The dynamics of regional inequalities^{*}
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Abstract

This paper analyses empirically the link between regional inequalities and economic development. Our starting hypothesis in this regard is that the evolution of regional inequalities should follow a bell-shaped curve depending on the level of national economic development since growth by its very nature is unlikely to appear everywhere at the same time, as has been argued by a number of authors, such as Kuznets (1955) to Lucas (2000). We test this hypothesis econometrically using semi-parametric estimation techniques and regional data for a panel of European countries. Our results provide strong support for such a bell-shaped curve and are robust to changing the regional administrative units and the time period, as well as controlling for other possible determinants of regional inequalities. We derive a number of policy implications from our results.

JEL classification: R1, R5, D31

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1. Introduction

Economists have increasingly paid attention to the role played by knowledge and spillovers in explaining countries' growth differentials and diffusion both across countries and regions; see, for instance, Jones (2004) and Klenow and Rodriguez-Clare (2004). Accordingly, knowledge spillovers should give rise to substantial scale effects in productivity stemming from their non-rivalry nature.¹ However, although knowledge and technological progress are in this regard seen as the main engines of economic development, the latter may inevitably increase rather than decrease regional inequalities since these two elements are very unlikely to be evenly spread both across time and space. As a consequence, economic growth may, at least initially, foster divergence, rather than convergence across spatial units suggesting that convergence may evolve non-linearly. Indeed, when considering the theoretical literature on growth and convergence, a wide array of arguments arise advocating either for the long-term reduction or, to the contrary, for the persistence and self-reinforcing nature of economic inequalities across countries and regions, see, for instance, Galor (1996), Prichett (1997) and Lucas (2000). Elements such as spillover effects and nonlinearities have also been considered in empirical studies providing growing evidence for the non-linear nature of the growth and convergence processes, see, for instance, Durlauf and Johnson (1995), Liu and Stengos (1999), Quah (1996b, 1997) and Canova (2004).

Interestingly, the idea that regional inequalities are likely to evolve in a nonlinear way can be traced back as early the 1950s. The evolution of regional inequalities was then usually linked to national economic development paths. As a matter of fact, it was Kuznets (1955) in his analysis of income disparities who suggested the existence of a “*long swing*” in regional income inequalities, where there was first a rise and then a subsequent fall of income differentials caused by the urbanization and industrialization process accompanying national development and the decline of agriculture. Several authors have built on this idea for regional analysis suggesting the existence of a *bell-shaped curve of spatial development* where inequalities should first increase as developed areas benefit from external economies, location of decision-makers, political power and capital and labour mobility, see for instance Myrdal (1957), Hirschman (1958), Williamson (1965) and, more recently, Ottaviano and Thisse (2004).²

While a non-linear relationship between regional inequality and national development clearly has important implications for economic theory and policy, there is to the best of our knowledge no explicit econometric study that has set

¹ This is a central theme in the works of Romer (1990), Kremer (1993) and Tamura (1996) among others.

² The evidence concerning the non-linear relationship between urbanization and development is also a well documented fact in urban economics, see, for instance, the seminal work of Alonso (1969).

out to investigate its existence, although a number of works have been suggestive of its possibility. In the current paper we explicitly test this hypothesis using data for EU countries. The EU economy makes arguably for a particularly suitable case study given the sizeable disparities in economic development both across regions and countries, compared to, for instance, the US. One may thus exploit the fact that these countries are on very different positions on their development path, hence allowing one to observe regional inequality across a wide range of economic development levels. To investigate this we use data on GDP per head for European regions between 1975 and 2000. We show using a flexible semi-parametric estimator that the relationship between national GDP per head and regional inequalities follows a bell-shaped curve, suggesting that growth first increases regional inequalities but then tends to lower them as the national level of income continues to rise. This result is robust to considering other OECD countries, alternative geographical units, and after controlling for other potential determinants of regional inequalities such as the degree of international openness, industrial specialization, regional aid, and the level of fiscal decentralization. Our paper is thus, to the best of our knowledge, the first study to provide robust evidence of the bell-shaped relationship between regional inequalities and national economic development.

The remainder of the paper is organized as follows. In Section 2 we review the existing empirical literature concerning the link between national development and regional inequalities. In this section we also present a simple theoretical model to illustrate the main mechanisms at hand. Sections 3 and 4 present some preliminary evidence and our main econometric results. Section 5 summarizes our findings and discusses some policy implications.

2. Revisiting the link between national development and regional inequalities

2.1 Related empirical literature

A number of empirical artefacts tend to support the possibility of a bell shaped relationship between regional inequality and national development. Following the footsteps of Kuznets (1955), Williamson (1965) provides an extensive analysis on the topic by analyzing in details the spillovers mechanism driving the evolution of regional inequalities according to the stages of development of a nation. According to Williamson (1965), spillovers may occur through a number of channels such as migration, capital flows, government policy and interregional trade. Using evidence based on descriptive statistics for a number of countries between the end of the XIXth Century and World War II, he found some supportive evidence for a non-linear relationship between regional inequalities and national development. His conclusions derive from two

main empirical facts: first, regional disparities are greater in less developed countries and smaller in the more developed ones; second, over time, regional disparities increase in the less developed countries and decrease in the more developed. Accordingly, regional income inequalities can be considered as a by-product of the development process of a nation and any attempts at lowering them may eventually hamper this process. Kim and Margo (2003) also show that in the US the rise of industrialization during the second half of the nineteenth century has increased regional income disparities, where manufacturing was concentrated in the North and specialization in agricultural activities occurs in the South. By the second half of the twentieth century, however, regional industrial structures converged through a dispersal of agriculture and the rise of services activities across the US States. More recently, in the European context, Quah (1996a) observes that the two countries that have reached the highest rates of economic growth during the 1980s and 1990s, Spain and Portugal, are those that have experienced the most striking rise in regional imbalances. In another contribution, Quah (1999) considers the case of three EU cohesion countries, Spain, Portugal and Greece, and shows that while the first two have experienced strong growth rates and growing regional imbalances during the 1980-89 period, Greece has experienced only modest growth rates accompanied by decreasing income inequalities across its regions.³ Petrakos and Saratis (2000) also find similar evidence for Greece, discovering that, during the 1980s, the most developed regions in Greece have faced growing difficulties due to tighter foreign competition implied by the European integration process, while less developed regions were less affected. The same authors also argue that this may be one of the reasons explaining why regional inequalities have tended to decrease in this country during the 1980s. In other recent contributions, Davies and Hallet (2000) together with Petrakos et al. (2003) also provide some descriptive evidence for growing regional income imbalances for the poorest EU countries.

