The European Journal of Comparative Economics
Vol. 4, n. 2, pp. 109-147
ISSN 1824-2979

European Region Types in EU-25

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Abstract

In this paper a categorization of 1,212 European NUTS 3 regions is conducted by means of factor and cluster analysis according to economic structure and spatial characteristics. Subsequently the hypothesis is tested that these region types do explain differences in level and growth of regional income. The resulting 14 region types (10 non-urban and 4 urban) do show differences in regional income per capita and some of them are expected to converge to different steady state levels. In particular, region types with low employment rates obtain lower per capita income on average than others, while those with productivity differentials in favour of industry obtain higher GDP p.c. when judged against region types comparable in their degree of accessibility. In estimating regressions on conditional β-convergence, the inclusion of national dummies shows a reduced speed of convergence (in the total and the western sample) and even divergence in the sample of (former communist) new member states, while the additional inclusion of region type dummies points again to a still low but higher speed of convergence. The estimates indicate significant lower steady state incomes in the peripheral agrarian regions, peripheral industrial regions with a lower productivity differential in favour of industry, peripheral tertiary regions and both types of central regions with low employment rates. A higher steady state income is estimated for metropolitan areas and big agglomerations.

JEL Classification: O18, O57, R11, C21

Keywords: Region Types, Cluster Analysis, European Regions, Convergence

1. Introduction

The purpose of this paper is to find a taxonomy of European regions, which incorporates at the same time geographic location (according to a core-periphery dichotomy but with regional centres also in the periphery) and economic structure (secondary and tertiary sector), as reflected by value added and employment shares and related productivity differentials.

Usually empirical studies on regional development compare the regions of interest to a conglomerate average of other regions such as the average of the EU-15 or the EU-25. Rankings of all kind afterwards hide interesting insights because of their pell-mell character. By benchmarking regions to a certain average, deeper insights on region-specific characteristics that might influence direction and speed of regional development are lost. The paper argues that economic structure (i.e. measured on a broad aggregate level), together with spatial conditions such as regional accessibility and density of population matters in determining level and growth of GDP among European regions. European regions are not homogenous, neither are their economies "well-behaved" in terms of economic structure, nor might their geographic location be

[1] I would like to thank my colleagues at the JOANNEUM RESEARCH Institute of Technology and Regional Policy for helpful comments and discussions on this piece of work. Special thanks go to Raimund Kurzmann, whose technical trainings in the fields of data compilation and analysis made this paper possible, Eric Kirschner for discussions and a critical view on the paper and Clemens Habsburg-Lothringen for the depiction of the maps. I am also very grateful to two anonymous referees, and discussants at the 46th congress of the ERSA who gave very valuable suggestions as far as both contents and methodology are concerned on a preliminary version of this paper, which in fact considerably ameliorated and changed its scope. Remaining shortcomings and errors are in my responsibility.
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an "asset" in the region's development - a condition which might change with time – i.e centrifugal forces such as urban diseconomies and growing wage differentials might lead to the spread of economic activities from geographical agglomerations to the hinterland, while at the same time agglomerative forces can support the further development of central agglomerations (e.g. Fujita *et al.* 2001). Urban areas may act as "springboards" in the economic development process (Scott/Storper 2003), while the political focus on polycentric urban systems consisting of several interacting urban areas may serve both, cohesion (i.e. reducing the dominance of one city) and competitiveness goals (simulating endogenous agglomeration potentials by fostering urban agglomeration, see Waterhout *et al.* 2005). Not only geography (North-South, core-periphery), also history (East-West and the communist central planners' propensity for high employment shares in industry), and in particular the current level of development, reflected in changing sectoral employment shares, induced through sectoral productivity differential-development matter (Rowthorn/Ramaswamy 1997; Raiser *et al.* 2004).

The classification is performed by utilizing the explorative instruments of factor and cluster analysis, the regional entity being the level NUTS 3 on data of 2003. On this issue Eurostat (2007) notes: the level NUTS 3 "broadly comprises regions which are too small for complex economic analysis, may be used to establish specific diagnoses or to pinpoint where regional measures need to be taken." However, there are some reasons, why this low level of regional aggregation seems to be a better choice for the present analysis: 1. NUTS 2 regions are broad regional aggregates comprised of several heterogeneous sub-regions, endowed with different growth factors, such that the analysis of the aggregate might hide interesting insights. 2. This leads to the observation that economic disparities as far as GDP is concerned are much more pronounced at the level NUTS 3 than at the level NUTS 2[2], and 3. The probability that functional units are separated is higher at the level NUTS 3. This opens the gate to regard e.g. regional centres separately from their hinterland, and to be able to more specifically address questions of polycentric development in future research. On the other hand, the choice of this level implies some caveats: 1. Spill-over effects become more likely, the smaller the regional aggregate. This raises the need to deal methodologically adequately with spatial proximity and the error of spatial autocorrelation in cross-section estimates as described in Anselin (e.g. 1988 or 2002), however this methodological refinement has to be left for future research. 2. On the level NUTS 3 data availability is by far lower than at the level NUTS 2. While the latter allows – at least for some regions – to deal with factors conditioning growth as described by the economic growth literature (such as human capital, different kinds of investments, R&D indicators etc.), and a more detailed disaggregation of economic structure, comparable Eurostat data on the level NUTS 3 is basically restricted to broad geographical and (socio-)economic measures (population and area, population density, GDP) and sectorally broadly aggregate economic employment and value added figures. As far as economic structure is concerned, only distinction between the primary, secondary and tertiary sector is feasible. This of course makes the analysis of patterns of regional specialisation (an important factor for determining growth) impossible and the analysis remains at a stylized level.

[2] Landesmann/Römisch (2006) show, basically with the same dataset applied in this paper, that regional disparities, measured by the coefficient of variation of per capita GDP are more pronounced at the level NUTS 3 than at the level NUTS 2: Including capital cities this is true for Austria, Germany, France, Greece, Portugal and the UK, Italy being an exception. This is less important for the new member states.

Attempts to obtain similar groups utilizing 1995 data[3] failed due to large data gaps, the subsequent impossibility to differentiate between group membership changes, and group changes (as a result of both: real change and data gaps) and the successive monitoring of these "structural regions"' dynamic is left for future research. Having identified ten types of non-urban and 4 types of urban regions, it is assessed by means of econometric estimations, whether these types do explain differences in GDP per capita (in purchasing power parities) that is, to what extent this classification is able to explain the current level of development. In a further exercise it is assessed on the sample of 1995-2003, whether evidence of β-convergence can be found within the region types, among all regions as well as different sub-samples, and whether different steady-state incomes can be expected for the region types. Rather than being an end-result, the outcomes of this cluster analysis are supposed to serve as a workhorse for future regional economic studies.

The paper is structured as follows: Section 2 gives an overview of the literature in three subsections on spatial development and regional structural change and their related impacts on regional growth and development. Derived from the literature review it further discusses on which types of regions a typology could potentially focus on. Section 3 comprises the empirical part: 3.1 briefly summarizes examples of other regional European cluster analyses, 3.2 presents the database. In section 3.3 the a priori distinction between urban and non-urban areas is pointed out. Section 3.4 devotes attention to the detection of the most suitable combination of variables by means of multivariate regression analysis. The following sections 3.5 and 3.6 present the actual factor and cluster analyses and describe the region types obtained in non-urban and urban-areas, while section 3.7 econometrically assesses the hypotheses that these region types can explain level and growth of regional income. Section 4 provides a summary of the main findings.

2. Background

In its recent 4th report on economic and social cohesion, the European Commission (2007) reports that in the period 1995-2004 convergence occurred in the EU-27, as disparities in GDP per head narrowed between NUTS 2 regions, particularly in the second half of the period. Part of this convergence can be attributed to a reduction in the gap between the core regions in the central part and the more peripheral regions – whereby not all peripheral regions did show this catching up pattern. Regional disparities widened within many countries, as the capital city regions generally exhibited the highest growth, especially in the new member states. The same document pays attention to differences in regional structure and calculates that a hypothetical shift of the sectoral employment distribution[4] towards the European average (assuming non-changed regional sectoral productivities) would significantly reduce the difference in GDP p. c. For regions with GDP p.c. below 50% and regions with GDP p.c. between 50 – 75% of EU average this would mean a reduction in the difference in GDP p.c. from 41 to 78% and from 71 to 84% of European average respectively.

[3] As suggested by a referee.

[4] EC (2007) distinguishes six broad sectors: agriculture, industry, construction, basic market services, business and financial services and public services.

2. 1 Regional growth and spatial development

Special attention is given to the connection between regional growth and spatial development both in the regional economic and the economic geography literature, with elements drawn from economic growth theories. Although explicitly on the research agenda of the New Economic Geography (NEG) also other growth theories and their application to regional development issues explain or describe how patterns of core-periphery emerge or dissolve. The development of these geographic and economic core-periphery patterns is closely linked to questions of economic con- or divergence as well as the reduction of regional disparities. European integration by establishing the common market, the fall of the iron curtain, the accession of new member states, investments in infrastructure and transport technologies have substantially reduced trade barriers and hence transport costs, and therefore – according to the findings of new economic geography – are likely to shape the spatial distribution of economic activities.

In the neoclassical world (assuming constant returns to scale of production and exogenous technological progress) growth disparities are basically explained by the savings rate. Regional disparities should – factor mobility of both labour and capital presumed – decline, as capital goes to regions with lower capital-labour ratios and labour migrates in the other direction. The question whether this equalization of factor prices indeed occurs drives the result of how much convergence might be expected. Endogenous growth theories on the other hand explain how rich economies (endowed with human capital and higher R&D activities) can sustain high rates of growth and generally predict divergence of regional growth, but less so with integration. These centripetal forces of endogenous growth (which lead to absolute divergence) are slowed down, insofar as external economies of scale are limited by interregional spillovers and diminishing returns due to growing factor-prices (Palme 1995b).

Models in the tradition of New Economic geography (NEG) are less determinate in their prediction of the development of income inequality. Agglomerations of economic activity and hence the emergence of core-periphery patterns occur because of increasing returns to scale industries ("manufacturing") taking advantage of Marshallian externalities of bigger home-markets through supply and demand linkages. In which particular region the agglomeration is finally situated is subject to the hypothesis of cumulative causation, or the stochastic impact of "historical small events" [5]. Agglomerations emerge where economic activity already agglomerates and the initial share of manufacturing determines this initial small advantage. Transport costs in these industries are the crucial factor in determining the stability of the core-periphery pattern. Both an initial reinforcement of disparities as a response to integration and reduced transport costs as well as a posterior potential spread of economic activities in response to a further decline in transport costs are possible outcomes and hence affect the convergence or divergence expectations. Labour mobility is a crucial variable in this context, when workers do not migrate, wage differentials persist and lead to firm reallocation. Additionally, transport costs in "agriculture" or in general in traditional non-increasing-returns industries act as breaks in urban development and can explain the persistence of rural areas in the "hinterland" of agglomerations (see Fujita *et al.* 2001; Krugman 1991 or Martin/Sunley 1996; Puga

[5] Arthur (1989) shows how under increasing returns to scale an economy can become locked in to inferior technologies (which does not reflect the taste of the majority of agents), when this technology gets a sufficiently big small initial advantage by "historical small events".

1998). Empirical evidence suggests that the clear positive correlation between transport infrastructure and the level of GDP might reflect historical agglomeration (and accumulation) processes, rather than a current causal relationship, while even lesser evidence is to be found between the growth of economic indicators and infrastructure improvements. Both converging and diverging regional development might occur from the better integration of peripheral regions into transport networks: on the one hand the peripheral regions gain better market access to the core-regions, while on the other hand competition is enhanced, which might affect the peripheral region to a higher extent[6] (see Vickerman *et al.* 1999 or Schürmann/Talaat 2002 for an overview). Furthermore, regional specialisation in the course of integration as a reaction to benefiting from increasing returns to scale and Marshallian externalities in the size of home markets can render regions more sensitive to outside demand-shocks and may result in leading regions losing their initial advantage, thereby counteracting the tendency of centripetal forces which hold cities or economic activities assembled. This may subsequently lead to the centrifugal spread of activities.

A rather policy oriented newer strand of literature is the discussion on polycentric development, which stresses the function of urban development in overall economic growth. At a mega level at the European scale[7] this view is opposed to the core-periphery concept of regional development in Europe, because there exist "pockets of deprivation within the core and pockets of development within the periphery" (Davoudi 2003, p. 989) Recent analysis of national European spatial and territorial development strategies by Waterhout *et al.* (2005) shows that both competitiveness and cohesion are on the agenda, though not in all countries at the same time[8]. While the latter refers to diminishing economic disparities within several urban centres and weakening dominant positions of just one city or the reduction of geographical disparities in a country, the earlier refers to creating critical masses of "urban networks" by fostering inter-city cooperation. The second approach is rather pursued by countries with already existing polycentric structures[9]. In the (observed) combination of these strategies, the authors detected a shift from a zonal to a nodal approach, which focuses

6 Vickerman *et al.* (1999) apply a detailed measure of accessibility to the development of the European high-speed-railroad network, and find that disparities of accessibility between central and peripheral regions will enhance with the EU-rail network. For Spain, Donaghy/Dall'Erba (2003) find that regional disparities have not reduced despite huge structural funds help. These EU funds in Spain were used for transportation in infrastructure: Investments can lead to agglomeration of firms in the richer area when they are built between regions of different levels of development, but transportation may not lead to agglomeration of firms in the richer area, when built between different levels of development. Agglomeration forces at work may be so powerful that giving a small advantage to a poor region will not alter the stability of the mechanism.

