Regional Productivity Differences in the European Union

Theoretical predictions and empirical evidence

Kurt Geppert, Martin Gornig, Andreas Stephan
(German Institute for Economic Research, DIW Berlin)

Abstract

There has been a long tradition of empirical analysis of regional productivity, particularly with reference to the neo-classical theory of growth. Our panel data and analyses based on a covariance model show that regional productivity differences are also determined by time-invariant factors that have to date been largely neglected. These include the degree of agglomeration and the geo-economic location described in the New Economic Geography. The economic performance of the regions in Europe is, however, determined to a far greater extent by national productivity regimes. In light of the historically strong influence of the national states this result may not come as a surprise. What is surprising is the fact that the role of the national states has not decreased over time, despite intensive integration efforts (European Single Market, Economic and Monetary Union).

JEL classifications: R11, O47, C33

1 Introduction

Research on the growth of regions and on the spatial structure of the economy was greatly stimulated in the 1980s by the "new" theories of international trade and economic growth. In the 1990s there followed a wave of empirical research, particularly on regional growth and on the question of the sectoral specialisation of regions. This boom was triggered by three factors: (1) the development of the "new" theories caused rivalry between the various theoretical approaches; (2) as the European integration progressed, there was a huge demand for political advice on the regional implications of these processes; (3) the data situation, particularly for analyses below the national level, improved significantly. As a result of these developments in research with a regional focus, a sort of "status of knowledge" has been reached both theoretically and empirically which is unlikely to change fundamentally in the near future. This does not, however, mean that all the major questions have been answered. On the contrary: which theory is right and which factors are decisive for the development of the regions is still largely open.

Empirical work on regional development in Europe has developed into two large, overlapping fields of research: (1) the analysis of the regional distribution of sectors (localisation) and the implications for regional income and productivity and (2) the analysis of aggregate growth with regard to convergence or divergence of regions. Our investigations are guided by another question. We want to know which factors determine the level and the development of regional productivity in Europe: is it – in a neo-classical sense – the initial level and the factor endowment of the regions or is it - as postulated by the New Economic Geography – market size and market access or do macro-economic factors play an important role?

In Chapter 2 the economic development of the European regions is considered from the perspective of the theory of growth and the New Economic Geography, comparing the empirical findings with the theoretical predictions. In Chapter 3 we present our empirical analysis. It covers the period from 1982 to 2000 and refers to the NUTS 2 regions; these are differentiated by spatial features (centrality and settlement density). In Chapter 4 a number of conclusions are drawn.

2 Regional development in Europe: theory and empirical evidence

Growth

The core statements of the traditional neo-classical growth theory (Solow 1956) on the development of regions are based on two assumed mechanisms: (1) Diminishing returns to capital cause regions to grow the more slowly, the richer they already are. (2) In the long term, growth in per capita income is determined by (exogenous) technical progress, and all regions have equal access to new knowledge. The resulting prediction is regional convergence; it becomes all the more probable, the more similar

the regions are in terms of basic conditions for growth and the more intensive interregional exchange of commodities and production factors is.

The "new" theory of growth, by contrast, explains the engine of growth - new knowledge - endogenously (Romer 1986 and 1990; Lucas 1988). Here, the framework of perfect competition and diminishing returns has - at least partially – to be abandoned. The decisive point is that in the course of capital accumulation external effects take effect - e.g. in the production of human capital or technical know-how - which ensure that the growth process does not come to a standstill. In a regional context this means that poorer regions or nations do not catch up. Regions which are relatively richly endowed with capital or technology also achieve relatively strong external effects. In this way, they preserve or even extend their head start. This is all the more probable, the slower knowledge spreads spatially. A significant disparity among backward regions may result. Regions which are able to absorb technical know-how quickly can close the gap on technologically and economically leading regions by imitation, while other regions may be not able to do so.

Neither of these approaches of growth theory can easily be reconciled with the reality. The convergence rates of 2% or less repeatedly found in empirical examinations are only compatible with the traditional neo-classical model if rather unrealistic factor ratios are used (Sala-i-Martin 1996). In models of endogenous growth, if one assumes strong external effects in the production of knowledge, a contradiction becomes apparent to the actual course of economic growth in the developed economies (Jones 2002, p. 105), while with weak external effects growth at some point comes to a standstill. It is then no longer explained endogenously, but depends rather on how the number of knowledge producers develops and thus ultimately on population growth.

The numerous empirical investigations of economic growth in the European regions manifest a complex picture (European Commission 2000). Nevertheless, in a number of respects they come to consistent or at least similar results. In this sense the status of research can be summarised in "stylised facts“. The two theoretical approaches of growth outlined here are partially confirmed and partially rejected.

(1) Over a long period of time after the second world war, the regional differences in per capita income (GDP per inhabitant) in Europe have declined; this process came to a standstill in the 1980s and in the 1990s there was no significant recovery of convergence (see, e.g. Barro, Sala-i-Martin 1995; Armstrong 1995; Neven, Gouyette 1995; Tondl 1999; López-Bazo et al. 1999; Boldrin, Canova 2001; Martin 2001; Puga 2001; Rodriguez-Pose, Fratesi 2002; Villaverde Castro 2002). This is paradoxical given the marked intensification of integration policy and the assistance given to backward regions, particularly in the last 20 years. The at best minimal convergence of per capita income contradicts the neo-classical theory of growth.

(2) The differences in per capita income between the states of the EU have diminished considerably, even in the 1980s and 1990s. However, the disparities between the regions within the states have tended to grow (see e.g. Martin 2001; Puga 2001; Rodriguez-Pose, Fratesi 2002; Terrasi 2002; European Commission 2003). From a neo-classical perspective, the reverse development would in fact have been expected.

(3) Neighbouring regions do not develop independent of one another; instead spatial clusters of regions exhibiting strong growth and regions of weak growth can be identified (Armstrong 1995; Quah 1996; López-Bazo et al. 1999; Paci, Pigliaru 2002). The evidence on the question of "convergence clubs" - regions with the same steady state, regardless of their location – is however divided (more in favour: Neven, Gouyette 1995; Canova, Marcet 1995; Tondl 1999; more against: Armstrong 1995; Boldrin, Canova 2001). The evidence of spatial clusters and convergence clubs tends to favour the theories of endogenous growth.