2.2 A simple model of growth, catching-up and technological diffusion

Before presenting our econometric results it is worth setting the basic mechanics underlying the non-linear relationship between regional inequalities and national economic development, and we do so via simple theoretical framework. This framework borrows directly from Lucas' (2000) model where spillovers are assumed to be the main vehicle of economic development. While Lucas' model was intended to examine the link between cross-country inequalities and economic progress, it can easily, however, be used to illustrate how growth transition dynamics can influence the evolution of regional inequalities within countries.

³ The group of Cohesion countries here refers to the countries entitled to the so-called EU Cohesion fund including, for the period considered here, Ireland, Greece, Portugal and Spain.

Let one consider a country composed of n regions. Initially all regions are assumed to have a constant level of income per capita y_0 . Now let us consider that growth occurs in only in one region at date $t=0$, so that growth is, at least initially, localized. The other regions will start growing at date $s>0$, each starting at a different date. In making this assumption, we are thus assuming that regions differ in their technological capability. The model then implies a distribution of starting dates characterising regional differences in technological capability. We can thus index regions by the date at which they start growing such that $y(s,t)$ will be the income per capita level of a region s which starts growing at a date $t=s$. The level of income of the innovative region at any date t can thus be written as $y(0,t)$:

$$y(0,t) = y_0(1 + \alpha)^t \quad (1)$$

where α is the constant growth rate of the leading region.

When the other regions start growing at a date $t>0$, they do so according to the following expression:

$$\frac{y(s,t+1)}{y(s,t)} = (1 + \alpha) \left(\frac{y(0,t)}{y(s,t)} \right)^\beta \quad (2)$$

where β is a catch-up rate that we assume to be constant for all the (followers) regions. This term represents the spillover effect described earlier. The growth rate of any of these regions will thus depend on the steady state growth rate α and on the differential in income per capita with respect to the leading region which can be interpreted as the technological distance with respect to this region. The development path of these regions can thus be described according to a hazard rate model where the conditional probability for a region to experience growth is given by a hazard rate $\lambda(t)$ that we assume to be equal to some constant value λ . The (unconditional) probability $F(t)$ that a region starts growing at date t can be easily derived in the usual way from hazard rate models.⁴ Thus, we assume that once the leading region starts growing, as time passes and average national income grows, the probability for any region to switch from stagnation to growth will rise and follow a cumulative process. The underlying intuition is that the larger the number of existing regions that are in a growth regime, the higher the total amount of knowledge and technological capability available in the economy and the higher the probability for any other region to get access to this knowledge and to start growing. The national level of income can thus be viewed as an indicator of the overall level of

⁴ If the hazard rate is given by $\lambda(t) = \lambda$ and the corresponding survival rate function is $S_t = e^{-\lambda t}$ such that the probability $F(t)$ that any region starts growing at a date t can be derived in the usual way from the hazard rates model such that $F(t) = \lambda(t) \left[1 - \sum_{s < t} F(s) \right]$

technological capability of a country. The average level of income can in turn be constructed as a weighted sum of the level of income of each region-type where the weights are given by the probabilities to be in a growth or in a stagnation regime as follows:

$$x(t) = \sum_{s \leq t} F(s) y(s, t) + \left[1 - \sum_{s \leq t} F(s) \right] y_0 \quad (3)$$

The extent of regional inequalities can be, as in Lucas (2000), described by the log of the standard deviation of income across regions $\sigma(t)$:

$$\sigma(t)^2 = \sum_{s \leq t} F(s) \left[\ln \left(\frac{y(s, t)}{x(t)} \right) \right]^2 + \left[1 - \sum_{s \leq t} F(s) \right] \left[\ln \left(\frac{y_0}{x(t)} \right) \right]^2 \quad (4)$$

and can be seen as the weighted value of the standard deviation of regional GDP per capita. Figure 1 depicts the relationship between the average level of income (or national average of income per capita) and $\sigma(t)$ for a given set of parameters values shown in the Figure. Accordingly, the relationship between the level of regional inequalities and the per capita national income level is non-monotonic and follows a bell-shaped curve. Regional inequalities initially rise while the forces for divergence dominate until, after a certain threshold, which depends on the level of development of the national economy, regional inequalities start falling. This outcome illustrates the role played by technological diffusion between regions: the larger the country-wide stock of knowledge, or, equivalently, the higher the level of average income, the higher will be the probability of any region to benefit from technological spillovers. One must reckon, however, that the diffusion of growth described by equation (2) constitutes very much a black box. The model thus does not rule out the fact that other mechanisms could as well explain growth transmission across regions. As noted by Lucas (2000), one could also assume that such spillovers may occur through human capital externalities, as in Tamura (1996), through institutions and the removal of barriers to technology adoption such as regulatory, or legal constraints, as argued by Parente and Prescott (1994), or simply through factor mobility and non-constant returns to capital as in Solow (1956). In this regard we thus must point out that the identification of and distinction to such alternative explanations goes beyond the scope of the present study, however. Here we rather try to assess whether the relationship depicted by Figure 1 holds for different samples of European countries, regardless through which channel the spillovers occur. One feature of EU economies is the existing huge levels of income disparities both across regions and countries. The latter means that, by observing the evolution of regional inequalities and the level of national economic development and considering all countries/regions together across time one may be able to analyse transition dynamics in regional inequalities. This would amount to consider that any point on the curve plotted in Figure 1

corresponds to the relative values of income per capita and level of regional inequalities of a given country at any date t .

3. Data and Preliminary evidence

3.1 Data and measure of regional inequalities

We use data on Gross value added per capita by NUTS2 regions taken from the Cambridge econometrics database which is based on Eurostat data; see Table A1 in Appendix for further details on the number of regions covered by country.⁵ Despite the fact that most studies on EU regions use this regional breakdown, an issue with the NUTS2 regions is that they are not necessarily economically homogenous. The consequence is that the geographical definition of regions NUTS2 may sometimes be artificial in order to comply with European statistical standards. For this reason, we will also use alternative datasets and definition of spatial units in order to check the robustness of our results.

The level of national development is represented by the GDP per capita expressed in Purchasing Power Standards (PPS) with one unit of PPS representing approximately one euro.⁶ Our measure of regional inequalities is the standard deviation of the logarithm of the GDP per capita following the model presented in Section 2. A number of alternative indicators could also have been chosen, such as the Gini index or the coefficient of variation, although one must note that the results obtained with these other possible measures are in line with the ones presented here.⁷ Note that the use of logarithm of GDP per capita reduces the potential bias related to the mechanical link between the evolution of the national GDP and its regional component. In addition, as usual in the growth literature, our GDP per capita variables are measured relative to the EU average. This allows us to reduce both serial correlation and the effect of potential outliers, see Canova (2004).