7 Mejers *et al.* (2005) state that the European Spatial Development Perspective (ESDP) embraces a "nested" polycentricity concept: Every centre with its functional inter-dependences and urban-rural partnerships can be seen as a polycentric system, while at the same time being part of a larger Global Economic Integration Zone, the sum of which itself constitutes the European polycentric system. Waterhout *et al.* (2005, p.163) define polycentric development policy as addressing "the distribution of economic and/or economically relevant functions over the urban systems in such a way, that a multitude of urban centres gains significance rather than one or two".

8 While countries such as France, Germany and Finland focus on fostering the endogenous potential of cities outside the capital regions, thereby pursuing cohesion oriented goals, Ireland and Poland state to concentrate on raising the competitiveness of the country as a whole and only in later stages concentrate on a more equal distribution among regions. (Waterhout *et al.* 2005 p. 171)

9 These are Switzerland, the Netherlands, Flanders, and Germany , Poland and Slovenia, see Waterhout *et al.* (2005).

on urban networks as "motors of the economy" for regional development by using existing endogenous potential (see Davoudi 2003; Kloostermann/Musterd 2001; Faludi 2005; European Commission 1999). A similar view is put forth by Scott/Storper (2003) who argue that urbanization has an impact on economic development (which is the reverse causality to what the NEG or EGT models put forth.) Selected regions may act as "springboards of the development process in general, and as sites of the most advanced forms of economic development and innovation in particular" (*ibid.*), and urbanization in the first stages of development is an essential condition of durable development, as urban or metropolitan areas with interrelated activities and high levels of productivity, a bigger innovative potential is the most important foci of national growth and home to export-oriented industrialization.

2. 2 Regional growth and structural change

The claim that regional structure and structural change are strongly related to regional growth is a widely used view. Earlier development theories have linked structural change (decline of agricultural employment, rise of industry and the later rise of the service sector) to economic development (i.e. Fourastié 1949; Fisher 1939[10]), a view which has been neglected by one-sector well behaved growth models of the Solow-type.

In Kaldor's demand driven model growth in demand increases productivity, induces increased competitiveness which in turn leads to additional increase in demand, with the manufacturing sector being the driver of growth. Kaldor's first law states that the manufacturing sector is the engine of growth (it exhibits higher productivity increases due to increasing returns to scale and can incorporate technological progress more easily, thereby inducing growth in the rest of the economy.) In Kaldor's second law a positive relation between labour productivity in the industrial sector and output productivity is hypothesized, while the third law claims a positive relation between the labour productivity of total economy and of manufacturing production. Pons-Novell/Viladecans-Marsal (1999) have assessed Kaldor's laws with regional data on the European NUTS 1 level and find support for the second and third, but not for the first law. Paci/Pigliaru (1997) estimate Kaldor's third law among a cross-section of 109 European regions, and find evidence for manufacturing output being a driver of overall labour productivity growth.

Rowthorn/Ramaswamy (1997) present a 3-sector closed economy model[11] which illustrates the hypothesis that deindustrialization is a "natural" consequence in the proceeding of development, because productivity in the manufacturing sector expands faster than that of the service sector. They claim that it is not the decline in demand of manufacturing products that serves as a major explanation for the secular decline of manufacturing employment after the mid 60s in the US, Japan and Europe, but essentially productivity differentials between services and industry. While in the earlier industrialization phase shifts of employment from agriculture to industry can be

[10] See Steiner (1986) for an overview and a critical discussion on empirical regional economic shift-share and benchmarking exercises, based on this strand of literature.

[11] Demand for agricultural products is income inelastic, demand for services rises with income and labour productivity grows faster in manufacturing than in services. Production exhibits constant returns to scale.

explained by Engel's law[12] and by productivity increases in agriculture due to technical progress, the later observed deindustrialization is a result of productivity differentials between the service and the manufacturing sector. Accordingly, the service sector has to employ an increasing number of persons to keep its output in line with that of the manufacturing sector. This in turn, Rowthorn/Ramaswamy (1997) argue, leads to total economy growth rather being determined by productivity growth in the "technologically stagnant" service sector than by growth in the "technologically progressive" manufacturing sector in the course of development. (Note that this argument is in contrast to Kaldor's first law).

For transition countries somewhat different results are expected. Raiser *et al.* (2004) extended the model of Rowthorn/Ramaswamy by introducing technological spillovers between countries. Productivity enhancing effects of innovations are higher in the follower country the farther it is away from the technological leader. As a result, follower countries industrialize faster and industrial employment shares of the lagging countries peak earlier than those of the technologically leading countries. Further simulations by including communist central planners' propensity to high shares of manufacturing together with a productivity handicap in the secondary sector reveal that employment structure is primarily determined by the planners' preferences. Although having started later in the process of development these preferences retard the "natural" decline of manufacturing shares. By using empirical benchmarks of transition economies to market economies the authors then show that the wealthier transition economies (now all member states of the European Union) still obtain persistently higher industrial employment shares after sectoral reallocation as opposed to the benchmark, while the industrial employment shares of the poorer transition countries have declined stronger. This tendency of the service sector crowding out industrial employment is also found by Gacs (2003) for a larger panel of 124 transition countries: while the service shares of a group of accession countries was far below average in 1988 for their levels of GDP, service shares in 1999 for the same group had caught up given the level of GDP, but not for all countries. Although being subject to debate[13], real expansion of services occurred due to unleashed consumer sovereignty, and growth of the service sector was not a simple replacement of industrial sector as the "engine of growth". Landesmann/Römisch (2006) detect a non-linear relationship between gross regional product and the share of employment in the tertiary sector, which explains the lower correlation between share of employment in the tertiary sector and gross regional product in the richer countries of the EU-15.

In a number of papers Paci/Pigliaru (1997a, b) and Paci/Saba (1997) stress the importance of sectoral reallocation of resources in (de)accelerating growth of labour productivity, and state that most convergence effects might be due to structural change. They criticize the way Barro/Sala-i-Martin (1995) suggest to control for economic structure in regressions on conditional convergence by simply adding the initial level of employment shares and instead opt for measures controlling for structural change.

[12] Due to Engel's law a lower proportion of income is spent on basic needs (and hence agricultural products) with rising per capita income.

[13] Still, as the author remarks, two arguments might question the observed increase of service shares: the first being the output fall, especially in the industrial sector in earlier stages of transition, and second - similar to the "outsourcing" growth of the service sector in western countries - the formerly highly conducted provision of "inhouse services" in industrial facilities during communism (such as health care and social services, maintenance and social services) which was reversed during privatization.

Applying shift-share techniques to more disaggregate Italian (NUTS 2) data (1993a), they find that a huge if not the whole part of detected convergence is attributable to structural change, but mainly due to the transitory shift of agricultural employment to manufacturing. Prados de la Escosura (2005) tries to find patterns of development for a historic time span of European market economies, and finds at the same time both, the pattern of structural change described by Rowthorn/Ramaswamy (1997) and a rapid increase in urbanization with rising income. Employment shares in the service sector and the degree of urbanization show higher elasticities with respect to low income levels than to higher income levels, while the opposite is true for the share of agriculture in employment and value added. The author furthermore finds evidence for Gerschenkron's proposition of a less active role of agriculture in the process of industrialization for more backwards countries.

2. 3 Summary and expectations on region types: structure and space

What does the discussion on economic structure's and spatial aspects' influence on the economic level and development imply for the envisaged typology of European region types? The literature review has shown that both models in the spatial and in the economic-structure dimension emphasize time and the interplay of "stages of development" as decisive factors as to when expect dissolving or emerging patterns of concentration and associated diminishing or widening economic disparities. Different phases of development are expected to coexist among the total sample of regions in a given point of time.

Concerning the spatial dimension there is an obvious need to distinguish regions along a centre-periphery and an urban-non-urban dimension, as economies of agglomeration and disagglomeration can appear between these types in response to changes in transport costs (however defined), labour mobility, the equalization of factor prices, cumulative causation in the endowment with favourable factors etc., or the non-presence of all these factors. Still, in the context of 25 European states with the most densely populated and hence most central regions being concentrated in the so called blue banana in few member states, the need to further distinguish between regional centres in the more peripheral areas and "non-central" but densely populated regions in the centre is obvious (as emphasized in the discussion on polycentric developments), especially when the typology should be used for further analytical assessments of smaller scale regional development.

From the economic point of view (and already holding data caveats in mind), the need to account for phases of development beside economic structure has been shown in the last section. Regions in early development stages still have higher productivity growth potentials by shifting resources from agriculture to other sectors than other regions[14]. In later stages of development and phases of industrial employment growth, manufacturing might become the Kaldorian engine of regional growth through additional demand for manufactured products, the regional specialisation on export industries with increasing returns to scale and the advantages of agglomeration economies. Of course, this is subject to empirical investigation only on a more

[14] The question whether this indeed occurs is subject to the region's ability to adapt to higher technological standards in industry and a "falling further behind" of late developers can also be expected. (See Abramovitz 1986, or Steiner 1986 for an empirical assessment on the adaptability of Austrian regions.)

disaggregate sectoral level as it depends crucially on the regional "portfolio" of industries and the regional focus on "technologically progressive" branches with their associated higher growth of labour productivity, due to easier possibility of standardization, easier replication (Baumol et al 1989) and the associated industry specific business cycles which might drive con- or divergence in shorter periods of time. Filtering out different types of specialized regions is not feasible within the present focus on NUTS 3, therefore the classification exercise will rather focus on the hypothesis of Rowthorn/Ramaswamy (1997) that in later stages of economic development economic growth may become determined by productivity growth in services. Regions in which labour productivity of industry is far above that of services are expected to be already in later stages of (post-industrial) development. According to this model regions in this paper will be classified not only according to employment or value added shares, but by additionally taking into account productivity differentials.

3. Empirical part: typology of European NUTS 3 regions

In this section a classification exercise of 1,212 European NUTS 3 regions is performed by means of principal component and cluster analyses. The resulting 14 types of European regions are then assessed in terms of GDP p.c. and by their growth performance. The analysis is based on 2003 data and is static in nature, as important variables such as the accessibility of population were only available for one year. Attempts to run similar classifications with 1995 (partly interpolated) data have not resulted in reasonably stable outcomes and the exercise is left for further research.

3. 1 Other regional cluster analysis

The present analysis is strongly inspired by Palme's work (1995a) - a classification of Austrian districts by means of similar variables as used in the present paper (except the measures on accessibility). This typology of Austrian regions is still being utilized for empirical studies on Austrian regions – as for example in Mayerhofer/Palme (2001) which assessed the impacts of the European enlargement on Austrian regions. Steiner (1986) classifies Austrian districts by spatial characteristics and their degree of adaptability. For Germany Kronthaler's work (2003) is related, grouping German regions by their endowment with factors acting as drivers for growth, such as innovations, public and private capital, human capital, entrepreneurial concentration and initiative. Central result of this paper is the completely different factor endowment of regions in Eastern and Western Germany, which is emphasized by the result that they never belong to the same cluster. Prettenthaler (2003) groups Southern and Eastern European regions based primarily on structural variables, including an indicator on the degree of regional specialisation. Bauriedl/Winkler (2004) group selected European regions according to the dimensions social justice, protection of natural resources and sustainability of economic activities. Blien et al (2006 a,b) classify German labour market districts according to labour market performance indicators, and Perugini and Signorelli (2004) perform a similar classification on Central and Eastern European regions including economic structure. Marelli (2007) concentrates on sectoral employment shares and the level of per capita income in European NUTS 2 regions. An early predecessor of this paper (Aumayr 2006) was utilized for comparing Styrian regions to European cluster members in a project on future scenarios' for the cross-boarder agglomeration Graz-Maribor (see Prettenthaler 2007 a-c).

3. 2 Regional data

The primary data source utilized in the empirical part of the paper is the Eurostat regional data base, the sample ranging from 1995 – 2003. Data on the accessibility of population were provided by IRPUD (University of Dortmund, Institute of Spatial Planning)[15] for the year 2002. This index is a travel-time measure of proximity (5 hours by car) population weighted index. As regional figures of purchasing power parities are not available, (Eurostat also uses the national figures in order to convert GDP), the national purchasing power standards were utilized in order to convert value added numbers.

3. 3 Distinction between urban and non-urban regions

If there is one particular agreement in the literature on the definition of the term "city", then this statement says that there is no agreed on "covering it all" definition. The encyclopaedia tells that cities – as opposed to rural areas – are defined as bigger, more densely populated settlements with specific functions in the spatial division of labour and the political system. In a geographical definition, cities are places with a certain size, closed edificial settlements, high densities of dwellings and workplaces, a dominance of non-agricultural sectors and a minimum degree of centrality. In economic definitions cities are subject to location economies because of internal and external economies of scale (see Gabler 1997).

In order to distinguish between urban and non-urban areas of European regions on the level NUTS 3, this paper follows subsequently DG REGIOS' definition of urban areas with a population density of 500 per square km and at least 50.000 inhabitants (European Commission 2001). This rule applied to a total of 1,212 NUTS 3 regions in 2003 yielded 239 urban areas, while when applied to data of 1995-2002 slightly other results were obtained. In particular 14 regions[16] were in a "grey zone" between these states, changing status in one of the years. As a rule, all those regions were further classified as urban areas which were at least 6 out of the 9 years observed "urban areas" according to the above definition, which reduced the sample to 236 urban regions. With this definition, there still remains a non-negligible sample of regions which are in fact urban areas, but surrounded according to the NUTS boarders by a greater amount of hinterland. These regions will in turn re-appear in the classification exercise of non-urban regions as regional centres or agglomerations.

3. 4 Choice of variables

The aim of this paper is to identify different "structural regions" according to spatial and economic characteristics, which can to some extent explain GDP per capita and can serve as starting point for further related research issues. Accordingly, the impact of different variables on the level of the gross regional product will be tested by means of multivariate regression analysis. Beside structural variables such as sectoral

[15] These data were initially constructed by Schürmann/Talaat (2000) in a project on the calculation of a European peripherality index. An updated version of these data for the year 2002 was conducted by IRPUD in the EU-funded project: „SERA – Study on Employment in Rural Areas". See also Schürmann et al (1997) and Talaat/Schürmann (2002).