(4) The regional convergence in terms of labour productivity (GDP per employed person) is greater than in the case of per capita income (Lopez-Bazo et al. 1999; Esteban 2000; Martin 2001; Puga 2001). Many backward regions have evidently succeeded in compensating for the shrinkage of agriculture by establishing industrial facilities, resulting in a marked increase in regional productivity. Employment, on the other hand, has tended to develop less favourably than in the wealthier regions; this is also expressed in the geographical pattern of unemployment in Europe (Martin 2001; Puga 2001; Dohse et al. 2002). The continuing – albeit not very strong – convergence of labour productivity between the regions favours the traditional rather than the new theory of growth.

Growth theory provides only a partial explanation of the regional development patterns in Europe. It lacks *inter alia* an explicit regional perspective. This may, however, be of central significance for an analysis of changes in the allocation of economic activities between the regions of Europe.

Geography

Taking a geographical perspective means above all considering distances and the expenditures needed to overcome them. Transportation costs play a key role in the "New Economic Geography“ (NEG) (Krugman 1991). This theory is static in that it does not care for overall growth, rather it deals with the spatial allocation of economic activities and with patterns of agglomeration and specialisation at a given level of economic activity. But it is also dynamic in that it describes causes and mechanisms of change in the spatial structure. It provides explanations of why regions can develop very differently, even if the starting conditions are similar.[1]

[1] For a critical appraisal of the NEG see e.g. Neary (2001). Growth aspects can also be integrated in NEG models, see Baldwin, Forslid (2000), Martin, Ottaviano (1996).

In a typical NEG model the economy consists of two regions and two sectors - an immobile sector (agriculture) and a mobile sector (industry).[2] The agricultural workers are distributed equally in space. They produce under constant returns to scale and sell their products on perfect markets. In industry, the returns to scale are increasing. All the firms produce with identical technology. Each of them produces their own variety of the industrial product and monopolistic competition prevails on the commodity markets. Transportation costs are incurred for deliveries from one region to another. For the consumers, who hold all the product variations in equal esteem, this means that the imported goods are more expensive than those produced in their own region - and vice versa. The same applies to industrial companies as consumers of intermediary goods.

Under these conditions, the industrial firms are faced with the question of the ideal location. Two categories of determinants are of importance for the decision-making process. This can be demonstrated if one assumes a situation in which the mobile sector is distributed unequally between the two regions:

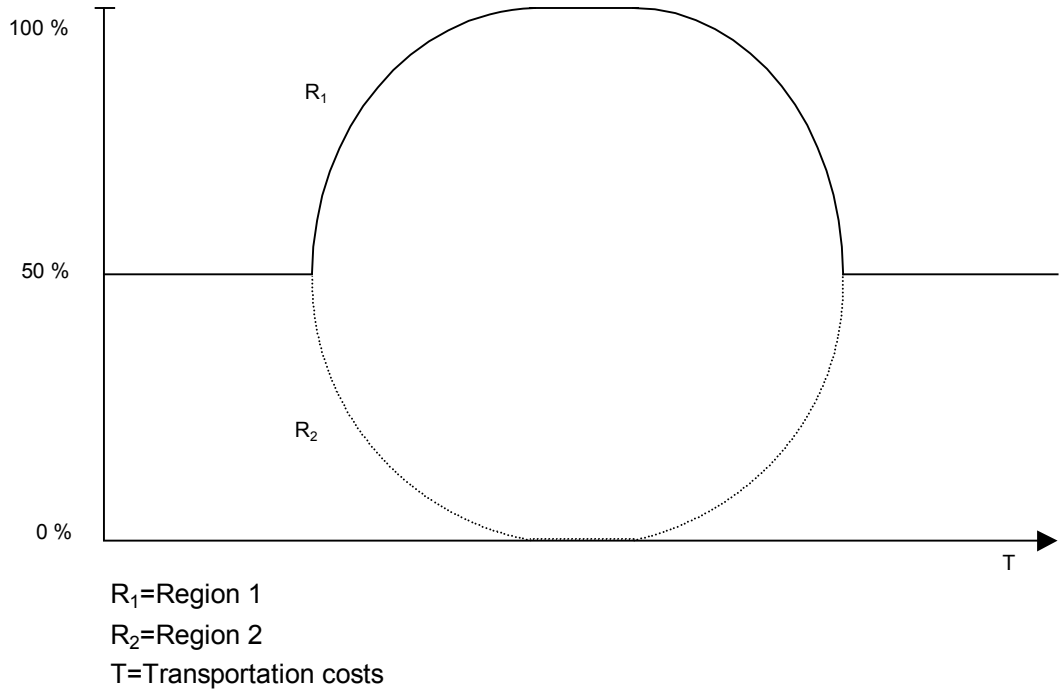
- *Competition on the local factor and commodity markets*. If a company is established in the densely populated core region, it has to compete with many other companies for labour; the wage costs are high. At the same time, the firm has to share the local sales market with many other suppliers; this restricts the sales volume of the firm. These two factors diminish the profitability of the company in the core regions, thus producing a spatial dispersion effect.
- *Pecuniary externalities*. The fact that many industrial firms are located in the core regions means that many variations of consumer and input goods are available there which are not burdened with transportation costs; there are forward linkages (cost linkages). At the same time, the market potential (firms and consumers) in this region is relatively large; there are backward linkages (demand linkages). These two factors enhance the profitability of the firms in the core region, thus producing an agglomeration effect.

Whether centrifugal or centripetal forces prevail is essentially determined by the transportation costs.[3] In models that assume perfect mobility of workers driven by interregional real wage differences, the industry is concentrating completely in one of the regions as soon as the transportation costs fall below a certain level. In which region agglomeration occurs depends on historical contingencies and/or political action. In the case of medium or low transportation costs, the companies in the mobile sectors under these models always strive towards the larger markets. The regional market volume changes endogenously; here too, processes of cumulative causation are set in motion.

[2] Puga (1999) offers a symbiosis of different variations of NEG models.
[3] Other structural parameters of the model are the substitution elasticity between the varieties, the share of industry in total demand and the share of input goods in total costs of the firms.

