Regional Growth and Regional Inequality in EU and Transition Countries: a Spatial Econometric Approach.

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Abstract

Is inequality good or bad for growth? This issue, with its important political bearings, has attracted much attention in the past in the economic literature. Starting from the seminal work of Kuznet (1955), in the literature there is some empirical evidence that economies with unequal distribution of income grow faster than those with an even income distribution.

Such a belief has been heavily criticised by recent studies, and some contrasting views, supported by empirical evidence, were expressed e.g. by Aghion et al. (1999). Barro (2000) also argues in this direction, but empirically found little overall relation between income inequality on one side and growth rates and investment on the other. The debate, thus, seems still open.

In our analysis we aim at investigating whether space and spatial relationships play a significant role in the specification of the relationship between regional inequality and regional growth. In particular, we analyse the case of European Regions, including the transition countries that recently joined the EU.

Keywords: Economic Growth, Income Inequality, European Regions and Transition Countries, Spatial Econometrics.

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Colore, l'elemento dello spazio, suono, l'elemento del tempo, il movimento che si sviluppa nel tempo e nello spazio, sono le forme fondamentali dell'arte nuova, che contiene le dimensioni dell'esistenza.
Tempo e spazio. [1]

Lucio Fontana, Italian sculptor and painter
Manifesto Blanco, 1946

1. Introduction

The European Union (EU) is one of the world's most prosperous economic areas, but there are large economic disparities between its Member States. These disparities are even larger if we look at the EU at regional level. The aim of regional policy is to gradually reduce the gap between countries. Apart from the efforts of local, regional and national authorities, article 158 of the Treaty of Amsterdam states that "... the Community shall aim at reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions or islands, including rural areas".

Moreover, one of the challenges facing the European Union's regional policy is the accession of new countries to the Single Market and to Economic and Monetary Union. As conditions in many of these Eastern European countries are worse than in the least developed regions of the 15 existing Member States, the enlargement process is likely to have a marked effect on the geographical distribution of economic performances in the rest of the EU regions.

A number of studies have appeared which investigates the evolution of inequality in Europe during the enlargement process. While they agree that Europe as a whole is experiencing a downward trend in the level of inequality, the same is not true when one looks at the intra-national dynamics, in particular for those countries directly involved in the transition. A frequent general interpretation is that economic integration may, at least initially, give input to the development of regional competition, with the creation of core regions opposed to weaker peripheral areas. Policy makers are challenged to find a way to give balance to the emerging trade-off between *intra-country* and *inter-countries* disparities.

Together with the evolution of disparities over time and space, several studies have analyzed the convergence process in Europe. Starting from classical growth models, more

[1] Colour, the element of space, sound, the element of time, the movement which develops in time and space, they are the fundamental expressions of the new art, containing the dimensions of the existence. Time and space.

recent years have seen strengthened the tendency to make use of spatial econometrics techniques (Le Gallo et al., 2003, Arbia and Paelinck, 2003a, 2003b). They have drawn the attention to the issue that regional income data and growth rates are highly spatially correlated, and inference based on traditional econometrics methods are likely to provide inefficient results.

Standard growth literature (Alesina and Rodrik, 1994, Forbes, 2000, Barro, 2000 among others) has often claimed that economic growth and income inequality are linked each other, giving origin in some cases to a positive, in others to a negative relationship.

We aim at integrating the two approaches, by including the inequality component inside the regional convergence framework. In doing so, we are aware that ignoring the presence of spatial effects can be misleading.

The paper is organized as follows. In section 2 we review the concepts of convergence and inequality, and their spatial implications. Section 3 gives a description of the data used for the empirical analysis. In section 4 we present a measure to capture regional disparities within and between countries and we present the results for our sample of European regions. Section 5 proposes an empirical model to integrate the impact of inequality on the growth process, considering the importance of spatial interactions among regions. Section 6 concludes with some summary comments.