[16] Salzgitter, Kreisfreie Stadt, Telford and Wrekin, Hof, Kreisfreie Stadt, Rhein-Neckar-Kreis, Frankfurt (Oder), Kreisfreie Stadt, Wismar, Kreisfreie Stadt, Rhein-Sieg-Kreis, Speyer, Kreisfreie Stadt, Hoyerswerda, Kreisfreie Stadt, Suhl, Kreisfreie Stadt, Rhône, Genova, Rimini, Darlington

employment and value added shares and spatial variables such as the accessibility index described above and regional sectoral employment rates[17] also the impact of a measure for sectoral productivity will be assessed, stemming from the following considerations: Concerning the economic structure, a high share of employment in the tertiary sector can mean both specialization in high-end services either with strong ties to (high productive) export industries and/or the services themselves being supra-regional traded services, or a specialization in rather labour intensive home-based services, and a missing industrial base. High sectoral shares in the industrial sector on the other hand might either reflect a "delay" in the process of de-industrialization ("old" industrial regions, regions in transition), as well as an ongoing regional specialization on productive export industries in the secondary sector. The crucial variable in this context of data-availability is of course sectoral labour productivity, which might distinguish between high and low productive regions in each sectoral type. Direct usage of labour productivity in this analysis is not feasible, because this would lead to separating between "poor" and "rich" regions from the very beginning, whereas the question is whether "structural" region types can explain differences in GDP level and growth. Hence, a "relative" measure of sectoral labour productivity Π will be constructed, which does account for productivity differentials between sectors, but not between regions:

$$\Pi_i = \frac{\frac{va_i}{va_{TOT}}}{\frac{e_i}{e_{TOT}}} * 100 = \frac{\pi_i}{\pi_{TOT}} * 100 \qquad [1]$$

The index i refers to the 3 sectors, TOT is the total sum of these sectors, va is value added and e is employment. Division of sectoral value added shares by sectoral employment shares is nothing else than the relation between sectoral labour productivity π_i and total labour productivity. Values higher than 100 indicate that the particular sector exhibits higher than average labour productivity in the region or equivalently that sectoral value added shares are higher than sectoral employment shares. On the sample of all regions this index amounts to 104 for services and to 107 for industry on average, indicating the commonly observed higher productivity in industry than in services, while it is agricultural productivity that diminishes the average and increases the index for services especially in rural areas. In the sample of urban areas the industrial-services productivity gap is even more pronounced, and service's labour productivity is on the mean below average labour productivity. This may reflect the concentration of high productive types of industry especially in the urban areas.

17 Sectoral employment rates instead of sectoral employment shares as in a former version of the paper were included upon the suggestion of an anonymous referee. This opens the gate to (partly) take into account regional commuting.

Table 1: Productivity index for industry and services in urban and non-urban regions

	Non-Urban	Urban	All Regions
Industry			
Mean	106	113	107
Std. Dev.	23	18	22
Coefficient of Variation	22	16	21
Services			
Mean	106	97	104
Std. Dev.	15	7	14
Coefficient of Variation	14	7	14

Source: Eurostat, authors calculations

In Rowthorn/Ramaswamy's (1997) model of sectoral development de-industrialization occurs in a later stage of development as a response to increases in industrial labour productivity and lower shifts from agriculture to industry. This implies declining employment shares in industry, converging to zero in the long run and employment shares in services converging to one. In terms of the above constructed productivity index the process of tertiarization would imply the rise of the productivity index of industry to infinity and the fall of the productivity index of services, the later of which would eventually converge to the share of value added of services, which is below 100. Hence with labour productivity increasing faster in industry than in services, the gap between the two indices will increase, or the ratio will grow over time as a result. In this sense, regions in which the productivity index of industry is very high and that of services comparatively low should be in later stages of development and have accumulated higher GDP p.c.

In order to identify suitable variables for the following cluster analysis, multivariate regression models over a cross-section of the European NUTS 3 regions were estimated[18], in which GDP in purchasing power standards per capita is explained by structural and spatial variables. This exercise is carried out over the whole sample of 1,212 regions and over the sample of 976 non-urban regions respectively.

The following model is estimated in the first place:

$$GDP_{p.c.pps} = \beta_0 + \beta_1 access + \beta_2 \left(beds/hab * 1000 \right) + \beta_3 \left(\frac{\Pi_2}{\Pi_3} \right) + \beta_4 \left(\frac{emp_3}{hab} \right) + \varepsilon_i \qquad [2]$$

Where $access$ is the accessibility index with respect to population as described above, $beds/hab$ are beds in hotels per 1000 habitants, the productivity index ratio between the productivity in industry and services and the employment rate of the tertiary sector.

Estimation outputs are given in Table 8 and Table 9. The estimations (see models 1 and 8) show the expected signs in all variables: a higher accessibility index is associated with higher GDP p.c., tourism further increases wealth, a high employment rate in the tertiary sector and a productivity differential in favour of industry all point to higher GDP p.c. In absolute terms, it is the employment rate in services which accounts for more than three quarters of GDP p.c. on the average of all regions, while both the accessibility index and the productivity differential account for further 11 and 9% of total GDP p.c., while the influence of tourism and the constant is rather negligible in

[18] As the White test on the residuals of the OLS regressions pointed to heteroskedasticity, the regressions were re-estimated utilizing White heteroskedasticity-consistent standard errors and covariance.

absolute terms. Both parameters of service sectors employment rate and the productivity differential become larger when estimated over the whole sample of regions, including urban areas. The employment rate in this context has a double or even triple function: at first it accounts for sectoral specialization and the degree of tertiarization. Furthermore, being a participation rate, it measures to some extent to what degree a region exploits its labour force. The restriction "to some extent" stems from the fact that employment is counted at the place of work and habitants are counted at the place of living. Hence, the third function of (sectoral) employment rates in this context is to account for commuting into and out of regions. In the subsequent cluster-exercises, it will to some degree help to identify regional centres from these considerations. Inclusion of the productivity index of industry instead of the ratio of the two sectoral indices gives again positive, but not significant parameter estimates (Models 2 and 9). Is this already the whole story? In fact not, as in this specification of productivity differentials, the relation to total productivity is lost. Indeed, a high ratio of the productivity indices Π_2/Π_3 is nothing else than the ratio of the respective labour productivities, as total labour productivity cancels out. This however means that nothing is said about the size of the industrial sector (in terms of value added shares) in comparison to the service sector. Hence, inclusion of the industrial sector's value added share into the regression seems to be a feasible solution, and checks of the correlation matrices (see Table 7) reveal that there is no substantial correlation between the productivity ratio or the sectoral productivity indices respectively and the value added share in industry.

It turns out that the inclusion of sectoral value added in the secondary sector results in positive parameter estimates for this variable, but that both the productivity index in industry and the productivity ratio between industry and services become significantly negative (Models 3, 4, 10 and 11 in Table 8 and Table 9). Estimation of the same model with "inverse" variables for economic structure (share of value added in services, productivity index for services and the employment rate in the industrial sector reduces the explanatory power of the model in terms of R^2 substantially (Models 6 and 13). Inclusion of population density instead of accessibility of population slightly decreases the R^2 of the model, while the estimated coefficient is significantly higher in the sample of non-urban regions (Models 5 and 12). Employment shares or rates in agriculture do not give the expected negative signs in the sample of all regions, and are not significant in the sample of non-urban regions (Model 7 and 14). In the following stages of work, model 4 and 11 will serve as further guides in choosing variables for the typology-exercises.

3. 5 Cluster analysis of non-urban areas

For the typology of non-urban areas a three-step procedure was applied: In the first step the (scarce) set of variables was reduced by means of principal component analysis to 4 factors, measuring on the dimensions space (peripherality and centrality) and economic structure (secondary, tertiary and tourism-oriented) including additional information on productivity differentials as already described above. In the second step, these four factors were used for classification in a first hierarchical cluster analysis (Ward, squared Euclidian distance). In the third step, following Blien *et al.* (2006a and 2006b) a further k-means cluster analysis was conducted in order to examine the robustness of the results. In this cluster analysis the group-means of the clusters obtained in the second step were used as starting values, which finally resulted in the re-grouping of 300 out of 976 regions. As the biggest changes occurred between "marginal" regions of related clusters the results were considered to be fairly stable and the k-means clusters were utilized in the following sections.

3. 5. 1 First step: principal component analysis

Employment shares, shares of salaried employment and employment rates (in terms of population) in services, and value added shares for industry entered the PCA in order to account for regional specialization. The choice of these variables was driven by consideration of correlations: In order to avoid multicollinearity one of the two major shares beside agriculture had to be left out, and given the generally high correlations between value added and employment shares of the same sector, usage of the opposite shares seemed to be a more adequate solution. The decision to include the service share in employment and the industry share in value added stemmed from the consideration that productivity differentials over the sample of regions are significantly higher in industry than in services[19]. This in turn means that high employment shares in industry are to a lesser extent (than in services) reflected in high value added shares in industry and hence less suitable to reflect industries' importance for regional production. This result was also obtained in the regressions above (comparing models 4 and 11 to 6 and 13) as far as the contribution of sectoral value added shares to the level of GDP p.c. is concerned.

In order to account for productivity differentials the sectoral productivity indices were included as further indicators for regional specialization. As an indicator for tourism (the only regional branch specific indicator available at the level NUTS 3) the number of beds in hotels per 1000 habitants was taken into account. Filtering out highly tourist regions arises from the consideration that these regions are more vulnerable than other tertiary regions and subject to own branch-specific business cycles. Furthermore an index on the accessibility of population by IRPUD and the density of population were included to account for spatial characteristics. While a major part of the accessibility index refers to a region's own size and population, it also reflects the size of accessible neighbouring regions. These data are not a perfect choice, but still suitable for a principal component analysis, with a Kaiser-Meyer-Olkin measure of sampling adequacy of 0.512.

Subsequently, four factors were extracted from the described set of data: The first, or "tertiary employment factor" loads high on the shares and rate of employment in services, and little lower but negative on the value added in industry. According to the high employment share-loadings, the loading of the productivity index on services is negative. (With high employment shares being negatively related to the productivity index for constant value added shares.) As the first factor also obtains some factor loadings on accessibility and density, it can at the same time serve as a factor of centrality. The second factor loads high on value added in industry and to a lesser extent on the productivity index in industry. The third factor accounts for the degree of peripherality and tourism, while the last one loads negatively on the productivity of industry index.

[19] For the 976 regions considered, the mean labour productivity in industry is 43.336 Euro per worker (Std. Dev.: 14.739) and in services 42.667 (Std. Dev.: 9.901).

Table 2: Component Matrix: Extraction of 4 components by Principal Component Analysis

	Component			
	Tertiary Employment Factor	Industrial Value added Factor	Periphery and Tourism Factor	Low Productive Industry Factor
Share of employment in services	.915	-.253	-.168	-.175
Share of salaried employment in services	.816	-.466	.051	-.216
Employment rate in the service sector	.855	.254	.335	.207
Share of value added in industry	-.421	.847	.013	-.158
Accessibility of population	.408	.313	-.599	.214
Density of population	.441	.389	-.330	.438
Productivity index of industry	.115	.419	.356	-.641
Beds in hotels per 1000 habitants	.091	-.343	.599	.198
Employment rate total	.361	.551	.568	.410
Productivity index of services	-.588	-.401	.136	.475

Source: Eurostat, authors' calculations

3. 5. 2 Second step: A hierarchical cluster analysis

Utilizing these four factors in a hierarchical cluster analysis (Ward, squared Euclidian distance as a proximity measure) resulted in 10 distinct clusters of region types. The usage of the composite factors as described above instead of single variable on the one hand blurs the "borderlines" between single clusters (when analyzed in terms of single variables) and makes interpretation more difficult, but on the other hand backs the classification of a single region into one particular type by taking into account the influence of several variables measuring along similar dimensions.

The result is depicted in in the appendix and the broad pattern of distribution goes as follows: Mainly agrarian dominated regions can be found in the most peripheral areas of Eastern and Southern Europe in Poland, the Baltic states, Greece, Southern Italy and the Iberian Peninsula. Tourist regions are located in the Alpine Space (Austria and Italy) and along the coastal shores of the Mediterranean sea and obtain even the lowest degree of accessibility of population. Peripheral regions with high productivity differentials in favour of industry are located in Sweden, Ireland, the UK and Austria, while those with lower productivity differentials in favour of industry are mainly located in Central and Eastern European countries as well as in Austria, Germany and Greece. Peripheral regions belonging to a tertiary type of cluster are spread over almost all EU-15 states. Mainly comprised of German and Italian regions is a cluster of more central industrial regions with a productivity differential for services, while regional centres with high productivity differential in favour of industry are located in the UK, Sweden, Austria and Germany. A small sample of outliers is comprised by a small number of smaller or less densely populated German cities, which do not fall into the sample of urban areas. The remaining two clusters are broad groups of central regions in Germany, the Benelux countries, France and Spain, but also obtain regions in the periphery, for some of which the regional centre character is rather questionable. As these clusters are on average characterized by low employment rates, the inclusion of rather peripheral regions in this central cluster might stem from low participation rates in some of the peripheral regions.

3. 5. 3 Third step: robustness check with k-means cluster analysis

The Ward-Method, belonging to the type of hierarchical cluster analysis, starts its clustering algorithm with all objects forming single clusters of their own, and assembles the most proximate objects at first (see e.g. Backhaus *et al.* 2000 for a methodological discussion). Decisions of creating new clusters are based upon the criterion of minimum variance. Once assignments are made, decisions upon group membership are no longer revised. The algorithm of k-means on the other hand belongs to the class of "partitioning" cluster analysis and obtains the property that starting from a given set of group means, objects may be relocated in order to achieve more homogeneous groups. This property is used by Blien *et al.* (2006a,b), Perugini and Signorelli (2004) and by Marelli (2007) to check for the robustness of a given cluster analysis on new data. Here the mean values of the four factors by the ten clusters obtained in the second step are utilized as starting values in the third step.