If the assumption of labour mobility is dropped - which corresponds more closely to the situation in Europe - non-monotonous spatial dynamics arise. With very high transportation costs, the industrial production is distributed equally between the regions; productivity and wages then, too, are the same in the two regions. With increasing economic integration and thus decreasing trading costs, the agglomeration of production becomes increasingly worthwhile. Although the concentration of industrial firms drives up wages, this is more than compensated by positive cost and demand linkages. If, however, the transportation costs fall to a very low level, the advantages of geographical proximity to customers and suppliers vanish and the disadvantages of high wages in the agglomerations are felt in full. The firms respond by moving back to less industrialised regions.[4] Thus, as transportation costs fall, the spatial distribution of the mobile sectors exhibits a non-linear, U-shaped development; for the two-region case this can also be illustrated graphically (Figure 1).[5]

Figure 1 Spatial distribution of the mobile sector depending on the level of transportation costs



On the one hand, the inclusion of agglomeration disadvantages brings the NEG closer to reality; it allows for equilibria in the case of partial agglomeration. On the other, it complicates the interpretation of empirical findings and the evaluation of the theory. If, for example, a growing spatial concentration

[4] According to this model, lagging regions can thus catch up. This requires, however, sufficient regional wage differentiation (Puga 1999). General wage agreements on a national level can impede the catching-up process (Faini et al. 1997).

[5] Independent of the question of labour mobility, other forms of agglomeration costs such as higher land prices and rents (Helpman 1998, Hanson 2000) or longer transportation times (Brakman et al. 2001, p.187 ff.) also can be considered. In such models, the agglomeration trend is weaker. Using simulations, Forslid et al. (2002) show that, in principle, the same mechanisms apply in a scenario with more than two sectors, factors and regions.

of economic activities were observed in the EU, this could be a result both of falling or rising transportation costs, depending on the part of the U-curve in which one is. Or conversely: if one assumes falling transportation costs, the intuitive assumption for Europe, both increasing and decreasing degrees of agglomeration can be predicted, again depending on the position on the U-curve. It is not, however, possible to determine this position precisely because transportation costs, i.e. all expenses associated with interregional trade, are hard to measure.

Attempts to test the NEG models directly have produced ambivalent results: although on the one hand increasing returns and regional differences in wages can be shown, on the other the estimates produce to a certain extent implausible values for the level and the development of the structural parameters of the models (Hanson 2000 for the USA; Brakman et al. 2001 for Germany). Other investigations provide evidence for certain aspects of the NEG, so Davis, Weinstein (1999) who show home-market effects for manufacturing sectors in Japanese regions. Empirical findings on the localisation of industries within the EU can be summarised into stylised facts which can, to a certain extent, also be interpreted as evidence of the relevance of the NEG:

(1) The industrial specialisation of the EU countries and - conversely - the spatial concentration of the industries increased significantly in the EU in the 1980s and 1990s (Brülhart, Torstensson 1996; Brülhart 1998; Amiti 1998; Haaland et al. 1999). Industries with significant scale economies and those with strong input linkages exhibit the highest degrees of localisation, and are still strongly concentrated on the centre of the EU. However, the attraction of the centre for scale-intensive industries does not appear to have increased further in the last 20 years, indeed it may have decreased (Brülhart, Torstensson 1996; Midelfart-Knarvik et al. 2000).
(2) Labour-intensive and low-tech industries are increasingly concentrating their activities in peripheral EU countries (Brülhart, Torstensson 1996; Brülhart 1998; Midelfart-Knarvik et al. 2000). Some industries belonging to the middle or upper technology segment are, however, also spreading from the centre to the periphery, particularly to Ireland and Finland but also to the south. Large companies are using the possibilities of regional division of labour within the company to increase their competitiveness obviously play a role here (European Commission 1999).[6]

For some time, the manufacturing sector as a whole has apparently been undergoing a process of spatial dispersion, and even in scale-intensive branches of industry there is a trend towards deconcentration. On the other hand, the overall employment in the central/wealthier regions of the EU tends to have developed more favourably than in the peripheral/poorer regions. The conclusion could be drawn that - contrary to manufacturing - tradable services continue to agglomerate. This does not, however,

[6] Most analyses of sectoral specialization of regions are - mainly due to data availability - restricted to the manufacturing industry. However, this covers an ever diminishing part of the economy as a whole and also of the

match the observation that aggregate productivity between the EU regions is converging.[7] Overall, a comparison of theory and empirical findings reveals that the NEG, too, cannot conclusively explain the real development of the European regions, it is consistent with reality only in certain respects.

Looking at the regional development of employment, production and productivity in Europe, it is nevertheless possible to derive three different hypotheses from the NEG, graduated according to the degree of centrality: (1) Growth in the densely populated geographical centre of the EU (from middle England to northern Italy) is above average. (2) Densely populated conurbations (e.g. south east England, the Ruhr area, the Ile de France, northern Italy) exhibit strong growth. (3) The agglomerations of the EU (from Helsinki to Lisbon) grow strongly. For a wide range of trading costs, such agglomeration trends would be expected, however the trading costs in the EU may in the meantime have fallen so far that for certain sectors of industry the trade-off between market proximity and input costs comes out in favour of the latter; they then operate on the left hand side of the U-curve.

3 Empirical Analysis

3.1 Data

Structure of the data

Meanwhile, the data information systems of EUROSTAT provide a comprehensive catalogue of data for the analysis of the economic development in the states and regions of the EU. However, much of the information has been drawn from the national statistics. Particularly with long time series, problems arise from differing national statistical definitions which result in gaps, especially in the series of indicators of economic structure.

In the case of regional economic analysis there are additional difficulties resulting from the nationally oriented demarcation of the NUTS regions. A consistent set of regions for EU statistics has still not been developed. The demarcations tend to follow the traditional regional subdivisions in the member states which turn out to be very different in terms of spatial function. For example, at the NUTS2 level city regions in Spain and Italy include the core city itself and the surrounding area. In Great Britain and Germany, on the other hand, many NUTS2 regions solely comprise the highly consolidated core city.

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supra-regionally oriented economy. Meanwhile, tradable services have attained a similar magnitude as material goods in interregional trade.

[7] For the counter-development of productivity and employment between the regions of the EU see also Martin (2001). The economic development of the European regions is clearly also determined by processes which are not considered in theoretical models and which are difficult to catch empirically.

