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383

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Productivity Differences in the European
Union: National, Regional and Spatial
Effects

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Productivity Differences in the European Union

National, regional and spatial effects[*]

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Abstract

Using panel data on European regions and applying Analysis of Covariance, our study provides an empirical assessment of the relative importance of national, regional and spatial factors for explaining variations of productivity. Our analysis shows that initial economic conditions or agglomeration and centrality are indeed relevant for differences in productivity levels. What is far more important, however, is which country a region belongs to. Productivity differences in the European Union are thus obviously dominated by national regimes. In light of the historically strong influence of the nation states, this result may come as no surprise. What is surprising is the fact that the role of countries has not decreased over time, despite intensive integration efforts (European Single Market, Economic and Monetary Union).

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1 Introduction

Empirical research on regional development in Europe has largely evolved in three separate but overlapping fields: (1) the analysis of aggregate growth with regard to convergence or divergence of regions, (2) the analysis of the regional distribution of sectors (localisation) and the implications for regional income and productivity and (3) the analysis of regional labour markets and regional unemployment. In our investigation, we do not directly address either of these issues, but rather, we focus on the question of what *level* the factors determining regional productivity are operating at – national, regional or spatial. We want to know whether levels and growth of regional productivity are predominantly determined by conditions and developments within the respective nations, by the specific characteristics of the regions themselves, or by the spatial context in terms of settlement structure and geographical location of regions. Furthermore, we examine changes over time in the importance of these different effects on regional productivity in order to establish whether national influences on regional economic development have given way to region-specific and spatial factors in the course of European integration.

In an early and comprehensive account of regional disparities within the European Union, Molle (1980) found that in the 1950s and 1960s countries rather than regions had played a decisive role in determining regional patterns in Europe. From the "preponderance of national effects" (p. 160), he concluded that in order to reduce regional disparities, supranational policy should be oriented towards assisting lagging countries, not regions. Nevertheless, the EU continued to build up and expand its own system of regional aid. There was an underlying expectation that further integration and enlargement might come at the expense of backward and peripheral regions, at least in the short and medium run, and that this would weaken the cohesion of the union. Such fears were supported by regional economists. Keeble et al. (1982) applied the economic potential approach, first introduced by Harris (1954), to the European Union. They stressed spatial factors in regional development and their calculations of accessibility indices led them to predict that peripheral regions would lose economic ground relative to the central regions.

In fact, the long-standing trend of decreasing regional disparities in Europe (Barro, Sala-i-Martin 1995; Armstrong 1995) slowed down and in fact came to a standstill in the 1980s, and there was no significant recovery of convergence during the 1990s.[1] In the process, the differ-

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[1] A somewhat contrasting result is obtained by Fingleton (2003). He finds a considerable rate of absolute convergence ($\beta = 0,03329$) for the period 1987-1997. Generally, the results of growth regressions are highly sensitive to the period considered and to the definition of regions. See Cheshire and Carbonaro (1996) for a discussion

ences in per capita income between the EU states have diminished. However, the disparities between the regions within the states tend to grow (Neven, Gouyette 1995; Fagerberg, Verspagen 1996; Tondl 1999; López-Bazo et al. 1999; Cheshire, Magrini 2000; Cuadrado-Roura 2001; Boldrin, Canova 2001; Martin 2001; Rodriguez-Pose, Fratesi 2002; Villaverde Castro 2002; Giannetti 2002; Terrasi 2002; European Commission 2003). The general direction of labour productivity, defined as GDP per employed person, is the same as for income, GDP per inhabitant, but the degree of convergence is significantly higher for productivity (Lopez-Bazo et al. 1999; Esteban 2000; Cuadrado-Roura et al. 2000; Martin 2001; Basile et al. 2003). As a result, regional disparities in terms of unemployment have deepened (Martin 2001; Puga 2001; Dohse et al. 2002). An important driving force behind the regional polarisation of unemployment in the European Union, according to Overman and Puga (2002), are agglomeration (neighbour) effects, as stated in the New Economic Geography. These effects are shown to be of similar strength across national borders and within nations. A potential for regional polarisation is also apparent in industrial localisation. Over the past two decades, the concentration of the manufacturing sector across regions has increased significantly (Midelfart-Knarvik, Overman 2002) and market services are further shifting to central regions of the EU (Brülhart, Traeger 2003).