Table 3: Matrix of regional transition probabilities between second and third step

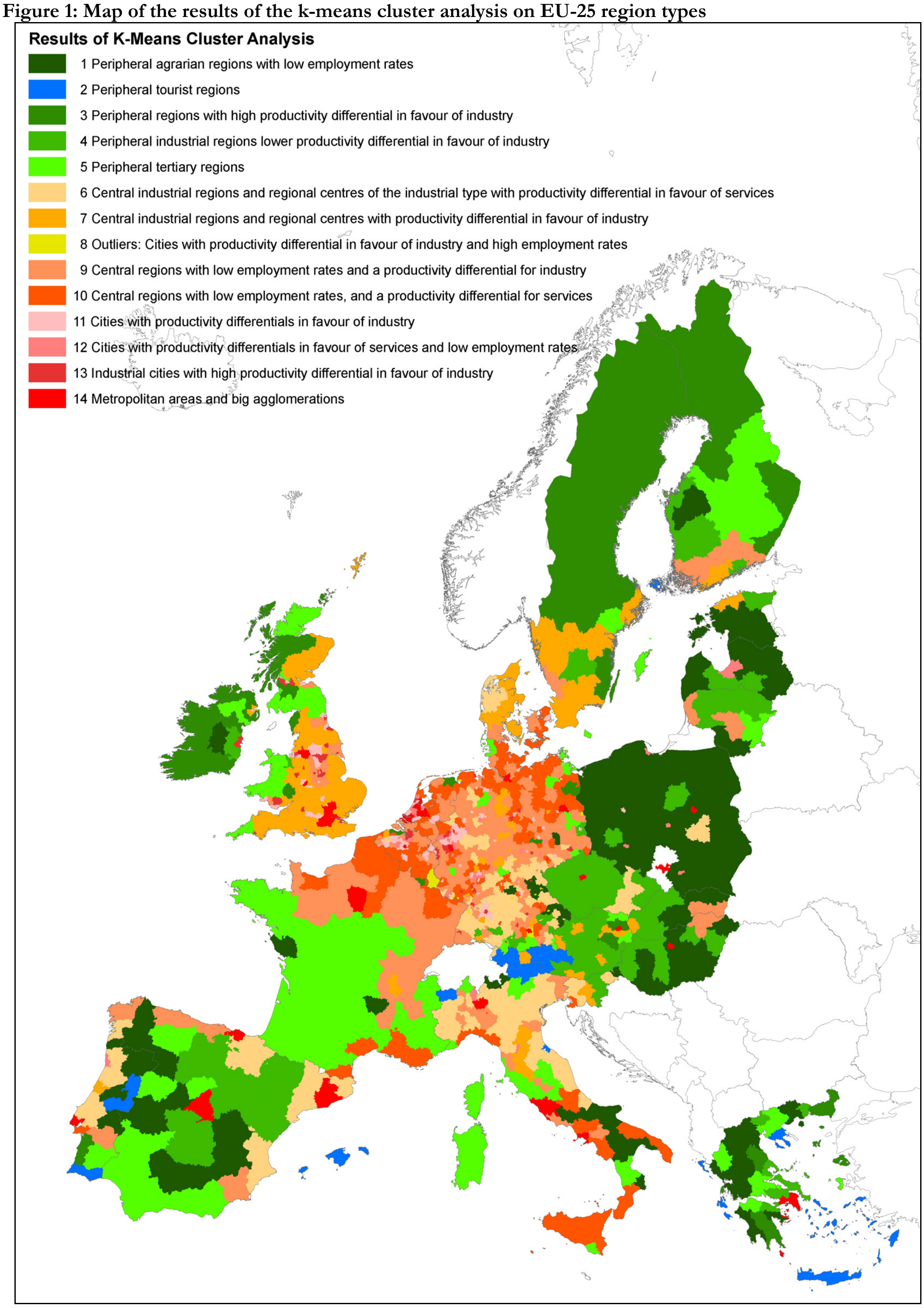
	K-Means Method										
Ward-Method	1	2	3	4	5	6	7	8	9	10	% of total
1	0.7	0.0		0.1	0.0	0.1			0.0	0.0	0.14
2		0.9		0.1							0.02
3			0.7	0.2			0.0				0.04
4				0.8		0.2					0.05
5	0.0	0.0	0.1	0.1	0.7	0.0	0.1			0.0	0.11
6	0.0					0.6	0.0		0.3	0.0	0.18
7		0.0					1.0	0.0			0.05
8								1.0			0.02
9	0.1		0.0	0.1	0.2	0.0	0.0		0.6	0.0	0.20
10					0.1	0.0	0.1		0.1	0.7	0.20
% of total	0.11	0.03	0.05	0.09	0.13	0.14	0.09	0.02	0.20	0.15	976

Source: authors' calculations

It turns out that the results are "reasonably" stable, with 300 out of 976 regions or 31% changing the cluster[20]. The transition matrix in Table 3 reveals that re-classification from peripheral to central clusters took place in the k-means analysis and indeed, the picture obtained by the k-means cluster analysis seems to be more plausible than the Ward-result, as far as the distribution along the peripherality-centrality dimension is concerned. Therefore, the k-means results will be used throughout the rest of the paper. The subsequent naming of the clusters has to be seen with the utmost caution: First of all any term implies a bunch of associated qualities, which – given the utilized variables - can not all be respected. Second, the classification was based on extracted factors, while the interpretation needs to rely on the observed variables. The clusters are therefore more heterogeneous in terms of the variables described than in terms of the factors. The clusters are depicted in Figure 1.

[20] In fact, 30% of changes is much higher than the results the other author's obtained, but given the comparatively very large sample of regions and the scarce set of data, this classification result was among the most stable results produced in this exercise.

Figure 1: Map of the results of the k-means cluster analysis on EU-25 region types



Source: Own depiction, JOANNEUM RESEARCH InTeReg.

Table 4 gives an overview over the qualities of the clusters identified. For a more detailed statistical description see Table 10 (in Appendix).

Table 4: Overview of the cluster-qualities

	1	2	3	4	5	6	7	8	9	10
Peripheral	x	x	(x)	x	x					
Central						x	x	x	x	x
Agrarian (v.a.) high	x	x								
Industrial (v.a.) high			x	x		x	(x)	x	x	
Tertiary (v.a.) high		x			x		x	x		x
Agrarian (employment) high	x	x	x	x	x					
Industrial (employment) high				x		x			x	
Tertiary (employment) high					x			x		x
Employment rate high		x				x	x	x		
Employment rate low	x				x				x	x
Productivity differential industry			x	x			x			
Productivity differential services	x	x				x				
Tourism		x								

Table 5: Description of clusters

Cluster Name	*Description*
1 Peripheral agrarian regions with low employment rates	On average the most peripheral group of regions, with high value added and employment shares in agriculture. This concentration is at the expense of services (lowest employment rates of all clusters in services), but value added shares in services are on average. This leads to a productivity differential in favour of services. Participation and/or commuter inflows in terms of total employment rate are low.
2 Peripheral tourist regions	These tourist regions obtaining the highest number of beds per 1000 habitants (on average 285), are mainly located in areas with low accessibility of population. On average these regions obtain the lowest share of value added and employment in industry, although the Austrian Alpine regions deviate from this rule – as far value added is concerned. The employment share in services is even below the average of all non-urban regions, but this is primarily caused by the high employment shares in agriculture. Total employment rate is high in these regions, indicating the labour intensity of tourism (as opposed to the comparable first cluster.)
3 Peripheral regions with high productivity differential in favour of industry.	Cluster 3 is again (with some exceptions) a low accessible cluster, with a generally low density of population. From its predecessors it can be distinguished by its high share of value added in industry, and at the same time high employment share in services. This results in productivity differentials in favour of industry or the highest industry-services productivity ratio. In the model of Rowthorn/Ramaswamy (1997) these regions would be in a more advanced stage of development – tertiarized and de-industrialized according to high productivity gains in industry. Still, employment rates of these regions are lower than in the previous cluster, and only slightly above average, pointing to further productivity-gain potentials.
4 Peripheral industrial regions with lower productivity differential in favour of industry	Cluster Nr. 4 is generally related to the previous cluster, but the importance of the industrial sector is reflected in both high employment and value added shares. This diminishes the productivity differential in favour of industry as compared to the previous cluster and furthermore, given the still high employment shares in agriculture, the productivity index for services is also above average. This cluster assembles many regions of transition countries (as described by Raiser *et al.* 2004), but also regions of Austria, Germany, Finland, Spain and Greece which in this context could be termed "old industrial areas" (see Steiner 2003).
5 Peripheral tertiary regions	Cluster Nr. 5 is still a peripheral and rural cluster, obtaining both high employment and value added shares in the tertiary sector and below average shares in industry. There is no productivity differential for either of the sectors and together with low employment rates, GDP p.c. is lower than that of regions comparable in their degree of peripherality but productive industries (cluster 3).

Cluster Name	*Description*
6 Central industrial regions and regional centres of the industrial type with productivity differential in favour of services	This cluster is a central relative to cluster Nr. 4. Here again, industry's importance is reflected by both value added and employment which on average leads to a lower productivity index in industry. Together with the centrality functions of these central regions or regional centres, and a resulting higher productivity in services, the productivity differential in favour of industry (which cluster 4 still obtained) diminishes. Total employment rate is high in these regions, pointing to the central character with high commuter-inflows.
7 Central industrial regions and regional centres with productivity differential in favour of industry	Cluster Nr. 7 is the central relative to the peripheral cluster 3. Although it obtains the highest employment and value added shares in the service sector, the employment share in industry is significantly lower than its importance in value added, thereby inducing a high productivity differential in favour of industry. Again these regions are expected to be the most advanced in terms of de-industrialization and tertiarization according to the productivity gap. High employment rates support the centre-character of these regions. As in cluster 6, the distinction between regional centres and central regions was not possible in this step.
8 Outliers: Cities with productivity differential in favour of industry and high employment rates	Regions belonging to cluster Nr. 8 are among the most densely populated and most accessible regions of this sample, and are (with the exception of München, Landkreis and Luxembourg, Grand Duché) German "Kreisfreie Städte" (cities without hinterland), which according to the definition of urban areas did not fall into the cluster analysis of urban areas either because of their size, or because of their low density of population. In terms of economic structure, these cities obtain high employment and value added shares in the service sector, and a slight productivity differential in favour of industry.
9 Central regions with low employment rates and a productivity differential for industry.	Belonging to the more central regions, this cluster obtains regions with a comparatively high share of value added in industry (slightly above the total average) and a slight productivity differential in favour of industry. The describing feature however is the low employment rate of these regions, which may point to the fact that most of these regions do not owe qualities of regional centres, but are part of this cluster rather because of their proximity either to regional centres or to one another. The observation that this cluster is mainly filled by Belgian, Dutch and German regions, which are generally small regional NUTS 3 entities in densely populated areas backs the supposition that this cluster does in general not (or to a lesser extent) contain regional centres. For the Italian regions of this cluster (Pisa, Udine, Ferrara, Asti etc.) this supposition might be questionable and reflects the generally lower participation rates in Italy (on average 34% among the non-urban regions) rather than the out-commuting feature which characterizes the European-core regions.
10 Central regions with low employment rates, and a productivity differential for services.	Cluster 10 is closely related to cluster 9 as far as concerns its accessibility and the low employment rate. Here again the presumption prevails that most of the group members are rather out-commuting central regions or in close proximity to central regions than regional centres themselves. What distinguishes this cluster from the previous one is its specialization in terms of both value added and (lesser in) employment in the service sector, with the employment share in industry being on average even higher than the average value added share, which in turn results in a productivity differential in favour of services.

3. 6 Cluster analysis of urban areas

Both de-industrialization and tertiarization have shaped and still do shape urban development. While industrialization and urbanization were closely interlinked phenomena in the past (see the above discussion of the NEG's models), adverse shocks in the 70s especially affected the coal and steel agglomerations in Europe and rendered some of them to "old industrial areas",[21] while more tertiary dominated cities remained rather unaffected. (Gornig, 2004). Phases of de- and reconcentration of economic activity alter in the course of development (for a historic overview see Benke 2004), and regional demographic development is a closely interlinked topic. For example in Germany phases of decentralization[22] were followed in recent times by a new revival of the cities –

[21] See for example case studies on Dublin, Sheffield (Northern England) and Finland in Cities and Towns in Transition - the European perspective, 2005.

[22] Bade *et al.* (2000) for the period 1976-1996 find deconcentration as a central tendency of spatial structural change in Germany and expect this trend to continue.

but: concentrated to those cities which obtained a high level of supra-regional services, (Gornig 2004), which are usually those that could already accumulate initial advantages. Candidates for such historically accumulated advantages are of course the capital cities, or other metropolitan areas or important cities with leading positions in economic, political and cultural aspects (see Adam, Gödecke-Stellmann 2002).