This seriously restricts the direct use of the EUROSTAT data for regional comparisons, particularly when, as is the case here, reference to the New Economic Geography requires the consideration of the settlement structure. To ensure the comparability of the regional demarcation across nations, individual NUTS2 regions have been combined according to characteristics of settlement structure such as population density.

The EU labour force survey forms the core of the consistent data set that has been developed here. From 1996 it contains a great deal of EU-wide uniform information on the regional economic development at the NUTS2 level. For a larger number of selected countries, the data on the workforce based on national samples extends back as far as 1988 or even 1982. In addition, further information about the population and economic performance from the regional database of EUROSTAT has been allocated to the total of 178 regions. The data contains information about employment by economic sector, demographic development, population density, employment rate, gross domestic product, per capita income, settlement type, geographical type and national affiliation.

Depending on the length of EU membership, the time series for the various regions ranges from 2000 back to 1982. The exceptions are Great Britain on the one hand which, despite much longer membership, has only been included in the statistics used here since 1996. On the other hand, before 1996 the figures for East Germany were not considered because the statistical information in the first years after reunification is not comparable with that of other regions due to the special transformation processes at work there.

Selection of indicators

One of the most frequently used and largely undisputed indicators of regional economic performance is output per capita. The ratio used here is the gross domestic product measured in purchasing power standards per employed person in a region. Due to measurement and allocation problems in determining regional values for the gross domestic product and the scale of work, there are doubtless inaccuracies. However, as the relative position of the regions to one another is of interest here rather than the absolute figures, these can be neglected for the purpose of this paper.

The measurement and allocation problems are of even less importance in comparisons over time. The development of output and the change in labour input have been observed separately here. This provides a wider scope of interpretation than the mere consideration of the change in output per capita as a whole.

The explanatory variables can be divided into four areas: in the first geo-economic indicators are used to reflect those influences on regional development that have been stressed in recent agglomeration

models (degree of agglomeration, geographical location). In the second area, special consideration is given to the initial income level (productivity in the start year), a central factor in the explanatory concepts of the traditional regional growth theories. In the third and fourth areas, control parameters are used to capture other determinants which do not directly relate to the regional economy. Specifically, these are country dummies and national growth rates to control *inter alia* the influence of the different macro-economic policies in Europe. Moreover, the sectoral component should be, at least roughly, considered. Its influence is tested here both via the employment structures in the start year (manufacturing share) and the change over time. The precise description of the variables used is presented in the Appendix.

3.2 Methodology

The three dependent variables of our approach are first the level of output per employee $\ln(Q_{it} / L_{it})$, where Q_{it} represents the regional output at the time *t* in region *i* and L_{it} the regional employment at time *t* in region *i*, second the growth rate of employed persons defined as $\Delta \ln(L_{it})$ and (3) the growth rate of the GDP defined as $\Delta \ln(Q_{it})$, where $\Delta = X_{it} - X_{i,t-1}$. With the last two variables it is possible to make differentiated statements about the development of output per employee, $\Delta \ln(Q_{it} / L_{it\,t}) = \Delta \ln(Q_{it}) - \Delta \ln(L_{it})$.

It is assumed that observed labour productivity $\ln(Q_{it} / L_{it})$ is a linear function of the determinants X_{it}, i.e.

$$\ln(Q_{it} / L_{it}) = f(X_{it}) + \mu_i + \lambda_t + \varepsilon_{it}. \quad (1)$$

Here μ_i is a specific regional fixed effect, *i=1,...,N*, λ_t a time-specific fixed effect, *t=1,...,T*, and ε_{it} an identical and independently distributed random disturbance with $\varepsilon_{it} \sim N(0, \sigma_\varepsilon^2)$.

For estimation, we apply Analysis of Variance to our panel data (see Hsiao, 2003). This method belongs to the class of *G*eneralised *L*inear *M*odels (Searle, 1997). The observed variance of the dependent variable is explained both by categorical and metric determinants.[8] It should be noted that the panel on which the analysis is based is unbalanced, i.e. the number of observations is not the same for all regions, see also the data description above.

[8] We use dummy coding for the categorical variables where the last category forms the reference. T-values indicate, whether the dummy variables differ significantly from the respective reference category.

We use a two-step approach. In the first step (model variant 1) we estimate a model with fixed regional-specific effects. This model exhibits the greatest number of degrees of freedom. In the second step, the fixed regional-specific effects are replaced by other time-invariant effects.

Starting from equation (1), model variant 1 is therefore specified as

$$Y_{it} = \mu_i + \lambda_t + \gamma_{kt} + \varepsilon_{it}, \tag{2}$$

with $Y \in \{\ln(Q/L), \Delta \ln Q, \Delta \ln L\}$, where γ_{kt} denotes the interaction effect between year, $t = 1, \ldots, T$, and country, $k = 1, \ldots, K$.

In the second step (model variant 2) the model is estimated without the fixed regional-specific effects μ_i, but with other time-invariant effects at the regional level.

Model variant (2) is therefore specified as

$$Y_{it} = \lambda_t + \phi_k + \gamma_{kt} + \varphi_i + \gamma_i + \nu_n + \theta_p + \varepsilon_{it}, \tag{3}$$

where ϕ_k denotes the country effect, φ_i the degree of industrialisation at time t_0, γ_i the initial productivity at time t_0, ν_n the type of settlement and θ_p the type of geographical location. While ϕ_k, ν_n, θ_p denote categorical variables with *K*, *N*, and *P* categories, φ_i and γ_i are metrically scaled regional variables which only capture variation between the regions, but not the variance over time.

The total number of degrees of freedom in the second model (equation 3) is much lower than in the first model (equation 2). If, however, unobserved heterogeneity between the regions is well explained when introducing time-invariant regional-specific effects, the total R^2 of this model should not be substantially lower than that of model 1 with the fixed regional-specific effects.

To estimate the influence of variables, in particular that of the categorical ones, we determine partial R^2, which indicate the contribution of a variable (or the effect of a categorical variable) for explaining the variance of the dependent variables under the condition that the other determinants are given. The partial R^2 can thus be interpreted as the independent explanatory contribution of a factor. The individual partial R^2 do not sum up to the R^2 of the model as a whole, because there is a redundancy. The individual variables are not independent of each other, rather they make a joint explanatory contribution, too.