2. Convergence, Inequality and the role of space.

The concepts of convergence among economies and income disparities are intrinsically associated each others. Rey and Janikas (2005) observe that the traditional literature has often examined the issue of regional inequality as an isolated phenomenon, without considering in a formal way its impact on the convergence process. At the same time they stress the attention on the important role played by space and spatial dependence in the context of inequality and economic growth, and provide an hypothetical agenda for future investigations in the field. Three are the area which offer potential enrichment inside the convergence literature: "[1] spatial effect in regional inequality and convergence analysis; [2] new measures for space-time analysis; [3] comparative regional dynamics"[2]

The present work aims at bridging the gap by examining the first point of their agenda, namely the relationship between regional economic growth and regional inequality in Europe.

[2] Rey and Janikas (2005), *forthcoming* in Journal of Economic Geography.

The role of space inside the theoretical and empirical literature of economic growth have attracted an increasing interest among researchers[3]. At the same time, several empirical studies have analyzed the process of convergence among European regions (Le Gallo et al., 2003, Arbia and Piras, 2004). From our knowledge there is no attempt to study the link between growth and inequality at regional level taking also into account the important role played by the presence of spatial interactions among units.

The standard methodologies for analysing the convergence hypothesis are the *sigma* and *beta* analyses as introduced in the literature by Sala-i-Martin (1990) and further discussed in Barro and Sala-i-Martin (1992).

The σ-convergence shows how the dispersion of real per capita income (in logarithms) across a group of countries (or regions) evolves over time. Therefore, if the dispersion - as measured by the variance of income per capita - decreases, there exists σ-convergence between the countries (regions). Both Barro and Sala-i-Martin (1991) and Sala-i-Martin (1996) derive the relation between *sigma* and *beta* and show that β-convergence is a necessary but not sufficient condition for σ-convergence to occur, therefore σ-convergence analysis is often used as a first approximation to the existence of β-convergence.

Absolute β-convergence tests the neo-classical hypothesis that poorer countries (or regions) grow faster than richer ones. If this is the case, there will be a negative relationship between the initial level of income and the average rate of growth of income for the period under consideration. Interest in unconditional β-convergence derives from interest in the hypothesis that all countries (regions) are converging to the same growth path. Typically, the unconditional model is supported when applied to data from relatively homogeneous groups of economic units such as the states of US, the OECD, or the regions of Europe.

Conditional β-convergence, as opposed to absolute β-convergence, analyses the incomes per capita of countries (or regions) that have identical structural characteristics and converge in the long-run to their own steady states. Conditional β-convergence can be analysed by introducing variables that account for differences among the regions or countries (Mankiw et al., 1992). These might include education levels, infant mortality rates, inequalities in income, assets or human capital, fiscal deficits, among other variables that might be considered relevant for the analysis.

Two are the crucial parameters to judge the convergence of an economy, namely the *speed of convergence*, and the so-called *half-life*. The former refers to the speed at which an

[3] Abreu, et al. (2004) provide an in-depth exposition of the literature on "growth and space".

economy is converging towards the steady-state, the latter refers to the time that is necessary for half of the initial gap in the per-capita output to be eliminated.

The literature in theme of inequality and growth offers a variegate picture. At the early stage, the consensus has been unanimous and the empirical results confirmed the belief that inequality is detrimental for growth (Alesina and Rodrik ,1994, Persson and Tabellini, 1994). In this phase studies are carried out at country level and are based on cross-section econometric techniques. The conclusion is that on the long-run economies with a higher level of initial inequality are likely to experience lower rates of growth. The compilation of a more complete dataset (Deininger and Squire, 1996) with country-level observations and a panel structure has allowed researchers to make use of more sophisticated techniques. The results have been shocking. They predict a positive relationship between inequality and growth, starting the well-known debate which can be perfectly summarized by the *Shakespearian dilemma* "is inequality harmful/not harmful for growth?". Forbes (2000), which also find a positive relationship between inequality and growth, concludes that the positive findings do not directly contradict the previous as [1] panel techniques look at changes within countries over time, while cross-section studies look at differences between countries (with the possibility that the within-country and cross-country relationship might work through different channels of opposite sign), and [2] panel studies look at the issue from a short/medium viewpoint, while cross-sections studies investigate the relationship in the long-run period.