Following these considerations, the 236 urban regions as identified in the first step were then grouped according to two dimensions: their economic structure and the number of habitants respectively. As discussed before, data availability is scarce on the level NUTS 3 and therefore only rough proxies could be used for the classification. Subsequently, a cluster analysis[23] among the sample of urban regions was conducted, utilizing the productivity index of services together with the number of regional habitants to account for the size of the cities. Other variables such as sectoral value added shares were not feasible, as they turned out to be highly correlated with the productivity index among this sample. The resulting five groups of cities were merged into the following four clusters:

Cluster Name	*Description*
11 Cities with productivity differentials in favour of industry	The biggest cluster of cities obtains an average productivity index of services and a higher than average index in industry. Industry is productive, but due to the already high share of employment in the tertiary sector, the value added contribution of industry is not as high as in the cluster of high productive industrial cities. GDP p.c. is slightly lower than in all urban areas.
12 Cities with productivity differentials in favour of services and low employment rates	Regions in this cluster on average still obtain higher than regional average employment shares in the industrial sector, but value added shares do not come up to this. This results in low productivity indices of industry, basically the lowest among all clusters. In absolute terms productivity in industry is lowest in this cluster, while productivity in services lies approximately in the average of all regions. Membership in this cluster can arise for various reasons: some of these regions might be termed "old industrial areas"[24], with absolute productivity in industries below average and productivity in services not too high either, while the other parts of the regions located in this cluster are rather tertiary regions, with the service sector's labour productivity being significantly higher than industries'[25]. This makes the naming of this cluster rather difficult, but the combining feature of these regions is that wealth stems to a higher extent from services than from industry due to multiple reasons. Employment rates and GDP p.c. are among the lowest in these cities.
13 Industrial cities with high productivity differential in favour of industry	This cluster of cities obtains both the highest shares of industry in employment and value added and accordingly on average also the lowest shares in services. The productivity index in industry is by far the highest and the productivity index in services by far the lowest of all groups, while there is still a comparatively high degree of variation. Employment rates are the highest among all urban areas, and GDP p.c. is the second highest of all urban areas. The high wealth of these cities (second highest in terms of GDP p.c.) stems from industry, while labour productivity in services in absolute terms is also the lowest in these cities.
14 Metropolitan areas and big agglomerations	The cluster of metropolitan areas obtains on average the second highest number of habitants and the most densely populated areas. Its group members are by far the most service and least industry-oriented regions, both in terms of value added and employment. On average, labour productivity in these regions is higher in industry than in services, while the productivity index in services is still slightly above the average of all regions. The observed highest wealth among all clusters in these regions (measured as GDP p.c. in purchasing power standards), hence results from both industry and relatively high productive services. A related cluster is a group of outliers, whose regions (Berlin, Madrid, Barcelona, Attiki, Milano, Roma, Napoli, Centralny slaski) obtain by far the highest number of habitants, as they are displayed with huge parts of their hinterlands, or generally widespread urban areas.) Employment and value added in services is not as high as in this cluster, and the productivity index of services is slightly higher than in industry on average, though, the range of these indices fits perfectly within the range of the metropolitan clusters' indices. Accordingly, these two clusters are merged into a group of "metropolitan areas and big agglomerations".

[23] Ward, Squared Euclidian Distance as a measure of proximity.

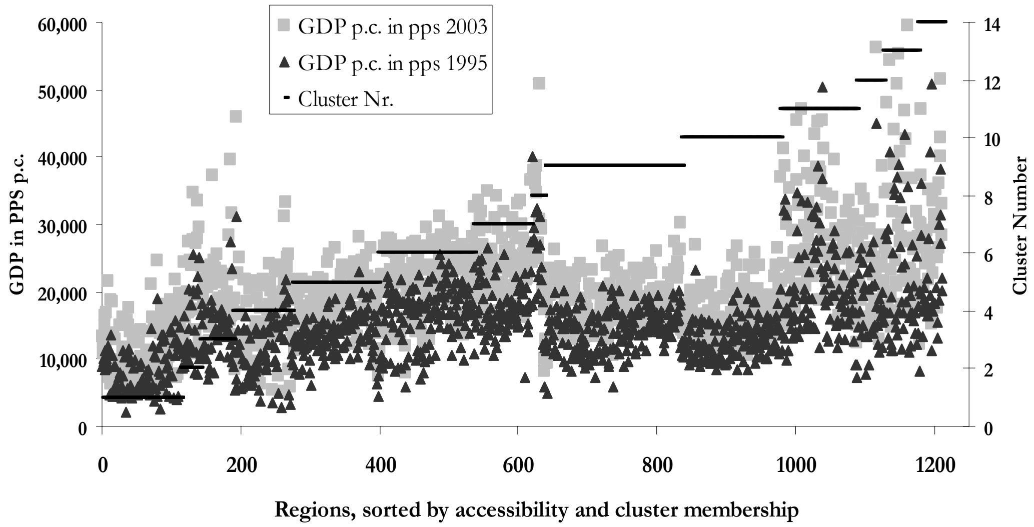
[24] e.g. Pforzheim, Strahlsund, Solingen , Bottrop, Porto or the Polish cities of Krakow, Wroclaw, Gdansk and Lodz.

[25] e.g. Mechelen, Fürth, Groß-Gerau, Düsseldorf or Het Gooi en Vechtstreek.

3. 7 Level and growth of GDP by region types

How far do the identified cluster explain GDP p.c. and the growth of the same measure? As clusters were ordered according to their degree of accessibility (at least in the non-urban areas), the following Figure 2 is a plot of inter-cluster accessibility and economic strength. At the first sight, GDP p.c. is increasing with the cluster number up to cluster number 8, with cluster 2 and 3 (both peripheral, one tourist, one with a productivity differential in favour of industry), showing considerable amounts of (positive) outliers. The more central regions of cluster 9 and 10 exhibit significantly lower GDP p.c., according to their significantly lower employment rates.

Figure 2: GDP p.c. in pps 1995 and 2003 by cluster

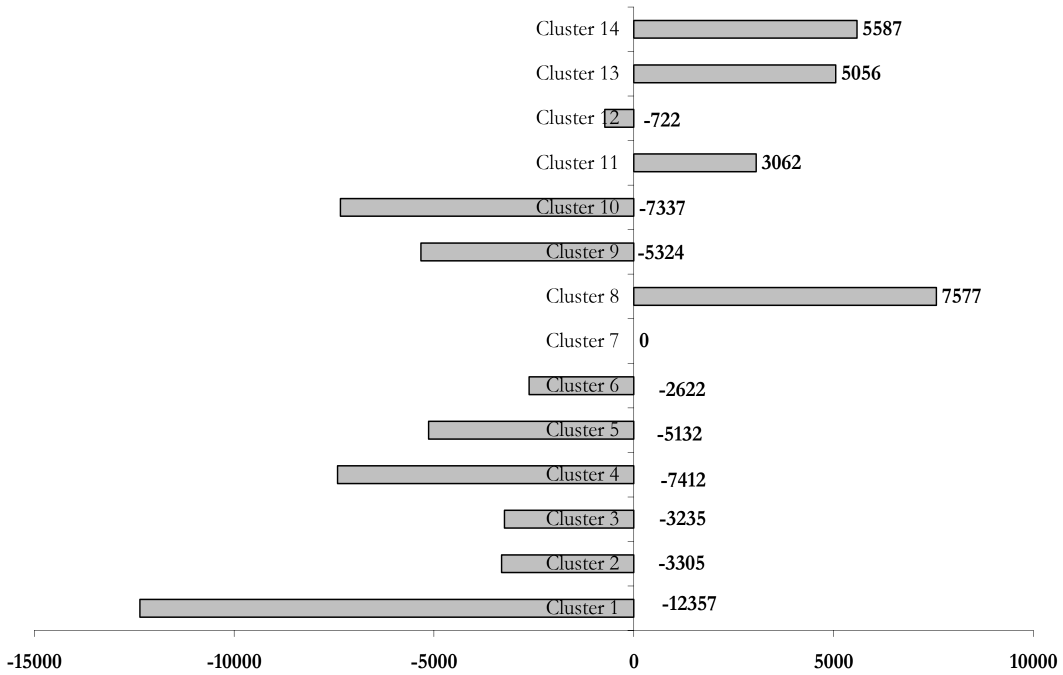


Source: EUROSTAT, authors' calculations; x-axis: regions, ordered by accessibility of population and cluster membership. Scale set to max. 60.000, (outliers are not displayed).

Subsequently it was tested by means of econometric estimations, whether GDP p.c. could be explained by cluster-membership. This was done by utilizing dummy variables for cluster membership (together with national dummies to account for spatial effects) in explaining GDP p.c. in 2003 in levels, utilizing cluster Nr. 7 (central industrial regions and regional centres with productivity differential in favour of industry) as the benchmark group, see the estimation outputs in Table 13. It turns out, that the explanatory power of the models is fairly good in the overall sample and in the sample of non-urban regions, with R^2 ranging from 0.39 – 0.65 (when national dummies are included), while among the sample of urban-regions, cluster-membership does not explain GDP p.c., neither does the inclusion of national dummies in the latter case.

In Figure 3 the estimation results are summarized: In the total sample of all 1,212 NUTS 3 regions, average GDP p.c. (in cluster 7) is 24,097 pps. Cluster specific deviations from this mean are plotted in the figure. The urban regions (including the urban outlier cluster Nr. 8, except the cities with productivity differential in favour services.) exhibit a higher GDP p.c. than the benchmark group. This cluster does not show a significant deviation from the benchmark cluster 7. Highest per capita GDP among all clusters is on average found by the outlier group of cities with productivity differentials in favour of industry and high employment rates. This cluster has employment rates which are by far higher than those of other clusters. As detected in section 0 the employment rate shows by far the largest influence on the level of GDP – before accessibility and economic structure. Central regions with low employment rates of either type (cluster 9 and 10) have a significantly lower level of GDP p.c. than their (on average more peripheral) higher employment rate-counterparts. Clusters with high productivity differentials in favour of industry generally exhibit higher GDP p.c. than those with productivity differential for services or those with a lower productivity differential in favour of industry. The inclusion of national dummies in the regression does not alter this general picture.

Figure 3: Estimation results: average deviation from GDP p.c. in cluster 7 (24.097) in the total sample of 1,212 regions



Notes: Results as obtained by estimation of model 15, see Table 13, without national dummies.
Source: EUROSTAT, authors' calculations.

The discussion on the estimation of convergence by adequately taking into account regional spillovers has been given some attention in the recent literature: Fischer/Stirboeck (2004) emphasize the importance of spatial interactions in regional cross section studies, and show that failure to include spatial proximity in appropriate models may result in strongly biased estimates of the speed of convergence. Among the sample of 1995-2000 NUTS 2 regions they detect two convergence clubs (North-West and South East) by means of exploratory spatial analysis and find that South-East converges to its own steady state with a higher rate of 2.4% than North-West with 1.5%. Braeuninger/Niebuhr (2005) in a sample of 1980-2002 NUTS 2 regions on the other hand show that by including country dummies, spatial effects already diminish. They furthermore test for different region types and find significant lower steady state convergence levels for urbanized and rural regions compared to agglomerations. Among the whole sample they find low, but significant convergence. Similar results are obtained by Feldkircher (2006) by using a spatial weights matrix which displays within-country interaction: once national influences are controlled for, spatial dependence is of the nuisance form and spillovers across regions to a lesser extent influence growth than national effects. In a sample of NUTS 3 regions (only German regions on a more aggregate level) for the period 1995-2002, Paas/Schlitte (2006) find no considerable convergence in the EU-25, EU-15 and EU-10 when estimating spatial models and significant processes of divergence when controlling for country-effects in the EU-10.

As far as the growth rate of GDP p.c. is concerned the simple regressions on absolute β-convergence (see Barro/Sala-i-Martin 1995) were estimated conditioning over various samples (total, east, west, urban and non-urban) and over different cluster types, testing the hypothesis that initially poorer regions grew faster than richer regions, thereby leading to convergence in the per capita GDP levels.

The model actually estimated is

$$\frac{1}{T}\log\left(\frac{GDP_{p.c.03}}{GDP_{p.c.95}}\right)=\alpha_0+\alpha_1*\log\left(GDP_{p.c.95}\right)+u_i \qquad [3]$$

with $\beta=-\ln(1-\alpha_1 T)/T$.

Results are displayed in Table 14 and for the total sample depicted in Figure 3. From this exercise it can be seen, that over the sample of all regions significant but low convergence can be detected (β: -0.015). The β-parameter and hence the speed of convergence is higher in the sample of non-urban regions (-0.018 vs. -0.014 in urban regions) and overall slightly higher in "west" than in "east"[26] (-0.013 vs. -0.012), although the explicative power of the model (in terms of R^2=0.08) is especially poor in the eastern sample. Hence the observed convergence in the overall sample results from some eastern regions catching up faster than others. In the eastern sample only 2 clusters are sufficiently filled for meaningful regression analysis. It turns out, that the poorest cluster 1 of the eastern sample (peripheral agrarian regions with low employment rates), which in fact includes almost half of the eastern European regions, exhibited very high convergence rates (-0.034), but that this conditional[27] convergence did not lead to an overall convergence in the total sample of cluster 1 (-0.019), although also the western agrarian regions (-0.024) themselves showed high convergence in their group. A similar but not as pronounced pattern can be found in cluster Nr. 4 (peripheral industrial regions with lower productivity differential in favour of industry), with high rates of convergence in the eastern sample (-0.025) and convergence among the western sample regions (-0.015) being of similar size than overall convergence (-0.015). These observations reveal that the eastern European regions are mainly converging to their own respective cluster members, but much slower to the more advanced western European regions.

In the total sample of regions it turns out, that convergence rates in the clusters to their own steady states are in almost all cases significantly higher than is total convergence among all clusters. No significant convergence can be detected in the more

[26] The eastern sample here covers the new member states of the EU-25 in transition, hence excluding Malta and Cyprus. In this paper Eastern Germany belongs to the western sample.