It should also be mentioned that for models with growth rates as dependent variables it can be expected that the influence of time-invariant effects, for instance of the regional-specific effect, is low because the first difference of time-invariant effects should be nil, i.e. $\Delta\mu_i = 0$. The reason for this is that the estimating equations for the growth rates can be interpreted as the first differences of equations (2) and (3).

In spite of this, the analysis of the growth rates may still reveal unobserved heterogeneity, i.e. that there are permanent differences in growth rates between the regions. If, however, there is heterogeneity between the regions mainly in levels, $\Delta\mu_i$ will not be statistically significant in the estimates with growth rates as dependent variables.

3.3 Results

The regression results in Table 1 show that our models explain a very large part of the observed dispersion in productivity levels. The total R^2 of the model for the productivity level is 0.97. With a partial R^2 of about 0.22 regional-specific effects are clearly important.

This result indicates a stable pattern of regional differences in productivity over time. The estimated μ_i imply that the highest expected regional productivity effects - besides special cases such as small islands - are achieved by the urban regions Genoa, Paris and Milan. Among the British and German urban regions, London and the Rhine-Main area stand out in terms of the estimated regional productivity level. Compared with all the regions, however, they only rank in the upper middle range. The lowest expected productivities are exhibited by a series of East German and Portuguese regions.

The results of model specification 1 for production and employment growth are far less clear. The overall R^2 are considerably lower than for the productivity level. However regional production growth (R^2=0.71) can be explained considerably better than regional employment growth (R^2=0.33). In addition, regional specific effects are only significant for production growth.

The empirical finding that there are persistent regional productivity differences in the EU alone does not provide proof for or against the theoretical considerations of the New Economic Geography. The question here is rather whether the spatial parameters, e.g. urban agglomeration and central location, significantly influence productivity levels or whether the regional patterns are in fact determined by other regional, sectoral or national macro-economic factors.

Table 1: Estimation Results

	Model specification 1									**Model specification 2**								
Dependent variable:	(1) *Productivity level* $\ln(Q_{it} / L_{it})$			(2) *Production growth* $\Delta \ln(Q_{it})$			(3) *Employment growth* $\Delta \ln(L_{it})$			(4) *Productivity level* $\ln(Q_{it} / L_{it})$			(5) *Production growth* $\Delta \ln(Q_{it})$			(6) *Employment growth* $\Delta \ln(L_{it})$		
Independent variables:	*part. R²*	*df*	*F value*	*part. R²*	*df*	*F value*	*part. R²*	*df*	*F value*	*part. R²*	*df*	*F value*	*part. R²*	*df*	*F value*	*part. R²*	*df*	*F value*
Year (λ_t)	0.159*	17	(591.7)	0.096*	16	(37.75)	0.021*	16	(3.48)	0.156*	17	(344.4)	0.096*	16	(36.31)	0.021*	16	(3.66)
Year*Country (γ_{kt})	0.019*	162	(7.59)	0.227*	145	(9.84)	0.169*	147	(3.05)	0.020*	162	(4.73)	0.227*	145	(9.51)	0.169*	147	(3.15)
Region (μ_i)	0.221*	162	(86.24)	0.039*	162	(1.51)	0.039	162	(0.63)	—	—	—	—	—	—	—	—	—
Country (ϕ_k)	—	—	—	—	—	—	—	—	—	0.149*	15	(372.2)	0.036*	15	(14.60)	0.042*	15	(7.67)
Initial industrialisation (φ_i)	—	—	—	—	—	—	—	—	—	0.000	1	(2.56)	0.001*	1	(6.15)	0.000	1	(0.15)
Initial productivity (γ_i)	—	—	—	—	—	—	—	—	—	0.140*	1	(5264)	0.002*	1	(11.71)	0.000	1	(0.07)
Type of settlement (ν_n)	—	—	—	—	—	—	—	—	—	0.004*	3	(46.96)	0.000	3	(1.52)	0.001	3	(1.20)
Type of location (θ_p)	—	—	—	—	—	—	—	—	—	0.002*	4	(14.16)	0.002*	4	(2.53)	0.002	4	(1.66)
Total R^2	0.970*	356	(172.5)	0.712*	338	(13.4)	0.331*	340	(2.58)	0.944*	203	(174.6)	0.685*	185	(22.5)	0.297*	187	(4.34)
No. of observations	2285			2101			2109			2285			2101			2109		

part. R^2=partial R^2, df=degrees of freedom. * statistically significant at α=0.05 level. 0.000 indicates <0.001.
Note that extreme observations with growth rates higher than 0,25 or lower than –0,25 have been excluded from the analysis.

To investigate this question, Table 1 presents the results for model specification 2. These show that the regional-specific productivity differences in the EU can essentially be attributed to a series of time-invariant influences (Table 1, columns 11-19). The overall explanatory contribution of model specification 2 is quite similar to that of the first one with fixed regional effects. The total R^2 of 0.94 for the productivity level, 0.69 for production growth and 0.30 for employment growth are in each case only slightly lower than in model specification 1.

Looking at the results of specification 2 in detail, it turns out that geo-economic factors, type of settlement and type of location, have significant effects on the regional productivity level. The coefficients for the individual types of regions are in line with the predictions expected from the New Economic Geography (Table 2). With all other factors being controlled for, the specific productivity advantage of urban agglomerations compared to rural regions is about 4.6 percent. At the same time, expected productivity for the EU's central regions is 9.5 percent higher than for the periphery. The more distant a region is from this core zone, the lower is the expected regional productivity level.

Table 2: Selected estimates for model specification 2

	Productivity level		***Production growth***		***Employment growth***	
	Parameter estimate	*t-value*	*Parameter estimate*	*t-value*	*Parameter estimate*	*t-value*
Initial degree of industrialisation	0.048	(1.60)	-0.018*	-(2.48)	-0.005	-(0.39)
Initial productivity	0.659*	(72.56)	-0.008*	-(3.42)	0.001	(0.26)
Type of settlement						
Urban regions	0.046*	(10.22)	0.001	(1.31)	0.000	-(0.12)
Town-dominated regions	0.022*	(3.64)	0.002	(1.36)	0.003	(1.13)
Rural regions[a]	0.000	—	0.000	—	0.000	—
Type of location						
EU centre	0.095*	(6.12)	0.012*	(3.09)	0.015*	(2.13)
Fringe of EU centre	0.078*	(5.23)	0.011*	(2.87)	0.013*	(2.00)
Intermediary zone	0.050*	(3.64)	0.009*	(2.61)	0.012*	(2.00)
EU inner periphery	0.039*	(3.50)	0.006*	(2.06)	0.005	(0.95)
EU outer periphery[a]	0.000	—	0.000	—	0.000	—

* statistically significant at α=0,05.
[a] reference category. Islands etc. are omitted as category.