The empirical literature indicates that country-specific effects on regional patterns in Europe are still important for *levels* of economic activity. This is reflected, for instance, in highly significant country dummies as conditioning variables in growth regressions. At the same time, many empirical studies suggest that national factors can no longer play a major role in explaining the economic *development* of regions. The "stylised fact" of national convergence and regional divergence is one of the indications along these lines. Our own empirical investigations depart from this state of affairs. We do not aim to single out explanatory factors for regional productivity, but rather we attempt to determine – in a summary way - to what extent differences in levels and growth of regional productivity are due, first, to region-specific characteristics (as considered in growth theory), second, to spatial factors (as considered in new economic geography) and third, to national policy and institutional influences. Our key result is that, in contrast to many other findings, national factors are very important for regional development and that their significance has not thus far abated in the course of European integration.

Section 2 of this paper presents our method, data and results. Section 3 concludes.

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of this latter problem. In the case of conditional convergence results crucially depend on the choice of conditioning variables (Levine, Renelt 1992; Cheshire, Magrini 2000). For a more fundamental criticism of growth re-

2 Empirical analysis

2.1 Method

The purpose of our empirical analysis is to assess the relative importance of regional, spatial and country effects for explaining regional economic performance in the European Union. To accomplish this analysis, we use a two-step approach. In the first step, we estimate a model with fixed effects for regions (Model specification 1). They reflect unobserved heterogeneity across regions, i.e. variables or effects that are not included in the estimation equation. In the present case, the fixed effects indicate whether there is a more or less stable regional pattern of productivity levels and growth in Europe. It should be emphasized that only time-invariant unobserved heterogeneity is captured by this approach. In the second step, we obtain estimates of the relative importance of country effects, economic geography factors and initial economic conditions within the regions (Model specification 2).

The second step is necessary because the latter time-invariant factors are perfectly collinear with the fixed effects for regions, so these factors cannot be estimated in the first step jointly with the fixed effects. However, the results of the second step will enable us to assess how much of the variation due to unobserved fixed effects in the first step can actually be explained by country, geography or regional economic conditions factors.

The two dependent variables for measuring regional economic performance are (1) the logarithm of 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, (2) the growth rate of productivity defined as $\Delta \ln(Q_{it} / L_{it\,t}) = \Delta \ln(Q_{it}) - \Delta \ln(L_{it})$, where Δ denotes the first differences. Labour productivity $\ln(Q_{it} / L_{it})$ is modelled as a linear function of determinants X_{it}, i.e.

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

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

In the estimations we apply Analysis of Covariance (see Hsiao 2003). This method belongs to the class of Generalised Linear Models (Searle 1997), i.e. both metric and categorical independent variables can be considered. The categorical variables (effects) are represented by

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gressions see Quah (1996).

dummy variables.[2] The panel is unbalanced, i.e. the number of observations is not the same for all regions. See also the data description below. In principle, it would have been possible to use a random effects model instead, and thus estimate jointly the impacts of all effects. However, the random effects model is based on more restrictive assumptions, for example, of random effects uncorrelated with the other explanatory variables. It is possible to show that in our case this assumption is violated. Furthermore, Analysis of Covariance remains a relatively robust approach even if the errors are not normally distributed. Finally, one can argue that the regions in our sample are not a random draw but represent the total population of regions in the EU.

As mentioned above, we estimate an equation with fixed effects for regions in the first step (Model 1). This model exhibits the greatest number of degrees of freedom, since a dummy variable is included for each region. Model 1 is therefore specified as

$$(2) \qquad\qquad Y_{it} = \mu_i + \lambda_t + \varepsilon_{it},$$

with $Y \in \{\ln(Q/L), \Delta\ln(Q/L)\}$.

In the second step, the fixed effects are replaced by other time-invariant factors, i.e. country dummies, economic geography indicators and initial economic conditions in the regions (model 2). Model 2 is therefore specified as

$$(3) \qquad\qquad Y_{it} = \phi_k + \nu_n + \theta_p + \varphi_i + \gamma_i + \lambda_t + \varepsilon_{it},$$

where ϕ_k, ν_n, θ_p denote country, type of settlement and type of location effects, the latter two being our economic geography indicators. These categorical variables (effects) have K, N, and P categories respectively. The regional economic conditions φ_i (initial industrialisation) and γ_i (initial productivity) are metrically scaled variables. However, like the categorical variables, they possess only variation between regions, not variation within regions.