[27] The expression conditional might be used in this context, as the cluster analysis itself controls for factors conditioning regional qualities, although separate variables have not been included into the regression.

central clusters 8, 10, and 14[28]. The highest rates of convergence to their own respective steady states can be found in peripheral regions with a high productivity differential in favour of industry (cluster 3), peripheral tertiary regions (cluster 5), central industrial regions and regional centres with productivity differential in favour of industry (cluster 7), central regions with low employment rates and a productivity differential for industry (cluster 9) and cities with productivity differentials in favour of services (cluster 12). Among those only 2 clusters show significantly higher convergence rates when eastern European regions are included, which is basically an "outlier-effect" as in the first case, only Vilniaus apskritis and in the second only Pohja-Eesti, Osrednjeslovenska and Bratislavsky kraj were included in the estimation.

These estimations were conducted separately on the cluster samples. In order to judge whether the region types converge to different steady states, the cluster dummies were included altogether into the regression, with and without national dummies. The findings appear to be in line with Paas/Schlitte (2006): upon inclusion of national dummies the speed of convergence reduces in the total and the western sample, while evidence for divergence is found in the eastern sample. But interestingly, when taking into account region types, the speed of convergence re-increases in all samples (with east still non-significant estimates). This finding is rather interesting: When considering different steady states only country wise the estimations point to low convergence rates or even divergence, while when allowing for steady states varying by country and region types, somewhat faster convergence can be found among the total and the western sample. The estimates point to significant lower steady states in the peripheral agrarian regions, the peripheral industrial regions with lower productivity differential in favour of industry, the peripheral tertiary regions and both types of central regions with low employment rates. The estimated coefficients and hence the deviation from the "average" steady state is highest in the peripheral agrarian regions (cl.1) and the central regions with low employment rates and a productivity differential for services (cl.10). In the western sample these two region types are the only clusters with significantly lower steady states. A higher steady state income is estimated for the metropolitan areas and the big agglomerations.

Table 6: Estimation outputs for β-convergence, national effects vs. cluster effects

	Mod. Nr.	**56**	**57**	**58**	**59**	**60**	**61**
		Cluster Dummies			National Dummies		
Variable		Total Sample	West	East	Total Sample	West	East
Constant	Coefficient	0.242	0.101	0.281	-0.014	0.228	0.114
	Prob.	0.000	0.000	0.000	0.723	0.000	0.000
LOG(GDPPPS5)	Coefficient	-0.021	-0.006	-0.024	0.009	-0.019	-0.008
	Prob.	0.000	0.000	0.000	0.053	0.000	0.000
R-squared	Coefficient	0.315	0.467	0.251	0.426	0.237	0.397

Note: Estimation with OLS, reference dummies Austria (total and western sample), Slovak republic (Eastern sample), cluster Nr. 7 (total sample) and all but cluster 1 and 4 (eastern sample). Dummy coefficients not displayed; checks with different reference groups showed robust parameter estimates for log(gdppps5).

[28] These are the following clusters: outliers/cities with productivity differential in favour of industry and high employment rates (cl. 8), central regions with low employment rates, and a productivity differential for services (cl.10) and metropolitan areas and big agglomerations (cl. 4).

4. Main findings and discussion

In this paper a static typology of European regions at the level NUTS 3 on economic structure and spatial categories was conducted, which should serve to explain differences in the level and growth of GDP p.c. and can be used in further research on European regions.

Multivariate regression analysis in the first stage showed that GDP p.c. is best explained by the regional employment rate, while spatial qualities or economic structure to a lesser extent determine GDP p.c. Still, the regional employment rate beside being a regional participation rate, also captures net-regional commuting and is henceforth also a spatial measure. Over the sample of non-urban regions accessibility of population is a better predictor of GDP p.c. than population density, while population density better predicts the GDP p.c. when urban areas are included in the sample. Interestingly, in non-urban regions beside the other factors used in the estimates a high specialization in agriculture (however measured) is not negatively related to the level of GDP p.c., and does even show significant positive influence in the whole sample. Higher shares of regional value added in the industrial sector are associated with a higher level of GDP, whereas a productivity differential in favour of industry corrects for this observation.

In further stages, 14 region types (10 non-urban and 4 urban) were identified, utilizing factor and cluster analytic methods. The regions were classified according to spatial qualities (urban/non-urban, accessibility of population, regional employment rate) and economic structure (sectoral value added and employment shares in the three main sectors and tourism as a separate branch), and productivity differentials between the industrial and the service sector which should reflect the stage of regional development in the course of tertiarization and de-industrialization.

Inclusion of these region types in cross regional regressions of GDP p.c. showed that GDP p.c. 2003 can be explained by cluster membership, but only in the sample of non-urban regions and over the whole sample. In the urban sample, further research is needed as to what explains the level of GDP p.c. The supposition is that data on accessibility and economic structure can to a certain degree explain GDP p.c. in the (bigger and more heterogeneous sample of) non-urban areas, but can not adequately account for differences in urban areas. This in turn calls for the utilization of a more detailed data set among the sample of urban areas. As a generalized rule, the expected core-periphery gap in the level of GDP p.c. does prevail, but with significant exceptions. Peripheral tourist regions (cluster 2), show significantly lower (negative) deviations of GDP p.c. than the benchmark cluster 7 of central regions and regional centres with productivity differential in favour of industry. On the other hand, the more central clusters 9 and 10 (central regions with low employment rates) obtain significantly lower levels of GDP p.c. as compared to the benchmark. Furthermore the estimates confirm the hypothesis that clusters with productivity differentials in favour of industry obtain a higher level of GDP pc. as compared to their service-productivity-differential counterparts[29]. Individual (OLS) regressions on β-convergence among the different

[29] Taking into account country effects, peripheral regions with high and lower productivity differentials in favour of industry (cl. 3 and 4) show significantly higher GDP p.c. than peripheral tertiary regions. Central industrial regions and regional centres with productivity differential in favour of services obtain a lower level of GDP p.c. (cl. 6) than those with a productivity differential in favour of industry (cl. 7). Central regions with low employment rates and a productivity differential in favour of industry (cl. 9) obtain higher GDP p.c. levels than the service productivity-differential counterparts (cl.10), and also

samples of region types show that convergence rates of GDP p.c. in the clusters to their own steady states are in almost all cases significantly higher than is total convergence among all clusters. This leads to the supposition that at least some of the clusters identified can be interpreted as convergence clubs. Eastern European regions are mainly converging to their own respective cluster members, but much less to the more advanced western European regions (especially in the agrarian cluster 1, lesser but still in the cluster 4 of peripheral industrial regions with lower productivity differential in favour of industry). Clusters without significant β-convergence estimates can be found in some central and urban clusters, which points to the persistence of differences in GDP p.c. "in the core " , while the periphery all in all catches up.

In line with other recent articles[30] this paper finds a reduction of the speed of convergences upon inclusion of national dummies in the total and the western sample, while evidence for divergence is even found in the eastern sample. But interestingly, when taking into account region types, the speed of convergence re-increases in all samples and still indicates small, but overall convergence. The estimates point to significant lower steady state incomes in the peripheral agrarian regions, the peripheral industrial regions with lower productivity differential in favour of industry, the peripheral tertiary regions and both types of central regions with low employment rates. A higher steady state income is estimated for the metropolitan areas and the big agglomerations. These region types form convergence clubs with individual steady states, while the other are suspected to converge to the same steady state.

All in all this paper has shown that both economic structure, which partly reflects the stage of development by the degree of tertiarization and de-industrialization through the interplay of employment and value added shares, together with spatial conditions such as the accessibility and density of population matter in determining level and growth of GDP per capita. Studies – be they comparative exercises or sophisticated convergence studies - should take these heterogeneity of European regions into account, which is by no means a dichotomic core-periphery or an industry-service type gap.

among cities those with high productivity differential in favour of industry (cl. 13) obtain higher levels of GDP p. c. than service-oriented cities (cl.12) or those with a lower productivity differential (cl. 11).

[30] Braeuningner/Niebuhr 2005 and Paas/Schlitte 2006;

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Appendix

Table 7: Pairwise correlations in different samples

	1	2	3	4	5	6	7	8	9
Correlation Matrix: Total Sample (1,212 regions)									
1 Accessibility index	1.00	0.28	-0.23	-0.03	0.23	-0.01	-0.32	0.11	0.06
2 Density of population	0.28	1.00	-0.04	-0.21	0.34	0.08	-0.17	0.12	-0.04
3 Beds per 1000 habitants	-0.23	-0.04	1.00	-0.19	0.15	-0.07	0.13	-0.09	-0.10
4 Value added share of industry	-0.03	-0.21	-0.19	1.00	-0.92	0.30	-0.22	0.35	0.74
5 Value added share of services	0.23	0.34	0.15	-0.92	1.00	-0.29	0.04	-0.26	-0.62
6 Productivity index of industry	-0.01	0.08	-0.07	0.30	-0.29	1.00	-0.33	0.90	-0.07
7 Productivity index of services	-0.32	-0.17	0.13	-0.22	0.04	-0.33	1.00	-0.65	-0.11
8 Ratio Labour productivity industry over services	0.11	0.12	-0.09	0.35	-0.26	0.90	-0.65	1.00	0.02
9 Employment rate in the industrial sector (per habitant)	0.06	-0.04	-0.10	0.74	-0.62	-0.07	-0.11	0.02	1.00
10 Employment rate in the service sector (per habitant)	0.31	0.54	0.04	-0.30	0.48	0.18	-0.40	0.29	0.09
Correlation Matrix: Non-Urban Sample (976 regions)									
	1	2	3	4	5	6	7	8	9
1 Accessibility index	1.00	0.44	-0.21	0.06	0.14	-0.08	-0.28	0.04	0.11
2 Density of population	0.44	1.00	-0.13	0.06	0.15	-0.03	-0.19	0.06	0.19
3 Beds per 1000 habitants	-0.21	-0.13	1.00	-0.22	0.20	-0.06	0.11	-0.07	-0.11
4 Value added share of industry	0.06	0.06	-0.22	1.00	-0.90	0.33	-0.25	0.38	0.76
5 Value added share of services	0.14	0.15	0.20	-0.90	1.00	-0.37	0.08	-0.34	-0.64
6 Productivity index of industry	-0.08	-0.03	-0.06	0.33	-0.37	1.00	-0.27	0.89	-0.10
7 Productivity index of services	-0.28	-0.19	0.11	-0.25	0.08	-0.27	1.00	-0.62	-0.08
8 Ratio Labour productivity industry over services	0.04	0.06	-0.07	0.38	-0.34	0.89	-0.62	1.00	-0.04
9 Employment rate in the industrial sector (per habitant)	0.11	0.19	-0.11	0.76	-0.64	-0.10	-0.08	-0.04	1.00
10 Employment rate in the service sector (per habitant)	0.24	0.38	0.12	-0.19	0.37	0.14	-0.46	0.30	0.11
Correlation Matrix: Urban Sample (236 regions)									
	1	2	3	4	5	6	7	8	9
1 Accessibility index	1.00	-0.01	-0.17	-0.03	0.00	-0.03	0.00	-0.03	-0.13
2 Density of population	-0.01	1.00	0.25	-0.30	0.32	0.01	0.05	-0.02	-0.18
3 Beds per 1000 habitants	-0.17	0.25	1.00	-0.22	0.23	-0.01	0.05	-0.03	-0.06
4 Value added share of industry	-0.03	-0.30	-0.22	1.00	-0.99	0.32	-0.63	0.48	0.76
5 Value added share of services	0.00	0.32	0.23	-0.99	1.00	-0.30	0.62	-0.46	-0.75
6 Productivity index of industry	-0.03	0.01	-0.01	0.32	-0.30	1.00	-0.82	0.96	0.06
7 Productivity index of services	0.00	0.05	0.05	-0.63	0.62	-0.82	1.00	-0.93	-0.41
8 Ratio Labour productivity industry over services	-0.03	-0.02	-0.03	0.48	-0.46	0.96	-0.93	1.00	0.23
9 Employment rate in the industrial sector (per habitant)	-0.13	-0.18	-0.06	0.76	-0.75	0.06	-0.41	0.23	1.00
10 Employment rate in the service sector (per habitant)	-0.13	0.35	0.31	-0.39	0.41	0.16	-0.04	0.10	0.08