3.2 Preliminary evidence

According to the existing evidence for Europe, the poorest EU members have experienced fast catching-up over the past two decades or so and this has

⁵ Note that we systematically checked the results obtained using the Cambridge Econometrics data by using the regio database which is less complete. The results obtained were nearly identical to the ones presented here.

⁶ Table A1 in Appendix provides further details concerning the countries considered and the number of observations available for the different datasets used in the paper.

⁷ Note also that, in order to check whether the standard deviation of regional GDP per capita was influenced by the number of regions by country, we computed correlation these two variables for the EU15 and it was equal to -0.33 .

translated into rising regional inequalities. In order to provide further evidence on this, we examine first the countries which, at the start of the period 1975-2000, had the lowest level of GDP per capita, namely, Greece, Portugal and Spain.⁸ Table 1 displays the level of national GDP and the standard deviation of regional GDP per capita for these countries. The level of regional inequalities appears to be, on average and for most of the period considered here, higher in the Cohesion country group compared to the rest of the EU. This distinctive feature also holds when considering Cohesion countries individually, except for Greece, which is also the EU15 country with the lowest GDP per capita during the second half of the period. One must note, however, that it is rather difficult to draw any conclusive evidence concerning given that regional inequalities may experience significant changes, especially, but not exclusively, for the cohesion country group as shown in Table 2. Despite this, one can still identify two distinct periods concerning the evolution of regional inequalities and convergence in the Cohesion countries. The first is the 1975-1985 period, marked by slow economic growth in the EU as a whole, and declining regional inequalities in Spain, Greece and Portugal. By contrast, the following two periods were characterized by fast catching-up and rising regional inequalities. These latter two periods are also marked by the accession of two cohesion countries in 1986, namely Spain and Portugal, with initial GDP per capita much lower than the EU15 average. During 1986-1992 national GDP per capita in Portugal and Spain converged steadily to the EU average together with a rise in regional income inequalities in these countries. In Greece, however, the slight decline in GDP per capita relative to the EU average was accompanied by a rise in regional inequality compared to the rest of the EU but remained at levels well below the EU average. The period 1992-2000 is characterized by a rather stable level of regional inequalities in Spain and rising inequalities in Greece and Portugal. This rise, in turn, corresponds to a rapid convergence of GDP per capita for the last two countries.

The evidence regarding the rise in regional inequalities that accompanies national economic development is even more pronounced when considering the countries that joined the EU in 2004. Table 3 provides detailed statistics for these and shows that, as for the Cohesion countries, these countries display, on average, higher regional inequalities than the EU15 countries, including the Cohesion countries. In addition, they have almost invariably all experienced a continuous increase in the level of regional inequalities during the period 1995-2000, except for Bulgaria, Poland and Slovenia. While part of this evolution is probably due to the transition from a planned to a market-oriented economy, most of the impact of this process at the regional level was experienced in the early 1990s. It follows that a large part of the rise in regional imbalances is likely to be due to the rapid catching-up process experienced by these countries

⁸ Lack of sufficiently disaggregated data at the regional level for Ireland does not allow including evidence for this country despite the fact that Ireland also benefited from the EU Cohesion fund.

during the past decade as argued by Petrakos et al. (2000). However, one must note that not all countries have been catching-up during the 1995-2000 period. Rather countries such as Bulgaria, the Czech Republic and Romania have even seen the level of their GDP per capita compared to the EU15 average decline during these years. On average, these countries have also experienced less pronounced rise in regional inequalities.⁹

One must reckon that these preliminary results face some limitations. First, one needs to further check whether non-observable country-specific features influence the nature of this relationship. Second, as mentioned earlier, regional inequalities have not only risen in the poorest EU countries but also in some of the richest ones. It follows that the non-linear relationship between economic development and regional inequalities is hard to detect from the descriptive statistics presented above. Indeed the existing evidence mentioned earlier on is essentially focused on the ascending part of the bell-shaped curve (i.e. increasing disparities in poorer countries) while much less evidence is available concerning the descending part (i.e. decreasing disparities in richer countries). A reason for this may be due to the fact that the processes underlying the descending part might be less automatic than for the ascending part. In addition, the descending part of the bell-shaped curve may be much more dependent on pro-active regional policy and/or on implicit income redistribution schemes. The evidence for Europe suggests that these policy-related factors may play an important role in smoothing income inequalities in some countries such as Germany or France, for instance, see European Commission (2000) and OECD (2004). In order to go a step further in the analysis, the next section provides econometric result based on parametric and semi-parametric methods.

4. Econometric Analysis

4.1 Econometric methodology

Following our underlying hypotheses, the level of economic development, here denoted as X , of a country should explain where this country lies in terms of regional inequalities, represented by Y , with poorer countries experiencing growing regional imbalances as they catch up with richer countries. One way to test econometrically the relationship between Y and X is to run a simple parametric OLS estimation including both country and time dummies to control for country specific time invariant unobservables and time specific factors common to all countries in the sample. We do so using data for the EU15

⁹ This can be seen by splitting the sample of new EU member states considered here into two sub-samples: those that have caught-up and those that have not. If one considers weighted average (using country-level population as weight), the non catching-up countries have seen the level of regional inequalities to increase by around 21% while the catching-up countries have more than doubled this figure with a rise equal to 43%.

regions over the 1975-2000 period, where we include both the level of national GDP per capita and its square-term in order to capture any non-linearity its relationship with Y . The results of the OLS estimates are given in the first Column of Table 4. As can be seen, our results suggest that national prosperity acts to decrease regional inequalities while the square value of this variable is insignificant. However, a simple Ramsey RESET tests suggest that the specified functional form may not be correct. We thus also experimented with other higher order terms of the national GDP per capita but were unable to obtain a RESET test statistic that did not suggest misspecification.¹⁰ Column 2 of Table 4 displays the results of our estimations using the EU25 sample of countries. Results are very similar to the ones concerning the EU15 with a negative and significant coefficient on the GDP per capita variable but no significant coefficient on its square term.