3. Description and characteristics of regional data.

Spatial data availability remains the most serious problem when dealing with economic phenomena at European level. Lately, empirical studies have known a substantial boost due to the efforts done by the European statistical office (Eurostat) in order to produce reliable data at sub-national level.

In the present work, data are based on the Eurostat regional classification. The Nomenclature of Territorial Units for Statistics (NUTS) has been established by Eurostat at the beginning of the 1970's in order to provide a single uniform breakdown of territorial units for the production of regional statistics. NUTS subdivides each Member State into a whole number of regions at NUTS 1 level. Each of these is then subdivided into smaller regions at NUTS level 2, and these in turn into smaller areas at NUTS level 3.

The empirical analysis is based on data extracted from the Cambridge Econometrics'(CE) regional database, which provides comparable regional data at NUTS-2

and NUTS-3 level on real gross value-added (GVA)[4] per capita and per worker, private sector investment, employment and labour participation rates, and the economy's sectoral structure. The data are annual and cover the period from 1977 to 2002.

We analyse two distinct samples of regions drawn from the CE, characterized by a different territorial and time coverage. Data used in the following are per capita annual GVA measured in purchasing power standards, to account for differences in standard of living among territorial units. The first group contains observations on 162 regions from 13 countries (Austria, Belgium, Germany, Spain, France, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Sweden and United Kingdom) and covers the period from 1977 to 2002. A second sample is then considered, which includes 203 regions from 16 countries (the former 13, plus Hungary, Poland, Czech Republic, and Eastern German regions) and a shorter time period, from 1991 to 2002. For both series, the time span have been selected to account for most of the crucial economical and historical events which have taken place during the European integration process. In 1973, with the inclusion of Denmark, Ireland and the United Kingdom, the first step of the enlargement took place, widening the composition of the European space from the original EU6 to EU9. Greece joined EU in 1981, and Spain and Portugal in 1986. This southern enlargement to a EU12 has been crucial, as it brought inside Europe a relatively poorer set of regions. The subsequent 1995 enlargement to EU15 caused even more diversity, but in the opposite direction, due to the inclusion of relatively affluent states of Austria, Finland and Sweden. The most recent phase in May 2004 have enlarged the European space up to 25 countries, with the inclusion of a much poorer group of acceding countries than those in 1986. Furthermore, the regions of these countries display wide economic diversity, and have had very mixed experiences of operating the liberal economic system required by membership of the EU.

Throughout our analysis data are at level NUTS-2 of desegregation, with the exception of United Kingdom, where data are at NUTS-1 level. The region of Groningen in Netherlands is not here considered because of anomalies dues to oil revenues accounting.

We are aware that the choice of the spatial scale may have some impact on our results. The issue is well known among geographers as MAUP, or "modifiable unit area problem" (Arbia, 1989). Nevertheless, the choice of the NUTS-2 level appears to be the most appropriate unit for modelling and analysing European data as [1] it allows one to consider phenomena at meso-levels, [2] it is sufficiently small, in most cases, to capture sub-

[4] GVA equals GDP net of taxes on and subsidies for production.

national variations, and [3] from a policy viewpoint, it is the unit adopted by the EU to define Objective 1 regions when allocating Structural Funds.

In the following we present the results of the estimate of unconditional beta-convergence for our sample of regions. Table 4, columns (1) displays results for 162 regions (without considering Eastern European countries) and a longer time period (1977-2001); column (2) shows results for the sample containing data on 203 regions, and a shorter time coverage (1992-2001). In both cases the speed of convergence is close to the notorious "2 percent" considered almost a constant by the traditional growth literature.

4. Measuring Regional Income Inequality in Europe

Theories of regional inequality as well as empirical evidence of its evolution over space and time has been largely examined and debated in the economic literature. In particular, if we look at the European space, the analysis of regional inequalities has attracted an increasing interest among researchers in the last years (Petrakos, 2001, Magrini, 1999, Duro, 2004). Duro (2004) points out some factors which are helpful to explain this trend. First, the deepening of European integration have raised some concern about the regional distribution of its consequences and costs; second the "new wave" of growth theories in the nineties has been partially devoted to the analysis of regional cases, and third, the improvement in term of quality and availability of European regional data have favoured the development of a large body of empirical studies.