Source: Eurostat, IRPUD, authors' calculations

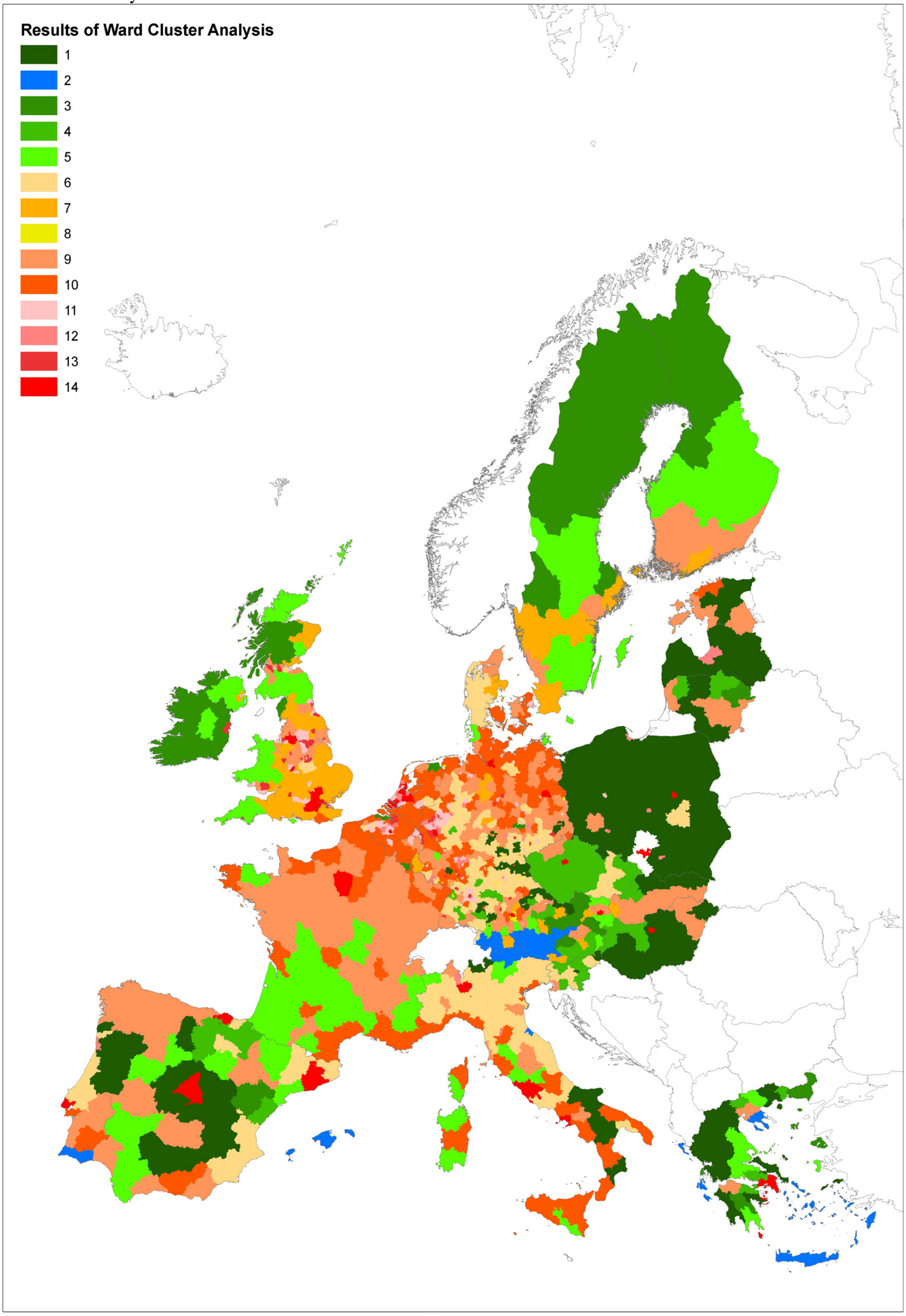
Table 8: Estimation outputs for the sample of all regions, dependent variable: GDP per capita in pps

Variable		1	2	3	4	5	6	7
Constant	Coefficient	348	1,172	-5,769	-4,093	-1,978	-6,699	-5,246
	Prob.	0.66	0.21	0	0	0.04	0.08	0
Accessibility of Population	Coefficient	0.08	0.08	0.08	0.07		0.06	0.09
	Prob.	0	0	0	0		0	0
Density of Population	Coefficient					0.87		
	Prob.					0		
Beds in hotels p.1000c.	Coefficient	10.19	9.41	15.61	15.36	12.7	16.85	14.75
	Prob.	0	0	0	0	0	0	0
Share of value added	Coefficient			24,311	24,602	25,932		26,409
in the secondary sector	Prob.			0	0	0		0
Share of value added	Coefficient						47837	
in the tertiary sector	Prob.						0	
Productivity index	Coefficient		6		-31	-36		-40
secondary sector	Prob.		0.48		0	0		0
Productivity index	Coefficient						-194	
tertiary sector	Prob.						0	
Productivity differential	Coefficient	1,750		-1,624				
	Prob.	0.03		0.03				
Employment rate	Coefficient						110,817	
secondary sector	Prob.						0	
Employment rate	Coefficient	54,810	56,048	64,157	64,215	62,778		66,826
tertiary sector	Prob.	0	0	0	0	0		0
Share of employment	Coefficient							6371
primary sector	Prob.							0.01
R-squared		0.64	0.64	0.7	0.7	0.7	0.49	0.7
Log likelihood		-12,025	-12,031	-11,924	-11,918	-11,920	-12,234	-11,913
F-Statistic		539	530	553	561	558	235	472
Included observations		1,212	1,212	1,212	1,212	1,212	1,212	1,212

Table 9: Estimation outputs for the sample of non-urban regions, dependent variable: GDP per capita in pps

Variable	Model Nr.:	8	9	10	11	12	13	14
Constant	Coefficient	1,039	1,523	-4,083	-2,740	-1,645	6,014	-2,891
	Prob.	0.18	0.1	0	0	0.09	0.11	0.01
Accessibility of Population	Coefficient	0.08	0.08	0.06	0.06		0.04	0.06
	Prob.	0	0	0	0		0.01	0
Density of Population	Coefficient					2.91		
	Prob.					0.01		
Beds in hotels p.1000c.	Coefficient	10.31	9.52	14.44	14.3	12.73	18.59	14.22
	Prob.	0	0	0	0	0	0	0
Share of value added	Coefficient			19,748	20,338	20,565		20,557
in the secondary sector	Prob.			0	0	0		0
Share of value added	Coefficient						29151	
in the tertiary sector	Prob.						0	
Productivity index	Coefficient		7		-23	-26		-24
secondary sector	Prob.		0.49		0.01	0		0.04
Productivity index	Coefficient						-167	
tertiary sector	Prob.						0	
Productivity differential	Coefficient	1,599		-1,047				
	Prob.	0.07		0.23				
Employment rate	Coefficient						82,771	
secondary sector	Prob.						0	
Employment rate	Coefficient	53,688	55,660	62,306	62,307	62,740		62,746
tertiary sector	Prob.	0	0	0	0	0		0
Share of employment	Coefficient							642
primary sector	Prob.							0.81
R-squared		0.5	0.49	0.56	0.57	0.56	0.45	0.57
Log likelihood		-9,562	-9,567	-9,495	-9,490	-9,498	-9,611	-9,490
F-Statistic		241	235	249	254	247	156	211
Included observations		976	976	976	976	976	976	976

Figure 4: Map of the results of the hierarchical cluster analysis (Ward, first step), including results of analysis on urban areas



Source: own depiction, JOANNEUM RESEARCH, InTeReg

Table 10: Descriptive Statistics for the final clusters obtained by k-means and among the sample of urban areas, cluster 1-7

Cluster Number	1	2	3	4	5	6	7
Number of Cluster - Members	**112**	**28**	**47**	**85**	**124**	**138**	**83**
Accessibility Index - Mean	**12,880**	**12,839**	**13,083**	**15,347**	**16,136**	**28,119**	**30,543**
Std. Dev.	6,298	7,336	9,953	5,842	7,150	6,497	9,356
Coefficient of Variation	49	57	76	38	44	23	31
GDP per capita in pps - Mean	**11,741**	**20,793**	**20,863**	**16,685**	**18,965**	**21,476**	**24,097**
Std. Dev.	4,284	6,269	5,229	6,644	3,166	5,088	4,767
Coefficient of Variation	36	30	25	40	17	24	20
Density of population - Mean	**72**	**82**	**52**	**78**	**84**	**195**	**243**
Std. Dev.	42	104	52	51	70	106	140
Coefficient of Variation	58	126	99	65	83	54	57
Employment rate (in terms of regional population) - Mean	**35**	**46**	**43**	**43**	**39**	**45**	**51**
Std. Dev.	5	9	6	6	5	5	6
Coefficient of Variation	16	18	15	14	12	11	11
Beds in Hotels per 1000 habitants - Mean	**21**	**285**	**35**	**28**	**44**	**26**	**26**
Std. Dev.	29	155	31	35	41	24	23
Coefficient of Variation	138	55	89	127	92	96	89
Share of value added in agriculture - Mean	**0.09**	**0.07**	**0.06**	**0.06**	**0.05**	**0.03**	**0.02**
Std. Dev.	0.06	0.05	0.06	0.04	0.04	0.02	0.02
Coefficient of Variation	61	71	88	67	69	90	111
Share of value added in industry - Mean	0.26	0.2	0.35	0.43	0.22	0.37	0.27
Std. Dev.	0.07	0.1	0.1	0.07	0.05	0.06	0.06
Coefficient of Variation	28.24	49.17	28.23	17.12	21.34	16.04	20.71
Share of value added in services - Mean	**0.65**	**0.74**	**0.59**	**0.52**	**0.72**	**0.6**	**0.71**
Std. Dev.	0.06	0.08	0.08	0.06	0.06	0.05	0.06
Coefficient of Variation	8.81	11.21	13.72	11.41	7.88	9.16	8.26
Share of employment in agriculture - Mean	**0.21**	**0.21**	**0.1**	**0.14**	**0.08**	**0.05**	**0.03**
Std. Dev.	0.12	0.13	0.11	0.11	0.06	0.05	0.03
Coefficient of Variation	58.98	63.46	101.72	75.66	75.65	89.02	91.23
Share of employment in industry - Mean	**0.27**	**0.21**	**0.23**	**0.36**	**0.22**	**0.4**	**0.23**
Std. Dev.	0.08	0.07	0.07	0.08	0.05	0.06	0.04
Coefficient of Variation	28.23	31.66	30.23	21.8	20.99	14.6	18.19
Share of employment in services - Mean	**0.52**	**0.6**	**0.67**	**0.5**	**0.7**	**0.55**	**0.74**
Std. Dev.	0.08	0.12	0.09	0.07	0.06	0.06	0.05
Coefficient of Variation	14.74	20.03	12.92	14.09	9.01	11.46	6.76
Employment rate in agriculture - Mean	**0.07**	**0.09**	**0.04**	**0.06**	**0.03**	**0.02**	**0.02**
Std. Dev.	0.05	0.07	0.04	0.05	0.02	0.02	0.02
Coefficient of Variation	64.28	77.1	103.28	78.68	74.94	102.86	100.54
Employment rate in industry - Mean	**0.1**	**0.1**	**0.1**	**0.16**	**0.09**	**0.18**	**0.11**
Std. Dev.	0.03	0.03	0.03	0.05	0.02	0.03	0.02
Coefficient of Variation	33.16	35.63	30.4	29.82	25.46	17.6	20.35
Employment rate in services - Mean	**0.18**	**0.27**	**0.29**	**0.22**	**0.28**	**0.25**	**0.38**
Std. Dev.	0.04	0.07	0.06	0.04	0.04	0.04	0.05
Coefficient of Variation	19.65	25.42	21.22	17.84	14.11	15.68	12.81
Productivity index in industry - Mean	**97**	**96**	**159**	**121**	**103**	**95**	**119**
Std. Dev.	21	34	38	20	14	10	18
Coefficient of Variation	21	35	24	16	14	10	15
Productivity index in services - Mean	**127**	**127**	**89**	**104**	**103**	**110**	**96**
Std. Dev.	20	25	14	13	6	13	6
Coefficient of Variation	15	20	16	13	5	11	7
Productivity ratio: industry to services - Mean	**77**	**77**	**184**	**117**	**100**	**88**	**125**
Std. Dev.	15	29	57	21	16	15	27
Coefficient of Variation	19	38	31	18	16	17	22

Note: Dark fillings in the mean lines refer to highest value of all clusters, light fillings to the lowest, while the light fillings in the coefficient of variation line refers to the cluster with the lowest degree of variation.

Source: EUROSTAT, IRPUD, authors' calculations

Table 11: Descriptive Statistics for the final clusters obtained by k-means and among the sample of urban areas, cluster 8-14

Cluster Number	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Number of Cluster - Members	**19**	**198**	**142**	**110**	**38**	**50**	**38**
Accessibility Index - Mean	**31,506**	**32,561**	**34,564**	**37,961**	**37,607**	**34,383**	**35,818**
Std. Dev.	5,286	8,520	9,800	9,826	11,202	8,973	13,044
Coefficient of Variation	17	26	28	26	30	26	36
GDP per capita in pps - Mean	**33,932**	**18,773**	**16,760**	**27,506**	**23,376**	**29,154**	**32,655**
Std. Dev.	12,015	3,694	3,694	8,489	8,205	11,439	16,451
Coefficient of Variation	35	20	22	31	35	39	50
Density of population - Mean	**688**	**162**	**193**	**1631**	**1339**	**1419**	**3286**
Std. Dev.	284	95	117	1111	685	896	3698
Coefficient of Variation	41	58	61	68	51	63	113
Employment rate (in terms of regional population) - Mean	**66**	**39**	**34**	**55**	**48**	**56**	**54**
Std. Dev.	12	4	5	14	11	18	20
Coefficient of Variation	18	10	14	26	24	32	38
Beds in Hotels per 1000 habitants - Mean	**19**	**17**	**19**	**19**	**15**	**14**	**20**
Std. Dev.	14	12	19	35	22	9	18
Coefficient of Variation	75	70	101	189	146	64	89
Share of value added in agriculture - Mean	**0**	**0.03**	**0.03**	**0**	**0.01**	**0**	**0**
Std. Dev.	0	0.02	0.02	0.01	0.01	0	0
Coefficient of Variation	51	70	56	299	135	84	113
Share of value added in industry - Mean	0.28	0.32	0.21	0.24	0.22	0.36	0.19
Std. Dev.	0.1	0.04	0.04	0.08	0.07	0.11	0.07
Coefficient of Variation	36.89	13.52	20.43	34.42	30.26	30.38	34.7
Share of value added in services - Mean	**0.72**	**0.65**	**0.75**	**0.76**	**0.77**	**0.64**	**0.8**
Std. Dev.	0.1	0.04	0.04	0.08	0.07	0.11	0.07
Coefficient of Variation	14.35	6.07	5.74	10.95	8.72	16.8	8.56
Share of employment in agriculture - Mean	**0.01**	**0.05**	**0.05**	**0.01**	**0.01**	**0.01**	**0.01**
Std. Dev.	0	0.02	0.03	0.01	0.01	0	0.01
Coefficient of Variation	42.24	51.83	53.12	161.08	95.97	58.12	103.6
Share of employment in industry - Mean	**0.27**	**0.31**	**0.23**	**0.21**	**0.25**	**0.27**	**0.19**
Std. Dev.	0.08	0.04	0.05	0.08	0.07	0.09	0.07
Coefficient of Variation	29.03	12.59	20.9	36.63	29.65	34.57	36.59
Share of employment in services - Mean	**0.72**	**0.65**	**0.72**	**0.78**	**0.74**	**0.73**	**0.81**
Std. Dev.	0.08	0.04	0.05	0.08	0.07	0.09	0.07
Coefficient of Variation	10.5	6.22	7.19	10.22	9.98	12.75	9.04
Employment rate in agriculture - Mean	**0.01**	**0.02**	**0.02**	**0**	**0**	**0**	**0**
Std. Dev.	0	0.01	0.01	0.01	0	0	0
Coefficient of Variation	44.33	54.88	49.38	143.72	85.41	55.15	87.88
Employment rate in industry - Mean	**0.18**	**0.12**	**0.08**	**0.11**	**0.11**	**0.16**	**0.09**
Std. Dev.	0.06	0.02	0.02	0.05	0.04	0.09	0.03
Coefficient of Variation	32.24	16.04	24.08	41.38	31.05	60.76	32.74
Employment rate in services - Mean	**0.48**	**0.25**	**0.24**	**0.44**	**0.36**	**0.41**	**0.44**
Std. Dev.	0.1	0.03	0.04	0.13	0.11	0.13	0.2
Coefficient of Variation	20.68	12.02	16.57	30.22	30.17	30.99	45.53
Productivity index in industry - Mean	**103**	**106**	**94**	**114**	**90**	**135**	**105**
Std. Dev.	17	12	13	9	10	13	13
Coefficient of Variation	17	12	14	8	11	10	13
Productivity index in services - Mean	**99**	**100**	**104**	**97**	**104**	**88**	**100**
Std. Dev.	6	6	5	2	4	6	3
Coefficient of Variation	6	6	5	2	4	7	3
Productivity ratio: industry to services - Mean	**106**	**107**	**91**	**118**	**87**	**155**	**105**
Std. Dev.	24	19	17	12	12	21	17
Coefficient of Variation	22	17	18	10	13	14	16