One problem, of course, with simply using higher order terms to estimate a possibly non-linear relationship is that even these place fairly strong restrictions on the possible link between the dependent variable and the explanatory variable of interest that may not reflect the true underlying relationship. A more flexible approach to tackle non-linearity issues in growth and convergence studies is to use semi-parametric methods, as suggested by Durlauf (2001). This way one can investigate the possible non-linearity of the relationship between regional inequality and national development, while also allowing for the (linear) effect of other conditioning variables. We follow the semi-parametric methodology proposed by Robinson (1988) using the Kernel regression estimator.¹¹ Accordingly, one can consider the following equation to be estimated:

$$Y = \alpha + g(X) + \delta Z + u \quad (5)$$

where Z are a set of explanatory variables that are assumed to have a linear effect on Y , $g(\cdot)$ is a smooth and continuous, possibly non-linear, unknown function of X , and u is a random error term. Robinson's methodology proceeds in two steps. First, an estimator of δ , $\hat{\delta}$, can be obtained by using OLS on:

$$Y - E(Y|X) = \delta [Z - E(Z|X)] + v \quad (6)$$

Where v satisfies $E(v|X, Z) = 0$ and $E(Y|X)$ and $E(Z|X)$ are estimated using the Nadaraya-Watson non-parametric estimator. For instance, the estimation of $E(Y|X)$, $\hat{m}_Y(X)$, can be written as¹²

¹⁰ The result of the RESET test when including the level of national GDP only displays a F-value equal to 10.84 and significant at 1%. When including this variable and its squared term the F-test value is 8.18 and is also significant at 1%.

¹¹ See Blundell and Duncan (1998) for details and a helpful discussion of the implementation of this method.

¹² See Nadaraya (1964) and Watson (1964).

$$\hat{m}_Y(X) = \frac{\sum_{i=1}^n K_h(x - X_i) Y_i}{\sum_{i=1}^n K_h(x - X_i)} \quad (7)$$

such that $i=1 \dots n$ are the n number of observations, $K_h()$ is the shape function, commonly referred to as the Kernel, that is a continuous, bounded and real function that integrates to one and acts as a weighting function of observations around X and depends on the choice of bandwidth h . More specifically, this technique corresponds to estimating the regression function at a particular point by locally fitting constants to the data via weighted least squares, where those observations closer to the chosen point have more influence on the regression estimate than those further away, as determined by the choice of h and K . An additional appeal of this sort of technique is that it avoids any parametric assumptions regarding $E(Y|X)$ and thus about its functional form or error structure. In a second step, the function g from (5) can be estimated by carrying out a nonparametric regression of $(Y-Z)$ on X such that $\hat{\delta}$ is the OLS estimator of:

$$Y - \hat{m}_Y(X) = \delta(Z - \hat{m}_Z(X)) + \varepsilon \quad (8)$$

where ε is a random error term. Intuitively, $\hat{g}(X)$ is the estimate of $g(X)$ after the independent effect(s) of Z on Y has been removed. Given that the estimate of $\hat{g}(X)$ is at least in part based on non-parametric estimation techniques, one cannot subject it to the standard statistical type tests, e.g., t -test. One can, however, relatively easily calculate upper and lower pointwise confidence bands as suggested by Härdle (1990).¹³ For all our estimations we use a Gaussian kernel for K_h and the optimal bandwidth h suggested by Fox (1990). One should note that the size of the estimated error variance, $\hat{\sigma}^2(X)$, at any point of X will depend proportionally on the marginal distribution of X . In other words, the accuracy of the estimate of $g(X)$ at X is positively related to the density of other observations around that point. In order to visualize this effect we, as suggested by Härdle (1990), calculate the pointwise confidence bands at points chosen according to the distribution of X . Specifically, we chose points so that one per cent of the observations lie between them.¹⁴ In terms of explanatory control variables to be included when estimating (5) we first utilised time and country specific dummies. The latter allows for year specific effects that are common to

¹³It is worth noting that the confidence band proposed by Härdle (1990) ignores the possible approximation error bias of . Including this would complicate the expression considerably since the bias is a complicated function of the first and second derivatives of $g(X)$. This bias tends to be highest at sudden peaks of and at the necessarily truncated left and right boundaries of the data. However, if h is chosen proportional to $1/n^{1/5}$ times a sequence that tends slowly to zero then the bias vanishes asymptotically for the interior points, see Härdle (1990) and Wand and Jones (1995).

¹⁴ For the endpoints we chose the 1 and 99 percentiles of the distribution.

all countries, while the former controls for unspecified time invariant country specific effects that could bias results. In a latter stage we also include other potentially important explanatory variables.

4.2 Results for the EU

Our semi-parametric kernel regression estimate of $g(X)$ along with pointwise confidence bands for the EU15 countries over the 1975-2000 period is shown in Figure 2. Before commenting on this, it is important to point out that, in contrast to the horizontal range, one cannot read too much into the vertical scale of the Figures, as the range is derived from predicted values where there is an issue of non-identification of the unrestricted intercept term, and thus does not completely overlap with actual observed inequality values. We thus do not depict the vertical range of our estimates in the figures that follows. However, this is not necessarily a problem since we are mainly interested, as one is normally when implementing this class of semi-parametric estimators, in the slope of the curve and how this changes across the range of the explanatory variable in question, i.e., national development. The distance between the confidence interval points and their vertical distance from the estimated figure suggests that our estimates are made with some precision. Even at the end points, where estimates normally tend to be relatively poorer because the neighbourhood around points is necessarily truncated, we obtain fairly accurate estimates. Most importantly, in terms of the shape of the relationship between regional inequalities and national economic development one discovers a clear bell-shaped relationship, which plateaus out at high levels of national economic development. In other words, at early stages of economic development regional inequalities tend to rise, but, after reaching a peak, this trend is reversed and regional inequalities fall. In this regard we also tested whether we could reject linearity of the relationship between X and Y by employing the test proposed by Li and Wang (1998), but could decisively reject the null hypothesis of a linear relationship.¹⁵

There are a number of reasons to suspect that our estimations are potentially biased. First, there is an obvious link between the regional GDP series used to compute our inequality measure and the national GDP per head used as main explanatory variable as evidenced in the model described in Section 2. Second, economic theory and empirical evidence suggest that the regional economic inequalities may directly affect regional economic performance through agglomeration economies, see Fujita and Thisse (2002) for a theoretical review and Ciccone and Hall (1996) and Ciccone (2002) for

¹⁵ The test statistic was and one per cent critical value, generated by bootstrapped replications, were 162.93 and 53.83, respectively. For all subsequent semi-parametric estimations we similarly employed this test, but in all cases were able to decisively reject linearity. Detailed results are available from the authors upon request.

empirical evidence. One way to handle the potential endogeneity of the level of national GDP per head is to use past levels of logged GPP per head as is usually done in the convergence literature, see Barro and Sala-i-Martin (2004, ch.11). Figure 3 plots our semi-parametric estimations using alternatively the actual value of the GDP per capita as explanatory variable, as in Figure 2, together with the 2-year lagged and the 5-year lagged value of the same variable. For visual convenience we only report the estimations without the confidence bands. According to these results, the bell-shaped link evidenced earlier still holds. Furthermore, the small bumps observed in Figure 2 both on the right and left hand-side of the sample estimates are smoothed and this is especially true when using the 5-year lagged series of GDP per head. In what follows we thus will use the lagged 2-year level of national GDP per head as main explanatory variable given that using the five year lagged values reduced our sample size considerably, especially when considering alternative datasets.