The explanatory variables may be divided into three areas: in the first, spatial indicators are used to reflect influences on regional development that have been stressed in recent agglom-

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[2] 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.

eration models (degree of agglomeration and geographical location).[3] In the second area, we use productivity and the share of manufacturing in the start year as indicators for the basic economic conditions in the regions (development status and sectoral structure). The former, in particular, is a central factor in traditional theories of regional growth. In the third area, control parameters are used to capture other determinants not directly related to the regional economy. Specifically, these are country dummies and national growth rates to control for differences in institutions and macro-economic policies of EU member states.

The total number of degrees of freedom in Model 2 is lower than in Model 1. Therefore, the R^2 of Model 1 will be higher than the R^2 of Model 2. If, however, the fixed effects from the first step can be properly explained by spatial, country and regional economic conditions effects, then the total R^2 obtained for Model 2 should not be substantially lower than that for Model 1.

Our main focus is to assess the relative importance of the various effects. This can be achieved by computing partial R^2s which show the contribution of each effect to explaining the overall variance of the dependent variable, whilst all other effects remain equal. The partial R^2 can therefore be interpreted as the independent explanatory contribution of an effect. It is worth noting that the individual partial R^2s do not add up to the overall R^2 of the model in most cases. One reason is a redundancy of the different effects, since these are not independent of each other. For instance, the geographical location effect is likely to be correlated with the country effect. On the other hand, if this dependency is not properly taken into account by including both effects simultaneously, the estimates will be biased and thus misleading. The second reason is that different determinants may even have a conjoint explanation, so that the sum of partial R^2s might be larger than the total R^2 of the model.

Furthermore, it is worth mentioning that for the model with productivity growth as dependent variables, it may be expected that the influence of time-invariant effects, for example, the fixed effect for regions, is lower than for the productivity level. If there is unobserved heterogeneity mainly for the level of productivity, when first differences are taken, such time-invariant effects are cancelled out. As an example, the first difference of the region fixed effect is zero, i.e. $\Delta\mu_i = 0$.

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[3] There are various ways to capture geographical location and market access. In their analysis for functional urban regions (FUR), Cheshire and Magrini (2000) use a variable derived from the concept of economic potential. One spatial dimension, neighbourhood, is not explicitly included in our set of variables. However, as our regions are broadly delimited to *incorporate* socioeconomic linkages across NUTS2 units, neighbourhood effects are not a big issue.

2.2 Data

The main basis for our data is the EUROSTAT Labour Force Survey. From 1996, it contains a great deal of EU-wide uniform information on the regional economic development at 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 a 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.

One major obstacle for the analysis is the definition of the NUTS regions based on nationally oriented demarcation. The demarcations tend to follow the traditional regional subdivisions in the member states that turn out to be very different in terms of spatial function. For example, at 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 densely populated core city.

This seriously restricts direct use of the EUROSTAT data for the analysis, particularly since settlement structure is an important aspect. To ensure comparability of regional demarcations across nations, we have combined individual NUTS2 regions according to the characteristics of settlement structure such as population density. (See maps in the Appendix.) A different way to construct comparable regional units is taken by Cheshire and Carbonaro (1996) and Cheshire and Magrini (2000). They restrict their analysis to functional urban regions (FUR), disregarding all other regions.

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

We use labour productivity, defined as the gross domestic product in purchasing power standards per employee, as a measure for regional economic performance. Due to measurement error and regional allocation problems in determining gross domestic product and employment figures at regional level, it is likely that there are inaccuracies in these statistics. However, as the relative position of the regions to each other is more important here than the

absolute figures, these potential inaccuracies may be neglected for the present analysis. Observations with absolute values of productivity growth larger than 15 % (approximately the value of the lower and upper percentile) were considered as outliers and excluded from the analysis.

A more detailed description of the data and variables used is given in the Appendix.

2.3 Results

In this section, we first present results with respect to the relative importance of regional, national and spatial factors for explaining variation in regional productivity (Table 1). Secondly, we present parameter estimates showing the direction and strength of spatial and region-specific effects (Table 2). Finally, we look at the development of the variation of country effects over time (Figure 1). This will indicate whether or not country effects have become weaker in the course of European integration.

As mentioned above, the dependent variables in our analyses are (1) the level of logarithmic labour productivity and (2) the growth rate of productivity. The panel regression results in Table 1 (columns 1 and 2) show that our model for the level of productivity goes a long way towards explaining the observed dispersion. The overall R^2 is 0.95. The partial R^2 of around 0.53 reflects the magnitude of fixed effects for regions. It implies that there is a relatively stable pattern of regional productivity differences. There has not been much change in the relative positions of regions over time. Significant fixed effects are not consistent with high fluctuations in productivity positions of regions.