Several studies agree on the conclusion that the process of enlargement is likely to cause deep transformations inside the European texture, both at *international* and *intra-national* level. Moreover, while the within countries disparities are decreasing inside the "old Europe", accessing countries are experiencing a period of boost in terms of economic growth, accompanied by an unquestionable intensification of regional disparities.

In this section we present a measure of regional inequality able to disentangle the two spatial components (*inter* and *intra*) at the basis of the overall inequality present in Europe.

Inequality is often measured by mean of an index able to reflect the degree of dispersion of the income among agents (individuals, regions, industrial sectors). The theoretical and empirical literature largely debated about the characteristics and properties of distinct measures[5]. In the present work we measure the level of inequality by mean of the Theil index. The index possesses the desirable property to be perfectly decomposable into

[5] See Cowell (1995) for a methodological discussion on inequality measures.

additive components. Such a characteristics turns out to be very useful when the aim of a study is to investigate the impact of the different components of inequality within the economic space. In the following of the analysis, the population-weighted formulation of the index has been used, as it is more sensitive to the transfers occurring at the bottom of the income distribution.

We apply to our data the one-stage decomposition method as reported in Akita (2003), here adapted for the case of European regions. Let us consider the following hierarchical structure for Europe (in crescent order of desegregation):

$$\text{Europe} \rightarrow \text{Countries} \rightarrow \text{Regions}$$

Using the regions at NUTS-2 level as underlying regional unit, overall regional income inequality can be measured by the following Theil Index.

$$T_{overall} = \sum_i \sum_j \left(\frac{N_{ij}}{N} \right) \log \left(\frac{N_{ij}/N}{Y_{ij}/Y} \right) \tag{4.1}$$

where

Y_{ij} is the income of region *j* in country *i*,

Y is the total income of all regions $\left(= \sum_i \sum_j Y_{ij} \right)$,

N_{ij} is the population of region *j* in country *i*, and

N is the population of all regions $\left(= \sum_i \sum_j N_{ij} \right)$.

If we define T_i as follows to measure between-regions income inequality for country *i*:

$$T_i = \sum_j \left(\frac{N_{ij}}{N_i} \right) \log \left(\frac{N_{ij}/N_i}{Y_{ij}/Y_i} \right) \tag{4.2}$$

then the Theil index $T_{overall}$ in equation (4.1) can be decomposed into

$$T_{europe} = \sum_i \left(\frac{N_i}{N} \right) T_i + \sum_i \left(\frac{N_i}{N} \right) \log \left(\frac{N_i / N}{Y_i / Y} \right) = T_{within} + T_{between} \qquad (4.3)$$

where

Y_i is the total income of country i $\left(\sum_j Y_{ij} \right)$,

N_i is the total population of country i $\left(\sum_j N_{ij} \right)$, and

$T_{between} = \sum_i \left(\frac{N_i}{N} \right) \log \left(\frac{N_i / N}{Y_i / Y} \right)$ measures income inequality between countries.

Equation (4.3) is the ordinary Theil inequality decomposition, in which the *overall* income inequality is the sum of the *between-country* component and the *within-country* (and then between European regions) component

The remaining of the section applies the decomposition method above mentioned to describe the evolution of regional inequality in Europe over the period from 1977 to 2002. For every year we have computed the Theil index for Europe. As last steps, we have decomposed the overall measure of inequality into the *between-country* and *within-country* components.

Table 2 illustrates the evolution of regional disparities in Europe. Our results are in line with previous findings in the literature. Duro(2004) argues that while the dispersion of GDP per capita between European countries has decreased during the 1980's and the 1990's, inequalities between regions have tended to increase. Our results give a confirm to the issue. The first block of the table (from 1977 to 1990) refers to our smaller sample and contains no observations for Eastern European countries. The bottom part of the table contains also data for post-sovietic economies. Results are stable over the two samples. We assist to a decrease of the level of inequality between countries, accompanied by the increasing of disparities within-country (and then between regions).

