant Wallon	3	U	U	U
BE32	Prov, Hainaut	3	U	U	U
CZ01	Praha	3	O	U	O
DE11	Stuttgart	3	U	U	O
DE12	Karlsruhe	3	U	U	O
DE30	Berlin	3	U	U	O
DE50	Bremen	3	O	O	O
DE60	Hamburg	3	O	O	O
DE71	Darmstadt	3	O	O	O
DEA1	Düsseldorf	3	U	O	O
DEA2	Köln	3	U	U	O
DEA3	Münster	3	U	O	U
DEA4	Detmold	3	U	O	U
DEA5	Arnsberg	3	U	O	U
DEC0	Saarland	3	U	O	U
DK01	Hovedstaden	3	O	O	O
ES30	Comunidad de Madrid	3	O	U	O
FR10	Île de France	3	O	U	O
FR30	Nord - Pas-de-Calais	3	U	O	U
GR30	Attiki	3	O	U	O
HU10	Közép-Magyarország	3	U	U	U
ITC4	Lombardia	3	U	O	O
ITE4	Lazio	3	O	U	O
ITF3	Campania	3	O	U	U
MT00	Malta	3	U	U	U
NL21	Overijssel	3	U	O	U
NL22	Gelderland	3	U	O	U
NL31	Utrecht	3	O	O	O
NL32	Noord-Holland	3	O	O	O
NL33	Zuid-Holland	3	U	O	U
NL41	Noord-Brabant	3	U	U	U
NL42	Limburg (NL)	3	U	O	U
PL22	Slaskie	3	O	U	U
PT17	Lisboa	3	O	U	U
RO32	Bucuresti - Ilfov	3	O	U	U
UKC1	Tees Valley and Durham	3	U	U	U
UKD2	Cheshire	3	U	U	O
UKD3	Greater Manchester	3	U	O	U
UKD4	Lancashire	3	U	U	U
UKD5	Merseyside	3	U	U	U
UKE3	South Yorkshire	3	U	U	U

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UKE4	West Yorkshire	3	U	O	U
UKF1	Derbyshire and Nottinghamshire	3	U	U	U
UKF2	Leicestershire, Rutland and Northants	3	U	U	O
UKG3	West Midlands	3	U	U	U
UKH2	Bedfordshire, Hertfordshire	3	U	U	O
UKH3	Essex	3	U	U	U
UKI1	Inner London	3	O	O	O
UKI2	Outer London	3	U	O	U
UKJ1	Berkshire, Bucks and Oxfordshire	3	O	U	O
UKJ2	Surrey, East and West Sussex	3	U	O	O
UKJ3	Hampshire and Isle of Wight	3	U	U	O
UKJ4	Kent	3	U	U	U