The parameter estimates of the fixed effects, μ_i, (not reported) show that the highest expected regional productivity – besides special cases such as small islands – can be attributed to the urban regions of Genoa, Paris and Milan. Among the British and German urban regions, London and the Rhine-Main area stand out in terms of the expected 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.

Time effects (year) are also highly significant for regional productivity. These time effects capture any unobserved heterogeneity across years that affected the productivity of all regions. Common business cycles or even technological progress are likely causes of these significant time effects.

The results of Model 1 for the growth of productivity are far less clear. The significance of fixed effects for regions falls short of the 10 percent level. This finding suggests that there is

no persistent pattern of regional development across European regions. In addition, the overall R^2 (0.25) is much lower than for the productivity level.

Table 1: Estimation results from Analysis of Covariance

	Model 1				Model 2.1				Model 2.2			
	(1)			(2)			(3)			(4)			(5)			(6)		
Dependent variable:	*Productivity level* $\ln(Q_{it}/L_{it})$			*Productivity growth* $\Delta\ln(Q_{it}/L_{it})$			*Productivity level* $\ln(Q_{it}/L_{it})$			*Productivity growth* $\Delta\ln(Q_{it}/L_{it})$			*Productivity level* $\ln(Q_{it}/L_{it})$			*Productivity growth* $\Delta\ln(Q_{it}/L_{it})$		
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)	0.523*	17	(1371)	0.179*	16	(27.68)	0.518*	17	(929.9)	0.179*	16	(28.96)	0.163*	17	(374.4)	0.054*	16	(10.51)
Region (μ_i)	0.535*	177	(135)	0.062	177	(0.869)	—	—	—	—	—	—	—	—	—	—	—	—
Initial industrialisation (φ_i)	—	—	—	—	—	—	0.001	1	(3.24)	0.001	1	(0.01)	0.001*	1	(2.89)	0.001	1	(0.01)
Initial productivity (γ_i)	—	—	—	—	—	—	0.130*	1	(3964)	0.006*	1	(14.33)	0.127*	1	(4959)	0.007*	1	(20.83)
Type of settlement (ν_n)	—	—	—	—	—	—	0.004*	3	(39.05)	0.000	3	(1.15)	0.004*	3	(47.6)	0.001	3	(1.50)
Type of location (θ_p)	—	—	—	—	—	—	0.001*	4	(9.31)	0.001	4	(0.08)	0.001*	4	(13.50)	0.001	4	(0.11)
Country (ϕ_k)	—	—	—	—	—	—	0.176*	15	(357.6)	0.025*	15	(4.30)	0.151*	15	(392.2)	0.024*	15	(4.93)
Year*Country (γ_{kt})	—	—	—	—	—	—	—	—	—	—	—	—	0.020*	161	(4.78)	0.179*	146	(3.82)
Total R^2	0.954*	194	(219)	0.245*	193	(3.15)	0.928*	41	(691)	0.220*	40	(14.24)	0.944*	202	(183)	0.398*	186	(6.69)
No. of observations	2244			2066			2244			2066			2244			2066		

part. R²=partial R², df=degrees of freedom. * statistically significant at α=0.05 level. 0.001 indicates ≤0.001.

In the next step of our analysis, we investigate how much of the fixed effects in productivity differences is due to regional economic conditions, economic geography factors and national influences. The overall R^2 of 0.93 for the productivity level in Model 2.1 of Table 1 is only slightly lower than for Model 1. This implies that a major part of the fixed effects can indeed be attributed to these factors.

Looking at the results for Model 2.1 in more detail, we find that most of the region-specific, geographic and country effects are significant for the level of productivity. Only the share of manufacturing (initial industrialisation) has no systematic influence on regional productivity levels. The country affiliation of regions makes the largest impact. This effect explains almost 18 percent of the total variation in regional productivity (Table 1, column 3). Initial productivity, too, is a good predictor for the values observed. Around 13 percent of the variation in regional productivity may be attributed to this effect. On the other hand, the role of economic geography factors, while statistically significant, is rather limited. Taking the other variables/effects as given, the partial R^2 is equal to or below 0.004 both for the type of settlement and for the type of location. Similar results were obtained with alternative spatial indicators. If, for instance, the type of settlement is replaced by population density, the relative explanatory power turns out to be even lower.