Table 3 displays the level of inequality within European countries for selected years. The years have been chosen to highlight the impact of fundamental events within the process of integration of Europe. In 1973 the first phase of the enlargement takes place with the

inclusion of Denmark, United Kingdom and Ireland, the 1980's witness the entrance of relatively poor southern European countries (Greece, Spain and Portugal) accompanied by a strong campaign of allocation of structural funds by the European Community; last, the 1990's have started with the falling of most of the communist governments, the following opening to the west of the post-soviet economies, and the entrance of Sweden, Finland and Austria, in 1996, within the EU.

[Table 3 about here]

Columns (3) and (4) from show the rising trend in the level of inequality in those countries actively involved in the process of integration. If we look at the value of the Theil of Spain, during the transition to EU, it exhibits an increase from 0.0079 in 1982 to 0.0091 in 1988. The same holds for Ireland, where inequality goes up from 0.0018 in 1982 to 0.0071 in 2002. The situation in Eastern European countries is nearly similar. In order to facilitate the interpretation of the results, we have highlighted in table 3 the most interesting results.

[figure 1 and figure 3 about here]

Figure 1 and Figure 3 illustrate the contribution given by the *within-country* and *between-country* component to the overall inequality in Europe for the two samples of regions. What is immediately clear is that inequality in the European area, when no Eastern European regions are considered, is due by disparities within countries. Once data for Eastern European regions are added the picture changes dramatically. The scenario is even more clear if we look at the time pattern of the evolution of inequality in Europe as shown in Figure 2 and Figure 4.

[figure 2 and figure 4 about here]

When we compare the two, we see that the lines corresponding to the between country component (yellow line) and the within country component (red line) change their position.

5. Regional growth and regional inequality in EU regions and accession countries: an empirical analysis.

A natural starting point when one analyzes the impact of inequality on growth is the seminal work of Kuznets (1955). Kuznets was among the first to speculate about the

existence of a systematic relationship between inequality and the process of development. According to him, inequality increases in the early stages of development, when the economy experiences the passage from the rural to the industrial organization, and decreases when the modern structure has taken over the entire social-economic texture. The result is the inverted U-shaped relation between inequality and per-capita income, well known as "Kuznets curve".

The theoretical literature is divided between those who suggest that inequality is detrimental for growth, and those who predict that the presence of an unequal distribution of resources is an important determinant for the development of an economy.

The empirical literature is even less unanimous and shows the same division that the theoretical models suggest. The standard procedure for estimating the impact of inequality upon economic growth is to assume a simple linear relationship between the two components. The equation estimated in the earliest studies is based on cross-country growth regressions on the type:

$$g_i = \beta_0 + \beta_1 y_{0i} + \beta_2 Ineq_i + X_i\beta + \varepsilon_i \qquad (5.1)$$

where g_i is the average growth rate of GDP per capita over the period under consideration, β_0 is the constant, $\beta_1 y_0$ is the level of gdp at the beginning of the period to account for convergence among regions, *Ineq* is a measure of income inequality and X_k is a vector of other control variables of interest.

In 1996 Deininger and Squire compile a new cross-country dataset in which they put together a much larger and comprehensive sample of data on income distribution than hitherto available, giving the researcher the opportunity to make use of more sophisticated techniques. Forbes (2000), Li and Zou (1998) all look at this relationship using fixed effects panel methods. They argue that OLS estimates result to be biased, as they do not consider country specific effects which can be omitted. Banerjee and Duflo (2003) investigate and conclude for the existence of a non-linear relationship between the two variables. Barro (2000) uses a three-stage least square estimator which treats country specific effects as random. Differently from the previous works, he doesn't find the presence of an overall (positive nor negative) effect of income inequality on economic growth.

Studies on the relationship between growth and inequality using regional data are less common. Panizza uses a cross-state panel for the United States to assess the relationship between inequality and growth. The paper shows that the relationship is not robust and that

small differences in the method used to measure inequality can result in large differences in the estimated coefficients.