However, compared to other time-invariant characteristics of the regions, the significance of geo-economic factors for the productivity level is quite low. Taking other variables into account, the partial R^2 is below 0.005 both for the type of settlement and the type of location (Table 1). The national af-

filiation has a far greater impact on the regional productivity level. This also applies if the cases where the country is only represented by a single region (Luxembourg, Denmark, Ireland) are excluded from the calculations. The country effect accounts for about 15 percent of the total variance.

An interpretation of the significance of national factors for regional productivity is difficult. While our models capture unobserved heterogeneity, the reason for the heterogeneity can only be speculated on. The country effect obviously stands for more than national differences in the speed of growth. For example, we obtained no significant results for alternative specifications where national growth variables are explicitly modelled. The same holds true for the effect of the type of settlement. If, for instance, population density is used instead, the explanatory contribution is reduced perceptibly.

By contrast, the findings for the impact of initial conditions on the productivity level is relatively clear. The sectoral structure – crudely measured here as share of manufacturing – does nor exert a significant influence on productivity. The initial level of productivity of a region, on the other hand, is a good predictor for the observed income over the entire period. Almost 14 percent of the variation in the regional productivity levels is attributable to this effect.

The parameter estimate for the initial productivity level, too, indicates the high degree of stability in regional productivity patterns of the EU. However, with a value of 0.66 the estimated parameter is significantly below 1. This means that the productivity differences have tended to decrease over time.

A similar observation is made for the relation of productivity and production growth (Table 2). Initially backward regions of the EU had a higher production growth than highly-developed regions. In the case of employment growth, on the other hand, the coefficient of initial productivity is not significant. These findings suggest that poorer regions have attracted more production but there is no difference regarding employment growth between poorer and wealthier regions. This is consistent with the results of other studies cited in chapter 2 according to which the poorer regions fare less favourably in the development of per capita income (GDP per inhabitant) than in the development of productivity.

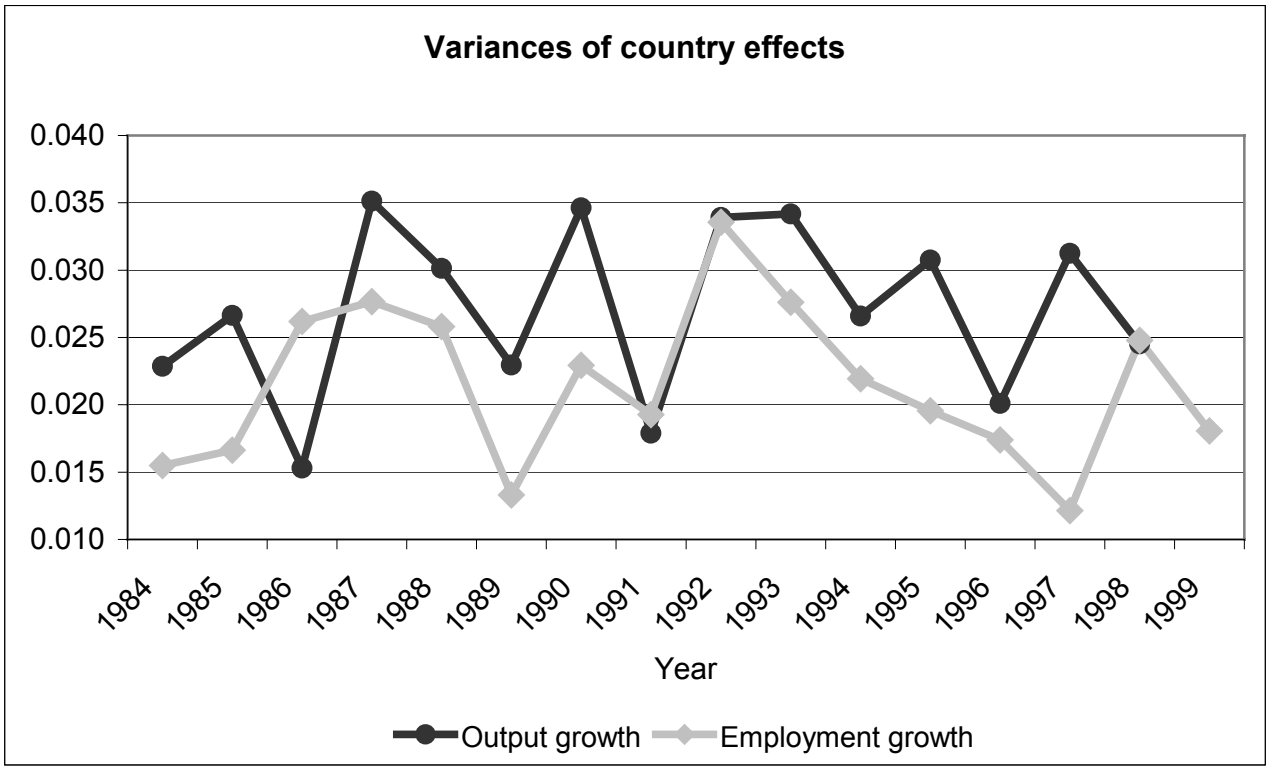
In these processes, the type of settlement plays no role, neither for production nor for employment growth. Geographical centrality, on the other hand, is positively connected to output and employment growth, but the effect is small.[9] The country effect is significant, but with a partial R^2 of about 0.04 its contribution to the explanation of the overall variance in regional growth rates is rather low.

[9] The partial R^2 for the impact of geographical location on employment growth is not significant (table 1), but three of the four single coefficients are (table 2).

By far the most important factor for regional production and employment growth is the interaction effect of country and year. This implies that regional growth depends substantially on the national development, which itself appears not to be constant over time. From this it might be concluded that national cyclical developments have a great impact on regional output and employment growth. If, however, aggregated national growth rates are used instead of unobserved macro-economic influences, the partial R^2 only reaches one tenth of the estimated value for the fixed effects model. It is therefore very unlikely that this country- and time-specific heterogeneity is attributable to national *cyclical* developments.