It is interesting to also examine whether the bell-shaped curve holds for the new Member States that entered the EU in 2004. Unfortunately the small sample of new EU entrants, ten countries over five years, is not enough to produce any separate estimates for these countries alone. Instead we consider them with the rest of the EU in our EU25 sample. The results of this exercise are shown in Figure 4. Accordingly, there is further support for our starting hypothesis, particularly since the data now cover a much wider range of GDP per capita levels. One should note that the regional data used for the new member states is not always based on the same spatial disaggregation, however. In fact, the NUTS2 level which was used for the EU15 countries sample is only available for Poland, the Czech republic, Hungary and Slovakia.¹⁶ In order to see whether this influenced our results we estimated again our equation including only the new member states for which NUTS2 regional data was available. Results displayed in Figure 5 shows indeed that our results remain broadly in line with those presented in Figure 4, although the precision of our estimate is less satisfactory due to the loss of sample size. We also run our estimations for the EU15 sample during the years 1995-2000 in order to check whether the change in the time period considered could potentially influence this latter set of results. The results of these estimations are displayed in Figure 6 showing that the bell-shaped curve found earlier still holds. Importantly, both Figures 4 and 5 show that the initial rise in regional inequalities accompanying national economic development is less pronounced in absolute terms than the decline that follows as development proceeds.

One can use our estimates from the semi-parametric regressions to say something further about where countries' position along the national prosperity/regional inequality path currently and have lied in the past. For this we first use information at what level of GDP per head (i.e., at what value on the

¹⁶ For the other countries the NUTS3 level was used instead given that NUTS2 data was not available.

horizontal axis) the turning point lies from our most general Figure, i.e., Figure 2. Accordingly, the peak occurs around a value of relative GDP level of 0.85. Referring to the actual values of this variable for EU 15 countries in 1975 in Table 1, one finds that at the beginning of our sample period, Greece and Portugal lied clearly to the left of the turning point, while Spain was slightly to the left. Thus, particularly for the former two countries, any increase in relative national prosperity was to likely go hand in hand with a rise in regional inequality. In contrast, the remaining members of the EU 15 would have experienced a fall in regional income dispersion with further economic growth. One should also note that, while some countries did experience changes in their national prosperity, this was never enough to push them to the opposing part of the curve.

We also used our estimated turning point from Figure 5 to assess positions along the path for our entire EU25 sample in 2000. Accordingly, the peak occurs when the relative GDP ratio measure is equal to 0.55. Table 3 reveals that in 2000, all the new EU Member States, excepting the Czech Republic and Slovenia, lied to the left of the turning point and thus their further development is likely to result in further regional inequality. In contrast, the Czech Republic and Slovenia are on the downward sloping part of the Figure, where thus further economic convergence should lower regional income discrepancies.

4.3 Results using alternative datasets: Functional Urban Areas and OECD data

In order to check the robustness of our results we have used two alternative datasets. The first dataset used is from a database compiled by the London School of Economics on European Functional Urban Areas (FURs). Following Magrini (1999, 2004), if we are to evaluate growth and convergence dynamics across regions correctly, the spatial units used should abstract from commuting patterns. The FURs are precisely defined on the basis of core cities identified by concentrations of employment and surrounding areas on the basis of commuting data. They are broadly similar in concept to the (Standard) Metropolitan Statistical Areas used in the US, see Cheshire and Hay (1989) for more details. It is, however, also worth pointing out that the FUR areas do not cover the whole territory of the countries they belong to. We use data on the FURs for seven EU countries for the period 1977-1996.¹⁷

The second dataset comes from the Territorial Statistics of the OECD. Statistics are collected through the National Statistical Offices of OECD Member countries and Eurostat. National censuses and surveys are undertaken in different time periods and years of observation may vary between countries. The appeal of this database is that it covers non-European countries such as

¹⁷ The data is in GDP per capita in US \$ expressed in PPP terms, see the Table A1 in Appendix for more details.

Australia, Canada, the US, Mexico, Norway and Japan in addition to the EU countries used earlier. In order to ensure time consistency for all countries these territorial Statistics are organised in four waves: Wave 1 (about 1980), Wave 2 (about 1990), Wave 3 (about 1995) and Wave 4 (about 2000). GDP figures are expressed in constant US dollars and data are collected at the level of 300 regions of the OECD area. Initially data on Island, Ireland and Luxembourg were available with the OECD database but consisted of very few regions. These countries were thus not considered in the analysis. Moreover, in the case of Germany, the OECD database includes Eastern German Länder after 1990, which greatly influences the level of regional inequalities. Only data before 1990 was thus used for this country.

Figure 7 displays our semi-parametric estimates using the Functional Urban Areas. As can be seen, these data are probably least supportive of a bell shaped relationship in that, while low levels of national development are associated with rising inequalities and after a certain turning point there is a clear fall in regional inequality, regional inequalities marginally rise with very high levels of development. Regional inequalities would then also rise for relatively high levels of national GDP per capita indicating that some regional divergence may occur for the corresponding countries, although the slope of the curve tends to be much lower for relatively rich compared to relatively poor countries. This result is not totally contradictory with our starting hypothesis given that the FUR data does not cover the whole set of EU regions but rather compare level of income of a limited number of metropolitan areas for each of the countries included in the sample. Given that these areas play a major role in fostering growth and technological diffusion, one may well expect this to be true across all countries and not only for the poorest ones. Our results show that these effects are stronger the least developed the country is, however, suggesting that metropolitan areas are more likely to play a greater role in fostering the catching-up of the poorest countries compared to the wealthier ones. The results using OECD Territorial Statistics are depicted in Figure 8. As with our regional databases there is a clear bell-shaped relationship, although this is not as pronounced as with our most of European data. In addition, point estimates appear to be less precise, especially for low levels of GDP per head, which may well be due to the small number of observations available.