In our study we estimate the relationship between inequality and growth by means of regional data at NUTS-2 level in the period 1977-2002. As in the previous sections, two different sample of regions are considered, with or without the inclusion of eastern European countries. Before presenting our final model we proceed by steps, moving away from the unconditional beta convergence model and gradually including the inequality index and the spatially lagged variables.

We first estimated, by means of Ordinary Least Square, a conditional beta-convergence model, when we introduce as additional explanatory variable, the Theil index. For every country of our samples we have computed a Theil index reflecting the level of internal inequality among the regions.

[Table 4 about here]

Columns (3) and (4) show the results. At lest for the sample without Eastern European regions, the effect of inequality on growth is positive and significant. It seems to be in contrast with the empirical findings in the traditional literature on growth and inequality based on cross-section data, where a trade-off between the two variables is presented as to be a constant.

We can at glance conclude that the use of regional data has lead to opposite results if compared to those found in cross-country based studies. Growth is associated with higher initial levels of (within country) regional inequality. This is in line with the recent literature in theme of spatial economics. Countries which experience high levels of growth rates are also the ones where inequalities are rising up, due to processes of agglomeration and concentration of economic activities.

In the next step we have estimates a cross-regressive model, where the lagged value of the Theil index is included in the regression. The aim is that we want to check how proximity to regions with a certain level of inequality can affect the growth process of European regions. Table 5, columns (1) and (2), shows the results. Looking at the estimated values we see that inequality in the regions and inequality in the neighbours work on the growth of a region in a different way. While a region receive benefit for experiencing a phase of high disparities inside the country it belongs to, the same doesn't hold for the fact of being located close to regions with an high level of inequality.

As final model we have estimated a mixed-regressive spatial autoregressive lag model (Florax and Folmer, 2002; Anselin, 2003). The model takes the following form

$$y = \rho W y + X\beta + WX^{*}\lambda + \varepsilon \tag{5.2}$$

where y is a vector of (R x 1) stochastic dependent variables, W is the binary contiguity matrix, X the (R x k) matrix of non-stochastic regressors, X^{*} the (R x (k-1)) matrix of explanatory variables with the constant term deleted, ρ is the autocorrelation coefficient, β the (k x 1) vectors of the non-weighted independent variables, λ is the ((k-1) x 1) vector of the cross-correlation components. By using our variables of interest the model estimated takes the form:

$$growth = \beta_0 + \beta_1 y_0 + \rho W growth + \beta_2 Ineq + \lambda W Ineq + u \tag{5.3}$$

where y_0 is the initial level if income to account for the presence of convergence among regions. Table 5, columns (3) and (4), presents the results for the mixed regressive spatial autoregressive lag model. The estimates confirm that the process of growth is positively influenced by the presence of regions with high level of growth rates. The relationship between regional growth and regional inequality is positive. The trade-off between growth and the lagged value of inequality holds, and it is now significant even when Eastern European regions are considered.

One can conclude that as long as disparities are within a region, this can be see as consequence of agglomeration processes and the consequent growth of the economy. On the other side, we observe that regions does not take any advantage by being located close to regions with high level of inequality. In this case the traditional findings on the relationship between inequality and growth are confirmed. 4 shows the results.

As argued by Petrakos et al. (2005) “the direction of the relationship is critical in term of policy choice. A negative relationship implies that in the long-term inequalities will disappear, and, as a result, there is limited scope and a declining need for regional policy. On the other hand, a positive relation between growth and inequality implies that, no matter what other factors may affect the evolution of inequalities, economic growth will always generate new inequalities”.

6. Conclusions

In the present work we have analyzed the evolution of income disparities in European regions and transition countries in the period 1977-2002.

Our result have confirmed the tendency in overall European inequality to decrease over time, accompanied by an expansion of the intra-country (and then between regions) disparities. The entrance of Eastern regions has caused at a first stage a consistent increase in the level of inequality in Europe, with a tendency of attenuation over time.