Note: Dark fillings in the mean lines refer to highest value of all clusters, light fillings to the lowest, while the light fillings in the coefficient of variation line refers to the cluster with the lowest degree of variation.
Source: EUROSTAT, IRPUD, authors' calculations.

Table 12: Regions in Cluster 3/urban areas: Productivity differentials in favour of services

Code	Region	Productivity in industry	Productivity in services	Share of employment in industry
BE212	Arr. Mechelen	62,418	66,328	0,26
BE231	Arr. Aalst	51,128	51,302	0,23
DE129	Pforzheim, Stadtkreis	41,649	46,190	0,31
DE244	Hof, Kreisfreie Stadt	36,319	42,545	0,22
DE253	Fürth, Kreisfreie Stadt	51,382	64,946	0,26
DE717	Groß-Gerau	52,305	58,372	0,35
DE71A	Main-Taunus-Kreis	59,317	61,279	0,18
DE71C	Offenbach, Landkreis	46,156	53,202	0,26
DE805	Stralsund, Kreisfreie Stadt	21,755	34,340	0,15
DEA11	Düsseldorf, Kreisfreie Stadt	54,406	64,670	0,16
DEA16	Mülheim an der Ruhr,Kreisfreie Stadt	44,815	48,520	0,26
DEA19	Solingen, Kreisfreie Stadt	33,643	43,340	0,37
DEA1E	Viersen	37,629	43,057	0,30
DEA22	Bonn, Kreisfreie Stadt	37,912	44,078	0,11
DEA2B	Rheinisch-Bergischer Kreis	40,578	42,782	0,25
DEA31	Bottrop, Kreisfreie Stadt	16,210	37,690	0,29
DEA41	Bielefeld, Kreisfreie Stadt	41,749	42,914	0,25
DEA51	Bochum, Kreisfreie Stadt	43,252	48,776	0,25
DEA54	Hamm, Kreisfreie Stadt	35,914	38,319	0,25
DEC01	Stadtverband Saarbrücken	37,331	41,089	0,23
DEC03	Neunkirchen	39,627	40,274	0,30
DED31	Leipzig, Kreisfreie Stadt	31,649	35,150	0,18
DEG01	Erfurt, Kreisfreie Stadt	33,465	34,384	0,17
DEG02	Gera, Kreisfreie Stadt	27,300	34,768	0,15
ITC41	Varese	50,461	55,582	0,41
ITE15	Prato	40,436	54,954	0,47
LV006	Riga	20,984	32,587	0,26
NL322	Alkmaar en omgeving	55,134	55,456	0,18
NL327	Het Gooi en Vechtstreek	53,570	61,422	0,16
NL331	Agglomeratie Leiden en Bollenstreek	58,728	56,009	0,19
NL334	Oost-Zuid-Holland	52,516	60,090	0,23
PL113	Miasto Lodz	26,497	31,624	0,30
PL213	Miasto Krakow	28,063	31,127	0,26
PL514	Miasto Wroclaw	30,861	33,320	0,24
PL633	Gdansk-Gdynia-Sopot	28,432	33,879	0,28
PT114	Grande Porto	23,008	32,077	0,31
UKK11	Bristol, City of	39,681	42,198	0,16
UKK42	Torbay	27,281	33,044	0,20

Source: Eurostat, IRPUD, authors' calculations.

Table 13: Estimation output for GDP p.c. and cluster membership; Dependent variable: GDP p.c. in pps 2003

	Model Nr.	15	16	17	18	19	20
Constant	Coefficient	24,097	24,097	23,376	27,569	27,221	21,459
	Prob.	0	0	0	0	0	0
Cluster 1	Coefficient	-12,357	-12,357		-8,536	-8,012	
	Prob.	0	0		0	0	
Cluster 2	Coefficient	-3,305	-3,305		-2,712	-2,307	
	Prob.	0.01	0.01		0.01	0.03	
Cluster 3	Coefficient	-3,235	-3,235		-4,594	-4,657	
	Prob.	0	0		0	0	
Cluster 4	Coefficient	-7,412	-7,412		-4,997	-4,369	
	Prob.	0	0		0	0	
Cluster 5	Coefficient	-5,132	-5,132		-7,135	-6,828	
	Prob.	0	0		0	0	
Cluster 6	Coefficient	-2,622	-2,622		-3,666	-2,757	
	Prob.	0	0		0	0	
Cluster 8	Coefficient	7,577	9,835		5,138	8,926	
	Prob.	0	0		0	0	
Cluster 9	Coefficient	-5,324	-5,324		-7,069	-6,306	
	Prob.	0	0		0	0	
Cluster 10	Coefficient	-7,337	-7,337		-9,713	-9,081	
	Prob.	0	0		0	0	
Cluster 11	Coefficient	3,062		4,130	2,241		3,874
	Prob.	0		0.01	0.02		0.02
Cluster 12	Coefficient	-722			-1013		
	Prob.	0.62			0.48		
Cluster 13	Coefficient	5,056		5,778	4,712		5,527
	Prob.	0		0.01	0		0.02
Cluster 14	Coefficient	5,587		9,280	5,299		11,146
	Prob.	0		0	0		0
R-squared		0.52	0.39	0.06	0.64	0.65	0.14
Mean dependent var.		20599	20,599	18,804	28,019	20,599	18,804
Log likelihood		-12207	-12,207	-9,653	-2,526	-12,023	-9,383
Included observations		1212	1,212	976	236	1,212	976

Notes: Including national dummy variables in models 18-20 (benchmark: France) and dummies for outliers in all models. Coefficients not displayed. Estimation with OLS, and White Heteroscedastic Standard Errors and Covariance.

Source: Data: Eurostat, IRPUD, authors' calculations.

Table 14: Estimation output on β-convergence of GDP p.c. in different cluster-samples;

Dependent variable: average annual growth rate of GDP p.c. in pps 1995-2003

Sample	CL. Nr.	C	Prob.		LOG (GDPPPS5)	Prob.		β	R^2	F-Statistic	Obs.
Total Sample	All	0.19	0.00	***	-0.016	0.00	***	-0.015	0.19	288	1,212
	1	0.23	0.00	***	-0.020	0.00	***	-0.019	0.32	51.2	112
	2	0.27	0.00	***	-0.023	0.00	***	-0.021	0.32	12	28
	3	0.48	0.00	***	-0.045	0.00	***	-0.038	0.27	16.8	47
	4	0.19	0.00	***	-0.015	0.00	***	-0.015	0.23	25.1	85
	5	0.41	0.00	***	-0.039	0.00	***	-0.034	0.42	88.8	124
	6	0.24	0.00	***	-0.021	0.00	***	-0.019	0.35	73.2	138
	7	0.31	0.00	***	-0.027	0.00	***	-0.025	0.17	16.4	83
	8	0.01	0.93		0.002	0.89		0.002	0.00	0	19
	9	0.33	0.00	***	-0.031	0.00	***	-0.028	0.35	104.9	198
	10	0.06	0.17		-0.003	0.56		-0.003	0.00	0.3	142
	11	0.24	0.00	***	-0.021	0.00	***	-0.019	0.17	22.2	110
	12	0.29	0.00	***	-0.026	0.00	***	-0.024	0.32	17.1	38
	13	0.17	0.01	***	-0.013	0.04	***	-0.012	0.09	4.7	50
	14	0.12	0.04	***	-0.008	0.20		-0.007	0.05	1.7	38
East-Sample	All	0.16	0.00	***	-0.012	0.00	***	-0.012	0.08	10.8	120
	1	0.39	0.00	***	-0.040	0.00	***	-0.034	0.37	30	54
	4	0.30	0.00	***	-0.028	0.00	***	-0.025	0.34	18.8	38
West-Sample	All	0.17	0.00	***	-0.013	0.00	***	-0.013	0.09	111	1,092
	1	0.29	0.00	***	-0.026	0.00	***	-0.024	0.19	13.2	58
	2	0.27	0.00	***	-0.023	0.00	***	-0.021	0.32	12	28
	3	0.48	0.00	***	-0.045	0.00	***	-0.038	0.27	16.8	47
	4	0.20	0.01	***	-0.016	0.05	**	-0.015	0.08	4	47
	5	0.36	0.00	***	-0.034	0.00	***	-0.030	0.36	66.9	123
	6	0.24	0.00	***	-0.021	0.00	***	-0.019	0.27	47.8	129
	7	0.19	0.01	***	-0.016	0.03	***	-0.015	0.06	5	80
	8	0.01	0.93		0.002	0.89		0.002	0.00	0	19
	9	0.32	0.00	***	-0.030	0.00	***	-0.027	0.28	74.8	194
	10	0.05	0.19		-0.002	0.60		-0.002	0.00	0.3	141
	11	0.23	0.00	***	-0.019	0.00	***	-0.018	0.15	19	109
	12	0.08	0.29		-0.005	0.51		-0.005	0.01	0.4	33
	13	0.17	0.01	***	-0.013	0.04	***	-0.012	0.09	4.7	50
	14	0.10	0.12		-0.005	0.39		-0.005	0.02	0.8	34
Urban Sample	All	0.19	0.00	***	-0.015	0.00	***	-0.014	0.12	30.6	236
Non-Urban sample	All	0.22	0.00	***	-0.019	0.00	***	-0.018	0.25	323	976

Notes: Without national dummies, coefficients not displayed. Estimation with OLS, and White Heteroscedastic Standard Errors and Covariance.

Source: Data: Eurostat, IRPUD, authors' calculations.

Table 15: Estimation output on β-convergence of GDP p.c., cluster-membership and national membership; Dependent variable: average annual growth rate of GDP p.c. in pps 1995-2003

Sample	Total	Total	Total	East	East	West	West
National Dummies	No	Yes	Yes	No	Yes	No	Yes
Constant	0.242	0.101	0.176	0.281	-0.014	0.228	0.114
	0.000	0.000	0.000	0.000	0.723	0.000	0.000
LOG(GDPPPS5)	-0.021	-0.006	-0.014	-0.024	0.009	-0.019	-0.008
	0.000	0.000	0.000	0.000	0.053	0.000	0.000
β	-0.019	-0.006	-0.013	-0.022	0.009	-0.018	-0.008
Cluster 1	-0.008		-0.013	-0.020		-0.005	
	0.000		0.000	0.000		0.032	
Cluster 2	0.003		-0.003			0.005	
	0.237		0.259			0.091	
Cluster 3	0.003		-0.004			0.004	
	0.186		0.140			0.057	
Cluster 4	-0.002		-0.006	-0.015		0.003	
	0.352		0.001	0.000		0.244	
Cluster 5	-0.004		-0.007			-0.003	
	0.023		0.000			0.080	
Cluster 6	-0.007		-0.005			-0.006	
	0.000		0.000			0.000	
Cluster 8	0.002		0.003			0.002	
	0.584		0.487			0.470	
Cluster 9	-0.009		-0.006			-0.008	
	0.000		0.000			0.000	
Cluster 10	-0.014		-0.011			-0.013	
	0.000		0.000			0.000	
Cluster 11	0.001		0.000			0.001	
	0.726		0.958			0.496	
Cluster 12	-0.005		-0.005			-0.007	
	0.031		0.017			0.005	
Cluster 13	0.001					0.002	
	0.517					0.308	
Cluster 14	0.009					0.009	
	0.000					0.000	
R-squared	0.32	0.47	0.50	0.25	0.43	0.24	0.40
Mean dependent var.	0.04	0.04	0.04	0.06	0.06	0.04	0.04
Log likelihood	3,572	3,723	3,765	343	359	3,244	3,373

Note: Estimation with OLS, reference dummies Austria (total and western sample), Slovak republic (Eastern sample), cluster Nr. 7 (total sample) and all but cluster 1 and 4 (eastern sample). National dummy coefficients not displayed; checks with different reference groups showed robust parameter estimates for log(gdppps5).