4.4 Controlling for additional explanatory variables

The preceding analysis assumes that regional inequalities are influenced by the level of national economic development only. This assumption is rather restrictive and our results can potentially suffer from the omission of other (possibly) important determinants of regional inequalities. We thus check whether the general relationship between regional inequalities and national economic development holds when including additional explanatory variables.

In this regard, we would ideally like to include all potential determinants as suggested by the existing empirical growth and trade literature. In practice, however, regional data on these topics are rarely available and/or of poor quality, we thus chose to focus on a limited number of variables and by considering the European NUTS2 regions for which data are most complete. Given these limitations, the variables to be considered in this section will be a measure of national trade-openness, regional industrial specialization, and a measure of the degree of regional fiscal decentralization.¹⁸

The first additional explanatory variable to be considered is a measure of national trade openness. The inclusion of this variable can be seen as important given the fact that the model presented in section 2 assumes that spillovers occur only at a national level, excluding international and, in particular, technological spillovers related to trade intensity which have been found to be important in the literature, see Coe and Helpman (1995). As a matter of fact, a number of authors including, in particular, Gianetti (2002), directly relate the rise of European regional inequalities in the 1990s to the setting-up of the Single Market Program and the rise in trade integration that followed. Following Gianetti (2002), economic integration intensifies international knowledge spillovers (compared to within-country spillovers), which has favored country rather than region-level convergence in the EU during the implementation of the Single Market Program.¹⁹ The empirical literature on trade and growth generally uses the ratio of total trade (import + export) to GDP in order to measure trade openness, see Frankel and Rose (2002). Recently, however, Alcalá and Ciccone (2004) have criticized the use of such index to measure the impact of trade on cross-country productivity given that trade tends to raise the relative price of non-tradable goods. In order to circumvent this issue they propose instead two alternative indices: the *real openness index*, which is the sum of imports *plus* exports expressed in common currency (here the euro) relative to the GDP expressed in PPP terms and the *tradable GDP openness* which is defined as the sum of nominal export and import divided by the nominal value of GDP in the tradable sector. In our estimations we will use the traditional openness indicators as well as the two alternative indicators proposed by Alcalá and Ciccone (2004). The expected sign for this variable is positive if we assume that not all regions benefit equally from greater trade openness such that regional inequalities may rise.

¹⁸ Additional explanatory variables such as labour mobility and differences in regional educational level were also initially considered but were dismissed given that they are only available on regional basis for few countries and only for very short time spans. Table A2 in Appendix provides further details on data sources and definitions of the variables.

¹⁹ It is worth noting, however, that recent papers looking more specifically at knowledge spillovers in the EU find, however, that R&D spillovers in the EU are subject to strong distance-decay effects with a significant influence exerted by national borders, see Bottazzi and Peri (2003). Accordingly, despite the fact that increased economic integration tend to lower the barriers to technological spillovers, the diffusion of knowledge and innovation in the EU have still strong country-specific components.

The second variable to be considered is a measure of regional industrial specialisation. Here we use the country/year average of the so-called Krugman indicators which corresponds to the expression: $K_{j,k,t} = 0.5 \sum_s |x_{s,j,t} - x_{s,k,t}|$ where $x_{s,j,t}$ is the share of sector s in total employment of region j at a given year t . The indicator value oscillates between 0 and 1 and will be low when two regions j and k have similar industrial structures (i.e. a similar distribution of employment shares across industries), and high otherwise. The use of such an indicator was made popular after the study by Kenen (1969) who first advocated that sectoral specialization may play an important role in determining regional economic fluctuations and growth patterns, see also Clark and van Wincoop (2002) for further discussion on this issue. In the same vein, Gianetti (2002) shows that regions with similar technological capabilities (directly linked to the specialization of regions in traditional sectors) have converged substantially while the rest of regions have displayed some tendency to diverge over the period considered. The expected sign on this variable is thus positive if countries where regions have similar industrial structures, i.e. lower average value of $K_{j,k}$, also tend to display lower regional imbalances.

The third additional variable to be considered is a measure of fiscal decentralization since it may arguably also have been the cause of growing economic divergence in the EU. Evidence in this direction has recently been provided by Rodriguez-Pose (1996) and Rodriguez-Pose and Gill (2003a), for instance.²⁰ These studies relate to the well-known Oates theorem on fiscal decentralization according to which differences in preferences about public goods across regions will require a decentralized provision of such goods in order to improve regional economic performance, see Carrion i Silvestre et al. (2004). In contrast, other authors, however, have found rather contradictory results finding little evidence for a significant effect of fiscal decentralization on regional growth, see for instance Xie et al. (1999) and Davoodi and Zou (1998). The question of the relationship between fiscal decentralization and regional inequalities thus appears to be an empirical one. In order to control for the possible influence of fiscal regional decentralization we use the indicator developed by the World Bank, which is based on data from the IMF's Government Finance Statistics. This indicator is the share of sub-national public expenditures in percentage of national GDP. It is worth noting that this indicator accounts for regional as well as local public spending decentralization which gives full account of the level of fiscal decentralization likely to have an impact on the extent of regional inequalities.

The fourth additional explanatory variable is a measure of the impact of EU regional policy. The main objective of this policy is to boost convergence and reduce regional economic development disparities in EU regions and

²⁰ Stansel (2005) provides similar evidence for the US.

countries. Especially since the end of the 1980s, European structural funds have largely benefited those EU regions with a GDP per capita lower than 75% of the EU average (the so-called Objective 1 regions).²¹ These regions, in turn, are mainly concentrated in the member states with the lowest GDP per capita. Over the period 1989-1999 these funds have represented, on average, around 2% of the GDP of the Cohesion countries group (including Spain, Portugal, Greece and Ireland) against 0.12% for the rest of the EU.²² Despite their importance, the evidence on the effective impact of EU structural funds remains inconclusive with a number of authors suggesting that, at best, their impact was negligible, see Boldrin and Canova (2001) and Beugelsdijk and Eijffinger (2003). De la Fuente (2002), however, finds a positive and significant impact of structural funds on the economic development of Spanish regions. In order to control for the possible influence of EU regional policy we use as additional control variable the level of Structural Funds as percentage of national GDP. The expected sign for this variable is negative if structural funds allocation tends to reduce regional inequalities.