The empirical literature in theme of convergence have argued that European regions are characterized by a high level of spatial dependency in income levels and growth rates. In our analysis we have tested that also inequality cannot be considered as an isolated phenomenon, and it requires to be modelled in association with space and the concept of spatial interaction.

Estimates from cross-country data have shown that the relationship between inequality and growth is positive, indicating that the process of development requires the presence of initial disparities to start. The impact is consistent when we introduce data for Eastern European countries. When we look at the effect of inequality in neighbouring regions, we have found evidence of a trade-off with the process of growth. A plausible interpretation could be that inequality within a country is useful for growth, while unequal realities in the neighbours have a detrimental impact.

For the future, we are confident that the availability of longer time series for transition countries will give us the opportunity to further investigate the relationship between growth and inequality in those regions.

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Tables and Figures

AUSTRIA		DE26	Unterfranken	ES51	Cataluna
AT11	Burgenland	DE27	Schwaben	ES52	Com. Valenciana
AT12	Niederosterreich	DE3	Berlin*	ES53	Baleares
AT13	Wien	DE4	Brandenburg-Nordost*	ES61	Andalucia
AT21	Karnten	DE5	Bremen	ES62	Murcia
AT22	Steiermark	DE6	Hamburg		
AT31	Oberosterreich	DE71	Darmstadt	**FRANCE**	
AT32	Salzburg	DE72	Giessen	FR1	Ile de France
AT33	Tirol	DE73	Kassel	FR21	Champagne-Ard.
AT34	Vorarlberg	DE8	Mecklenburg-Vorpomm.*	FR22	Picardie
		DE91	Braunschweig	FR23	Haute-Normandie
BELGIUM		DE92	Hannover	FR24	Centre
BE1	Brussel	DE93	Luneburg	FR25	Basse-Normandie
BE21	Antwerpen	DE94	Weser-Ems	FR26	Bourgogne
BE22	Limburg	DEA1	Dusseldorf	FR3	Nord-Pas de Calais
BE23	Oost-Vlaanderen	DEA2	Koln	FR41	Lorraine
BE24	Vlaams Brabant	DEA3	Munster	FR42	Alsace
BE25	West-Vlaanderen	DEA4	Detmold	FR43	Franche-Comte
BE31	Brabant Wallon	DEA5	Arnsberg	FR51	Pays de la Loire
BE32	Hainaut	DEB1	Koblenz	FR52	Bretagne
BE33	Liege	DEB2	Trier	FR53	Poitou-Charentes
BE34	Luxembourg	DEB3	Rheinhessen-Pfalz	FR61	Aquitaine
BE35	Namur	DEC	Saarland	FR62	Midi-Pyrenees
		DED1	Chemnitz*	FR63	Limousin
CZECH REPUBLIC*		DED2	Dresden*	FR71	Rhone-Alpes
CZ01	Praha	DED3	Leipzig*	FR72	Auvergne
CZ02	Stredni Cechy	DEE1	Dessau*	FR81	Languedoc-Rouss.
CZ03	Jihozapad	DEE2	Halle*	FR82	Prov-Alpes-Cote d'Azur
CZ04	Severozapad	DEE3	Magdeburg*		
CZ05	Severovychod	DEF	Schleswig-Holstein	**GREECE**	
CZ06	Jihovychod	DEG	Thuringen	GR11	Anatoliki Makedonia
CZ07	Stredni Morava			GR12	Kentriki Makedonia
CZ08	Ostravsko	**SPAIN**		GR13	Dytiki Makedonia
		ES11	Galicia	GR14	Thessalia
GERMANY		ES12	Asturias	GR21	Ipeiros
DE11	Stuttgart	ES13	Cantabria	GR22	Ionia Nisia
DE12	Karlsruhe	ES21	Pais Vasco	GR23	Dytiki Ellada
DE13	Freiburg	ES22	Navarra	GR24	Sterea Ellada
DE14	Tubingen	ES23	Rioja	GR25	Peloponnisos
DE21	Oberbayern	ES24	Aragon	GR3	Attiki
DE22	Niederbayern	ES3	Madrid		
DE23	Oberpfalz	ES41	Castilla-Leon	**HUNGARY***	
DE24	Oberfranken	ES42	Castilla-la Mancha	HU01	Kozep-Magyarorszag
DE25	Mittelfranken	ES43	Extremadura	HU02	Kozep-Dunantul