Unlike the level, the dynamics of regional productivity can hardly be explained by the time invariant variables used in Model 2.1. Only the effects of the country dummy and of initial productivity are significant at the one percent level. Obviously, regions do not follow stable development paths, but rather, there is considerable churning in the distribution of growth rates. The only regularities, apart from the general trend (λ_i), are national influences and the initial position in the hierarchy of regional productivity (Table 1, column 4). However, we conclude from the low partial R^2s of 0.025 and 0.006, respectively, that the contribution of these effects to explaining overall variation in regional productivity dynamics is only minor.

The direction of the effects observed in Model 2.1 may be seen from parameter estimates for the different categories of the respective variables. Table 2 reports estimates obtained from Model 2.1 for region-specific and spatial factors. With all other effects being controlled for, the expected productivity level of urban agglomerations is 4.7 percent higher than that of rural areas (which is the reference category) and, in addition, agglomerations have a significantly higher expected productivity growth.[4] At the same time, expected productivity for the central

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[4] Estimates for agglomeration effects are sensitive to, for example, the spatial concept used. The results obtained by Ciccone (2002) imply a productivity difference between densely populated urban regions and rural areas of around 25%. While in his study the regional level of observation is NUTS 3, our analysis is based on a concept

regions of the EU is 8.2 percent higher than that for the periphery. The more distant a region is from this core zone, the lower the expected regional productivity is. Thus, the estimated coefficients for the spatial effects are in line with predictions in the New Economic Geography, but, as indicated by the partial R^2s, this does not explain very much of the total variation in regional productivity.

Table 2: Selected parameter estimates from Model 2.1[a]

	Productivity level		Productivity growth	
	(1)		(2)	
	Parameter estimate	*t value*	*Parameter estimate*	*t value*
Regional economic conditions				
Initial degree of industrialisation	0.059	(1.80)	0.001	(0.04)
Initial productivity	0.670*	(62.97)	-0.020*	-(4.56)
Type of settlement				
Urban regions	0.047*	(9.59)	0.004*	(2.09)
Town dominated regions	0.021*	(3.32)	0.001	(0.49)
Rural regions[b]	0.000	—	0.000	—
Type of location				
EU centre	0.082*	(4.79)	0.004	(0.59)
Fringe of EU centre	0.067*	(4.11)	0.004	(0.59)
Intermediary zone	0.041*	(2.69)	0.003	(0.45)
EU inner periphery	0.037*	(3.03)	0.002	(0.41)
EU outer periphery[b]	0.000	—	0.000	—

* statistically significant at α=0,05.

[a] Table 1, columns 3 and 4. [b] reference category.

There is also evidence in favour of neoclassical growth theory according to which regional convergence is the expected outcome of European integration. The negative coefficient on initial productivity in column 2 indicates that backward regions of the EU grew faster than highly developed regions. This is also supported by the coefficient below one (0.67) of the initial productivity level in column 1, which shows that productivity differences across re-

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of functional regions at NUTS 2 level. In cases of intensive socioeconomic linkages across NUTS 2 borders, these units were combined to form one region.

gions have decreased over time. But similar to the spatial effects, the tendency towards convergence accounts only for a small fraction of total variation in productivity dynamics.[5]

Finally, returning to the relative importance of national, regional and spatial factors in explaining regional productivity differences, we consider variation over time of independent variables. In particular, country effects are unlikely to remain constant. For instance, national business cycles or the deregulation of input and product markets have temporary effects on productivity. Therefore, Model 2.2 includes an interaction term of country and year (Table 1, columns 5 and 6). It reflects an unobserved time-varying impact of the country on its regions. The estimation results show that this is actually the most important factor for regional productivity growth. The overall R^2 increases from 0.22 to almost 0.40 (Table 1, columns 4 and 6), which implies a contribution of the interaction term of about 0.18. One might presume that business cycles at country level are behind this finding. However, if the national annual growth rates are included as a proxy for countries' business cycles, it turns out that the partial R^2 of this variable is quite low. It is therefore unlikely that country-specific and time-specific heterogeneity is mainly due to national business cycles.

The most convincing explanation of these time-varying country effects on regional productivity growth appears to be that they reflect the (temporary) influence of national economic policies or external events affecting all regions of the respective country. Examples are the employment 'miracle' in the Netherlands during the 1980s, the positive development in Finland due to the IT boom during the late 1990s, or the catching up of Ireland.