As an initial step we would first like to verify that the impact of these additional explanatory variables on regional inequalities coincides with a priori expectations and thus whether they are likely to serve as good proxies of their intended purpose. One option would be simply to estimate their effect with standard OLS including relative GDP per capita as in Table 4. However, clearly our semi-parametric results suggest that the relationship between GDP per capita and regional inequalities is of a non-linear nature, not even necessarily well captured by higher order terms as evidenced earlier. One method to take account of this while still obtaining estimates of other explanatory variables assumed to have a linear impact is to follow the method proposed by Yatchew (1997). Accordingly, we assume a partial linear model as in (5), sort the data according to values of X (i.e. the level of national GDP per head) and first difference Y and all other linear determinants given by Z (i.e. all the other explanatory variables). This allows the direct effect of $g(X)$ and the indirect effect of Z on X to be purged from (5) so that one can get estimates of δ using OLS on the first differenced data. The results of these estimations are given in Table 5. Column (1) shows that the estimated signs on these extra-variables coincide overall with a priori expectations with the Structural funds variable displaying negative sign while the Fiscal Decentralization and the Openness measures display positive sign. The coefficient estimated for the Openness variable is not significant, however. In Column (2) and (3) we re-estimated our

²¹ Another important component of EU cohesion policy is the Cohesion fund. While this fund may also have an impact on regional inequalities, this impact is less clear-cut given that it is attributed on a national basis (the criterion being that the EU country must have a GDP per head below 90% of the EU average) in order to boost growth mainly through public investment in transport and energy infrastructure and also for the environment.

²² Sources: Annual reports of the EU Court of Auditors for data from 1976-1996 and EU Commission's Annual report on allocated expenditure from 1997 on.

model using the Tradable Openness as well as the Real Openness measures as defined earlier. The Tradable Openness variable displays negative but insignificant coefficient while the Real Openness variable displays the expected positive and significant coefficient. We thus kept the Real Openness variable to estimate the full model in Column (4), including the Dissimilarity variable. This latter variable displays negative sign which goes counter a priori expectation. The coefficient on this variable is insignificant, however. In turn, the Structural Funds variable now displays an insignificant coefficient which could well be explained by the fact the time period considered here is shorter given data restriction on the Dissimilarity variable, See Table A2 in Annex.

In Figures 9 through 11 we thus proceeded and re-estimated our semi-parametric specification for the EU15 sample including these additional control variables for various combinations. One should note that the results obtained in these figures must be compared to Figure 2 where we only included the *national level of GDP per capita* as explanatory variable. Accordingly, regardless of what fiscal decentralization or openness variable we use, the estimated shape of the regional inequality-national development link remains bell-shaped. In Figure 11 we also included our dissimilarity index, although one must note that this meant reducing our sample period to start from the 1980s given data restriction, as mentioned before. Nevertheless, one still observes the outlines of a bell-shaped curve.

5. Summary and conclusion

In this paper we examined the link between national economic development and regional inequalities for a number of European countries and found strong evidence of a bell-shaped relationship between these two elements, in line with early works such as Kuznets (1995) and recent theoretical models by Tamura (1996) and Lucas (2000) where spillovers play a central role in transmitting growth and technological progress. In particular we show that regional inequalities inevitably rise as economic development proceeds but then tend to decline once a certain level of national economic development is reached. This is robust to including other OECD countries and new EU entrants, using different regional units, and including other control variables.

Arguably our findings have important policy implications. For example, in terms of EU Cohesion policy, which has been aimed at boosting convergence and catching-up of lagging EU regions, the evidence presented here implies that some degree of regional inequality is probably unavoidable, at least at the initial stages of national economic development. As argued in this paper the main reason for this is that growth, because of its very nature, is unlikely to appear everywhere at the same time. Thus, one may argue that regional policy and

public investment should aim at boosting national growth in order to guarantee greater national prosperity at the expense of temporarily rising regional inequality, especially for the least developed countries such as the new EU member states. Accordingly, the cost of re-shifting funds towards the most dynamic regions is likely to be mitigated by national-level interpersonal income redistribution mechanisms. In our analysis of the evolution of regional inequalities we try to take into account policy-related elements, such as structural funds and fiscal decentralization, which could possibly explain the evolution of regional inequalities in the EU. However, other policy-related factors such as countries' own pro-active regional policy or redistribution mechanisms through social security schemes might also influence the evolution of regional inequalities. A possible extension of this work could thus be to consider these elements to analyse the efficiency of public policies addressing regional disparities by taking explicitly into account the non-linearity inherent in the evolution of regional inequalities as evidenced in this paper.

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Tables and Figures

Table 1: Level of national GDP and regional inequalities in Cohesion countries*								
	<i>GDP per capita</i>				<i>Regional inequalities</i>			
	1975	1986	1992	2000	1975	1986	1992	2000
Spain	0.83	0.75	0.82	0.83	1.05	1.03	1.06	1.02
Greece	0.72	0.66	0.65	0.69	1.03	0.68	0.75	0.83
Portugal	0.55	0.57	0.69	0.75	1.56	1.19	1.07	1.13
<i>Cohesion</i>	0.82	0.70	0.77	0.79	1.16	1.00	1.00	1.00
<i>Rest of the EU15</i>	1.09	1.12	1.12	1.07	0.93	0.94	0.99	0.95

* Figures are relative to the EU15 countries, GDP per capita is measured at PPS

Regional inequalities are measured using the standard deviation of the logarithm of regional GDP per capita. The figure for Portugal is for 1977. Values for country groups are in weighted (population) average

Table 2: Summary Statistics for the EU15 countries, 1975-2000				
	<i>GDP per capita</i>		<i>Regional inequalities</i>	
	Mean	Standard Deviation	Mean	Standard Deviation
Austria	1.11	0.02	1.19	0.05
Belgium	1.11	0.03	1.18	0.05
Germany (Western only)	1.20	0.02	0.92	0.04
Spain	0.79	0.03	1.04	0.06
Finland	1.01	0.05	1.12	0.06
France	1.11	0.05	0.75	0.06
Greece	0.68	0.04	0.80	0.09
Italy	1.05	0.02	1.31	0.09
Netherlands*	1.11	0.04	1.01	0.09
Portugal**	0.64	0.07	1.17	0.20
Sweden	1.14	0.08	0.77	0.08
United Kingdom	1.04	0.02	0.75	0.03

Notes: Figures are computed relative to the EU25 average

* Regional inequalities computed excluding Groningen region

** Regional inequalities computed excluding Alentejo region

Table 3: Level of national GDP and regional inequalities in new Member States and candidate countries*