In light of the historically strong national character of Europe, the dominant influence of the country appears to be highly plausible. What is astonishing, however, is that even the *growth* of production and employment to a large extent is determined at the national level, and the national influence is evidently not subject to any time trend. We computed the variance of the country effect on output and employment growth, ϕ_k, year for year. This measure of heterogeneity across countries shows no decline (Figure 2). Neither the introduction of the single market in 1992 nor the announcement of the economic and monetary union with the Maastricht Treaties in 1996 have eroded the national impacts on regional productivity.

Figure 2



4 Conclusions

There has been a long tradition of empirical analysis of regional income and productivity differences in the European Union. The theoretical basis of the majority of studies is the neo-classical growth theory. Accordingly, convergence of growth and income over time is tested in these studies. The New Economic Geography offers an alternative theoretical approach. Attempts to empirically verify the predictions of the New Economic Geography on the regional development in Europe are, however, largely lacking.

In this study, geo-economic indicators used in the New Economic Geography - degree of agglomeration (type of settlement) and geo-economic location (type of location) - have proved to be clearly significant for the explanation of regional productivity differences in the EU. The economic performance of a region is, however, determined to a far greater extent by the country to which it belongs than the degree of agglomeration or centrality. The regional structure of the output per worker in the European Union is thus obviously dominated by national productivity regimes. By contrast, in the USA, a single market of similar size to the EU, the influence of the federal states does not play a major role. Presumably, geo-economic factors have a much greater effect on the regional productivity there.

In the 1980s and 1990s, the development of productivity in the regions of the European Union was characterised by a tendency towards convergence. In this respect, the findings of most existing studies have been confirmed here. The decrease in regional productivity is mainly the result of convergence of production but not of employment. In addition, the regional trends in production and employment, too, can be predominantly ascribed to national influences. In both cases country-specific influences proceed in waves rather than continuously.

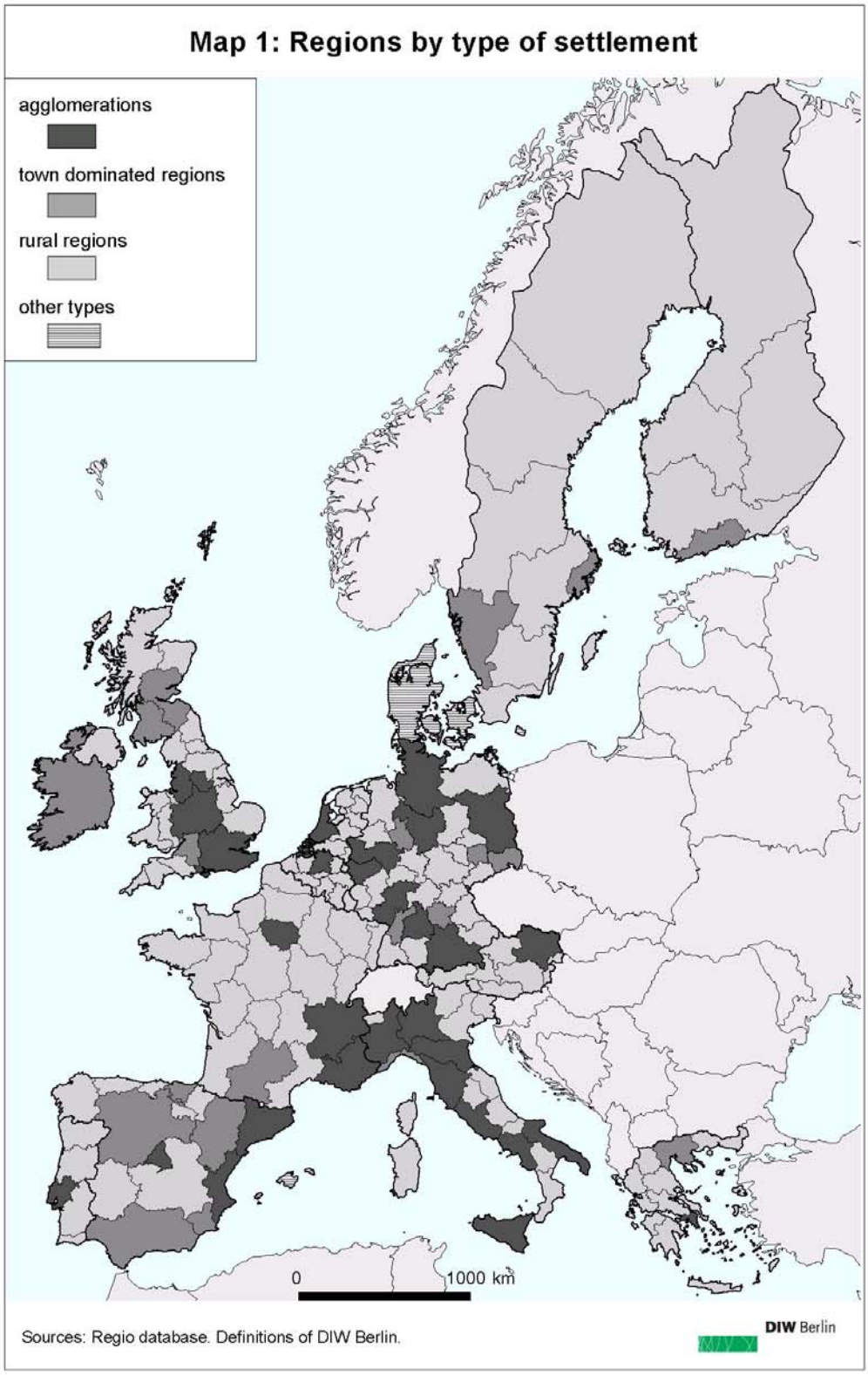
The strong impact of the national affiliation on regional productivity *levels* may not be surprising regarding the historically pronounced national divisions of Europe. But in light of the integration efforts of economic policy in Europe, it is astonishing that the *development* of production and employment, too, is still strongly determined by national events and strategies. Moreover, the country influence does not appear to be subject to any time trend. The introduction of the European Single Market and the development towards economic and monetary union have, so far, not significantly diminished the influence of national factors.