In light of the historically strong national character of Europe, the dominant influence of the country effects on regional productivity levels appears highly plausible. What is astonishing, however, is that even the growth of productivity is largely determined by national factors. Moreover, it is possible to demonstrate that the national influence is not subject to any time trend. In order to do so, we computed the standard deviation of the parameter estimates of the Year*Country effect for productivity growth, γ_{kt}, year by year, both for all countries (unbalanced panel) and only for the core countries that have been included in the sample for the entire period of observation (balanced panel). Figure 1 shows that there is no decline in the variation of country effects. 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 country-level impacts on regional development.

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[5] The observation that no single theoretical approach can explain the whole pattern of regional development in Europe is common to a number of analyses (e.g. Haaland et al. 1999; Midelfart-Knarvik et al. 2000). Both economic geography and neoclassical trade and growth theories account for certain aspects of reality.

Figure 1: Standard deviation of estimated country effects for productivity growth over time
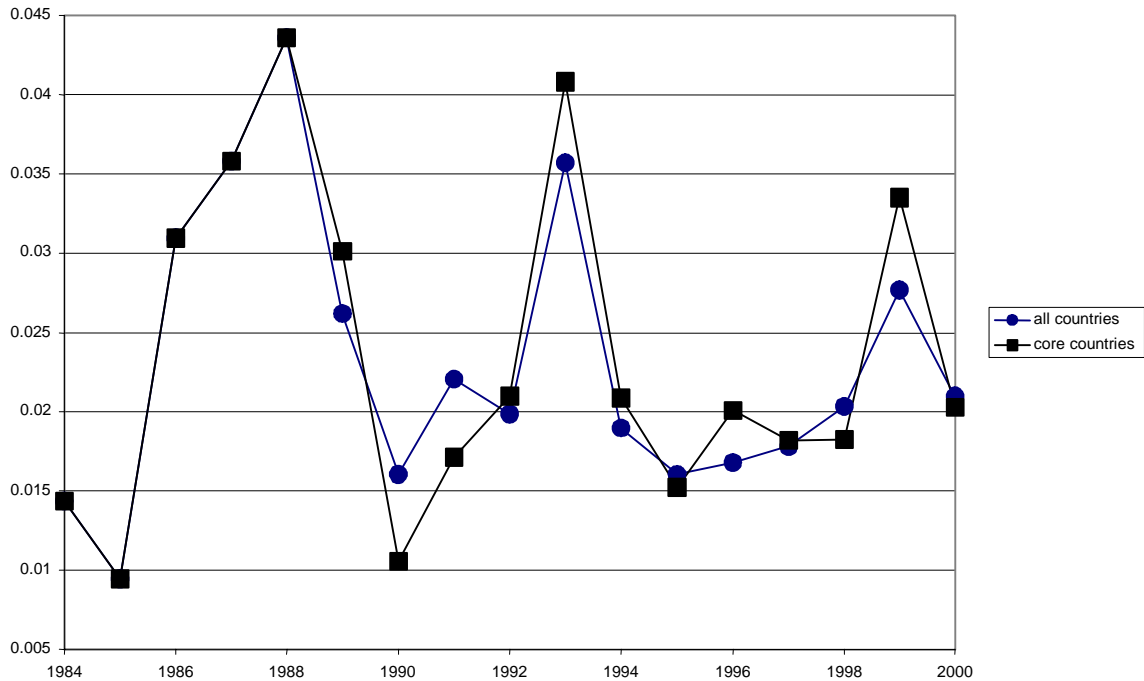
This result is in contrast to many studies on regional development in Europe, which find evidence of divergence of productivity at the regional level but convergence among nations. It should be noted, however, that none of these studies takes time-varying country effects or geo-economic indicators into account.

3   Conclusions

In this study, geo-economic indicators considered in the New Economic Geography literature - degree of agglomeration (type of settlement) and geographic location (type of location) - have proved to be significant for explaining regional productivity differences in the EU. Regional productivity is, however, determined to a far greater extent by the country to which the regions belong than by agglomeration or centrality. Differences in regional productivity levels in the European Union are thus obviously dominated by national productivity regimes.

In the 1980s and 1990s, the growth of productivity in the regions of the European Union was characterised by a slight tendency towards convergence. In this respect, the findings of most existing empirical studies have been confirmed here. However, the dynamics of regional productivity, too, can be predominantly ascribed to national factors but the country-specific influences evidently proceed in waves rather than continuously.