	<i>GDP per capita (EU25=100)</i>		<i>Regional inequalities</i>	
	1995	2000	1995	2000
<i>Average</i>	0.43	0.45	1.10	1.22
Bulgaria	0.31	0.27	0.96	0.90
Czech Rep.	0.70	0.65	0.95	0.99
Estonia	0.34	0.42	1.52	1.54
Hungary	0.49	0.53	1.09	1.22
Lithuania	0.34	0.38	0.65	0.96
Latvia	0.30	0.35	1.46	2.21
Poland	0.41	0.46	1.43	1.35
Romania	0.30	0.25	0.83	1.06
Slovenia	0.68	0.73	0.60	0.58
Slovakia	0.44	0.48	1.53	1.38

* Figures are relative to the EU15 countries weighted average, weights given by population
GDP per capita is measured at PPS and regional inequalities are measured using the standard deviation of the logarithm of the regional GDP per capita

Table 4: Parametric Estimations of the relationship between regional inequalities and National GDP per head

	EU15	EU25
GDP per capita	-0.322** (0.166)	-0.491** (0.110)
(GDP per capita)²	0.175 (0.278)	-0.084 (0.165)
R²	0.76	0.54
# obs	310	132

Note: Results for the EU15 concern 1975-2000 and for the EU25 1995-2000, all regressions include time and country dummies

Table 5: Parametric Estimations of Partial Non-Linear Model, EU15 1975-2000

	(1)	(2)	(3)	(4)
Structural Funds	-0.04* (0.02)	-0.04* (0.02)	-0.043** (0.021)	-0.015 (0.024)
Fiscal decent. % GDP	0.010** (0.004)	0.012** (0.005)	0.010** (0.004)	0.022*** (0.005)
Openness	0.224 (0.157)	-	-	-
Tradable openness		-0.161 (0.745)		
Real openness	-	-	0.502*** (0.185)	0.612*** (0.204)
Dissimilarity	-	-	-	-0.157 (0.584)
R²	0.73	0.73	0.74	0.78
# obs	264	264	264	180

Notes: (1) data was sorted according to the relative GDP per capita range and then all variables first differenced (2) country dummies included, but time dummies excluded because these were in all cases jointly insignificant; (2) standard errors in parentheses; (3) ***, ** and * indicate one, five and ten per cent significance levels respectively, all regressions include a constant term.

Figure1: Theoretical analysis of the relationship between National GDP per capita and regional inequalities.

Parameter values for Figure 1: $\alpha = 0.02$ $y_0 = 50$ $t=300$, $\lambda=0.02$, $\beta=0.05$.

Figures 2-11: Semi-parametric estimations results; *X-axis*: National GDP per capita, *Y-axis*:

Standard deviation of regional GDP per capita (deviations with respect to EU average)

The symbols $\square$ and Δ correspond to the optimal band points

Figure 2: Results for EU15, 1975-2000

Figure 3: Results for EU15, 1975-2000 – using lagged GDP values (2 and 5 –year lags)

Figure 4: Results for EU25, 1995-2000

Figure 5: Results for EU25, 1995-2000
inequality measures based on nuts2 regions only

Figure 6: Results for EU15, 1995-2000 **Figure 7: Results based on Functional Urban Areas 1977-1996** **Figure 8: Results based on OECD Territorial Statistics, 1977-1996**

Figure 9: Results for EU15, 1976-2000,
controlling for fiscal decent,
regional aid and openness

Figure 10: Results for EU15, 1976-2000, controlling
for fiscal decentr., regional aid and Real Openness

Figure 11: Results for EU15, 1980-2000
controlling for fiscal decentralization, regional aid, real openness
and Industrial dissimilarity

Table A1: Number of regions and dataset used

Country	Eurostat/Cambridge Econometrics database (NUTS2 regions)	Functional Urban Areas	OECD Territorial Statistics
Australia	-	-	8
Austria	9	-	9
Belgium	11	4	3
Canada	-	-	12
Czech Republic	8	-	8
Denmark	-	-	3
Finland	5	-	6
France	22	22	23
Germany	31 (42*)	28	11
Greece	13	-	4
Hungary	7	-	7
Italy	21	17	20
Japan	-	-	10
Mexico	-	-	32
Netherlands	12	4	4
Norway	-	-	7
Poland	16	-	16
Portugal	7	-	7
Slovak Republic	4	-	4
Spain	18	16	18
Sweden	8	-	8
United Kingdom	37	24	-
United States	-	-	51
Total # of observations	312**	180	72

* including new Landers

** 132 for EU25

Table A2: Statistical sources of explanatory variables used in Section 4.3*

Indicator	Definition	Source	Time period covered
Traditional Openness index	$(\text{export}_{i,t} + \text{import}_{i,t}) / \text{GDP}_{i,t}$	Ameco database, European Commission, Directorate General for Economic and Financial Affairs	1975-2000
Real openness index	$(\text{export}_{i,t} + \text{import}_{i,t}) / \text{GDP}_{i,t}^p$ where $\text{GDP}_{i,t}^p$ is the GDP expressed in purchasing power standard	Ameco database, European Commission, Directorate General for Economic and Financial Affairs	1975-2000
Tradable openness index	$(\text{export}_{i,t} + \text{import}_{i,t}) / \text{GDP}_{i,t}^t$ where $\text{GDP}_{i,t}^t$ is the GDP of the tradable sectors	Ameco database, European Commission, Directorate General for Economic and Financial Affairs	1975-2000
Industrial dissimilarity index	$K_{i,t} = \frac{1}{0.5 N_i (N_i - 1)} \sum_{k,k \neq j}^{N_i} K_{j,k}$ <p>where N_i is the number of regions located in country i and</p> $K_{j,k,t} = 0.5 \sum_s x_{s,j,t} - x_{s,k,t} $ <p>Where $x_{s,j}$ = share of sector s in total employment of region j</p>	Cambridge Econometrics sectors s concern agriculture, construction, energy and manufacturing, market services and non-market services	1980-2000
Fiscal decentralization index	Sum of local and regional total expenditures, excluding current and capital transfers to other levels of government, divided by National GDP	World Bank	1975-2000
EU Regional aid	Total EU payment for regional development from the European Regional development Fund (ERDF), the European Agricultural Guidance and Guarantee Fund (EAGGF), , and the European Social Fund (ESF) in % of national GDP	European Commission, Directorate General for Economic and Financial Affairs	1975-2000

* Indicators subscripts indicate country i and year t . Monetary variables are expressed in current euros

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