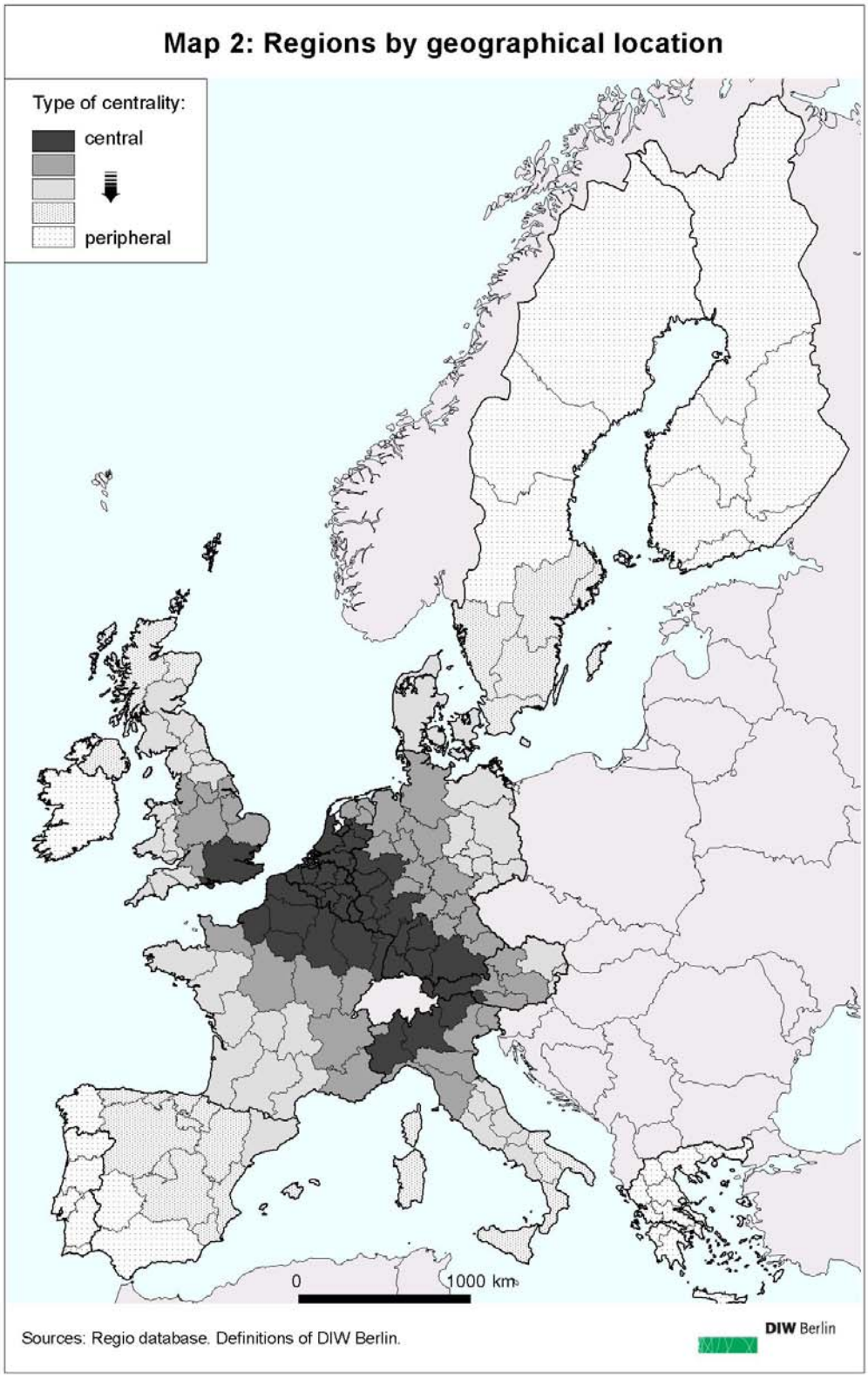
We found evidence both for considerations based on the neo-classical growth theory (convergence) and on the New Economic Geography (market potential), but contrary to these theories the regional development processes are not heading for equilibrium in the sense of homogeneous trends over time. Rather, the changes in productivity differences and the growth of output and employment appear to be largely a result of discrete developments in the individual member states of the European Union.

We therefore consider the analysis of the national influences to be an important task of future research. Numerous hypotheses are conceivable: How important are national business cycles? Which role have differences in physical infrastructures to play? Is it possible to find evidence for the influence of national education systems or labour market organisations? Empirical tests in the context of regional and national developments might be worth while. Finding answers to these questions, particularly in view of the eastern expansion of the EU, should be of great interest for economic policy. Strategically, the role of national policies in the catching-up process of the regions in central and eastern Europe, according to our findings, is likely to be very important.

Appendix: Description of the variables used

GDP	Gross domestic product at purchasing power standards. In principle, these are nominal output quantifications, but adjusted to exclude differences in price levels between the EU member states.
Employed persons	Are persons who are gainfully employed at the respective date of reference. They are classified into the segments agriculture, industry and services.
Productivity	GDP per employed person. The initial level of productivity is established for the year in which the region was fully reflected in the statistics for the first time.
Degree of industrialisation	Manufacturing employment as a percentage of total employment. In each case, the initial level is established for the year in which the region was fully reflected in the statistics for the first time.
Type of settlement	Each of the 178 regions used here has been classified by type of settlement. The main distinctions are between agglomerations, other urban regions and rural regions (see map 1). Specifically, the demarcation applied in European regional planning (BBR 2001) was used. On the aggregated NUTS2 level, classifications often had to be made on the basis of the main settlement structure. In some cases, e.g. for smaller islands or in the case of Denmark, a categorisation did not appear possible.
Type of location	The geographical position of a region in the EU is recorded by means of a categorical classification. Based, for example, on the centre and periphery model by Keeble or the "Blue Banana" model by RECLUS, the distance to Europe's economic core zone of London via the Rhine Valley to Milan is used as the key location parameter (BBR 2001). The differing degree of centrality is represented in the type of location in descending order from 1 to 5 (see map 2).


Map 1: Regions by type of settlement
agglomerations
town dominated regions
rural regions
other types
0
1000 km
Sources: Regio database. Definitions of DIW Berlin.
DIW Berlin


Map 2: Regions by geographical location
Type of centrality:
central
peripheral
0
1000 km
Sources: Regio database. Definitions of DIW Berlin.
DIW Berlin

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