The strong impact of national factors on regional productivity *levels* may not be surprising regarding the historically pronounced national divisions of Europe. But in light of the pro-

gress political and economic integration in Europe has made, it is astonishing that the *development* of productivity is also still largely 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 importance of national factors for regional productivity growth.
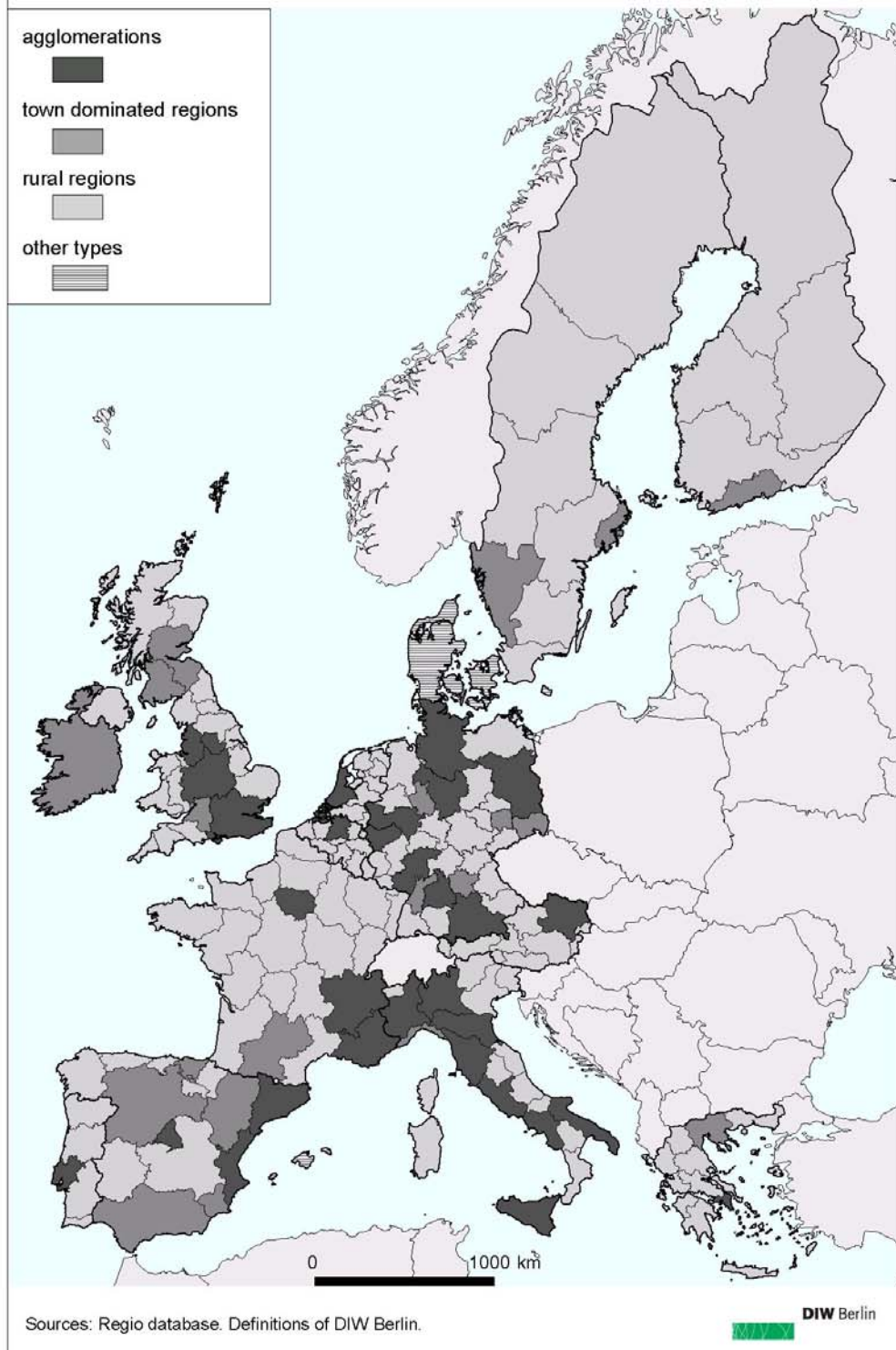
We therefore consider the analysis of the national influences to be an important aspect of future research. Numerous hypotheses are conceivable: How important are national business cycles? What role are differences in physical infrastructures to play? Is it possible to find evidence for the influence of national education systems or labour market organisations? Empirical tests in the context of regional and national developments might be worthwhile. 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 a very important one.
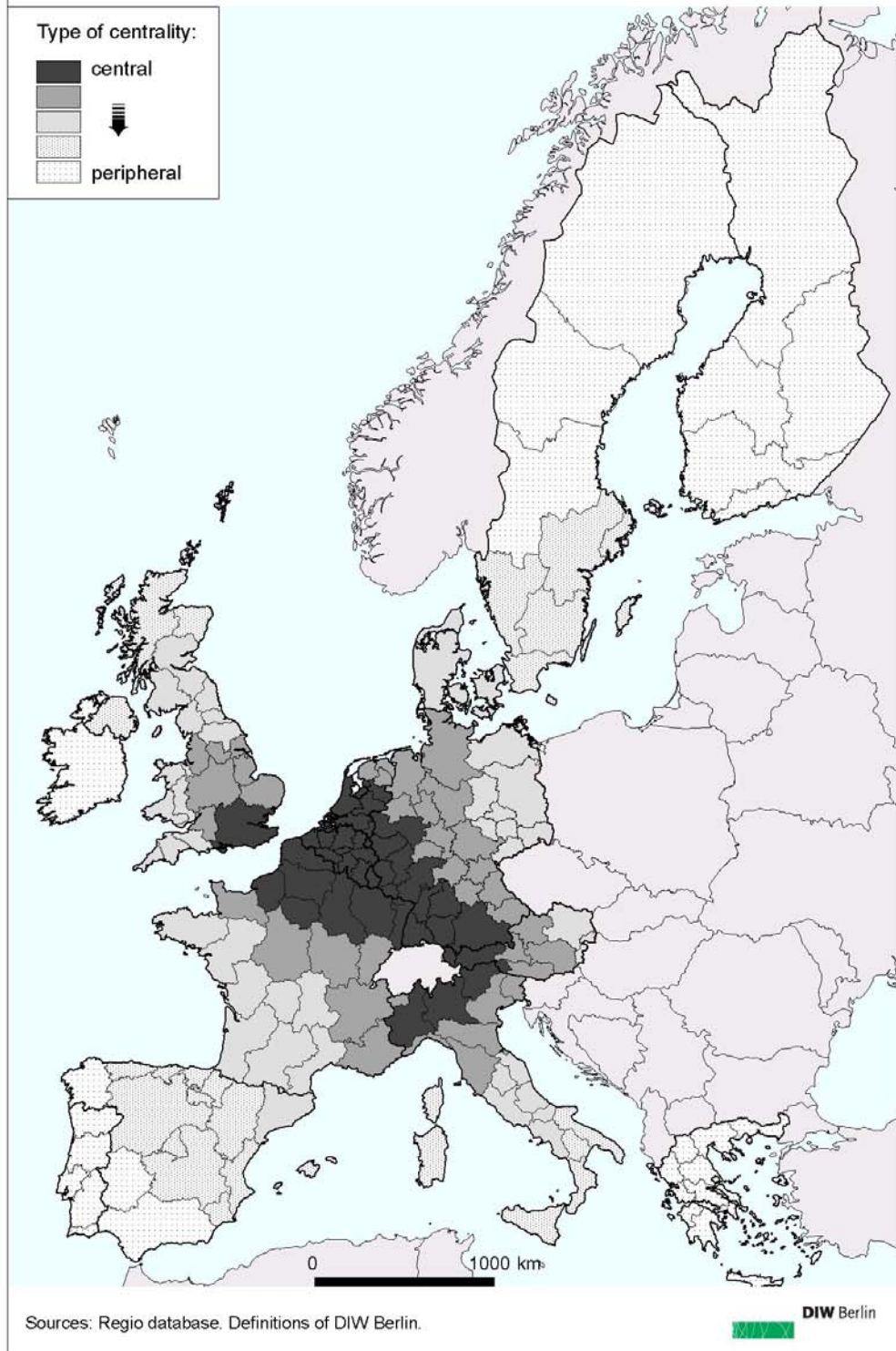
Appendix: Description of the variables used

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. At an aggregated NUTS2 level, classifications often had to be made on the basis of the main settlement structure. In some cases, for example, for smaller islands or in the case of Denmark, no categorisation seemed to be 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

16

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
- (gradient)
- peripheral

Sources: Regio database. Definitions of DIW Berlin.

DIW Berlin

0   1000 km

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