Table 1: nuts-2 regions included in the sample. * is for Eastern European regions included in the larger sample

HU03	Nyugat-Dunantul	NL22	Gelderland	**PORTUGAL**	
HU04	Del-Dunantul	NL23	Flevoland	PT11	Norte
HU05	Eszak-Magyarorszag	NL31	Utrecht	PT12	Centro
HU06	Eszak-Alfold	NL32	Noord-Holland	PT13	Lisboa e V.do Tejo
HU07	Del-Alfold	NL33	Zuid-Holland	PT14	Alentejo
		NL34	Zeeland	PT15	Algarve
IRELAND		NL41	Noord-Brabant		
IE01	Border	NL42	Limburg	**SWEDEN**	
IE02	Southern and Eastern			SE01	Stockholm
		NORWAY		SE02	Ostra Mellansverige
ITALY		NO01	Oslo og Akershus	SE04	Sydsverige
IT11	Piemonte	NO02	Hedmark og Oppland	SE06	Norra Mellansverige
IT12	Valle d'Aosta	NO03	Sor-Ostlandet	SE07	Mellersta Norrland
IT13	Liguria	NO04	Agder og Rogaland	SE08	Ovre Norrland
IT2	Lombardia	NO05	Vestlandet	SE09	Smaland med oarna
IT31	Trentino Alto Adige	NO06	Trondelag	SE0A	Vastsverige
IT32	Veneto	NO07	Nord-Norge		
IT33	Fr.-Venezia Giulia			**UK**	
IT4	Emilia-Romagna	**POLAND***		UKC	North East
IT51	Toscana	PL01	Dolnoslaskie	UKD	North West
IT52	Umbria	PL02	Kujawsko-Pomorskie	UKE	Yorkshire and the Humber
IT53	Marche	PL03	Lubelskie	UKF	East Midlands
IT6	Lazio	PL04	Lubuskie	UKG	West Midlands
IT71	Abruzzo	PL05	Lodzkie	UKH	Eastern
IT72	Molise	PL06	Malopolskie	UKI	London
IT8	Campania	PL07	Mazowieckie	UKJ	South East
IT91	Puglia	PL08	Opolskie	UKK	South West
IT92	Basilicata	PL09	Podkarpackie	UKL	Wales
IT93	Calabria	PL0A	Podlaskie	UKM	Scotland
ITA	Sicilia	PL0B	Pomorskie	UKN	Northern Ireland
ITB	Sardegna	PL0C	Slaskie		
		PL0D	Swietokrzyskie		
NETHERLANDS		PL0E	Warminsko-Mazurskie		
NL12	Friesland	PL0F	Wielkopolskie		
NL13	Drenthe	PL0G	Zachodniopomorskie		
NL21	Overijssel				

Table 1: continued

	T(EU)	T(within)	T(between)	within (%)	between (%)
1977*	0.0146	0.0096	0.0050	65.52	34.48
1978*	0.0151	0.0095	0.0056	62.98	37.02
1979*	0.0160	0.0093	0.0067	57.92	42.08
1980*	0.0168	0.0097	0.0071	57.55	42.45
1981*	0.0170	0.0099	0.0072	58.01	41.99
1982*	0.0171	0.0100	0.0071	58.45	41.55
1983*	0.0167	0.0095	0.0072	56.72	43.28
1984*	0.0169	0.0093	0.0076	55.23	44.77
1985*	0.0172	0.0096	0.0076	55.67	44.33
1986*	0.0182	0.0100	0.0083	54.66	45.34
1987*	0.0178	0.0101	0.0077	56.71	43.29
1988*	0.0169	0.0098	0.0071	57.78	42.22
1989*	0.0165	0.0102	0.0063	61.82	38.18
1990*	0.0162	0.0098	0.0063	60.81	39.19
1991**	0.0484	0.0126	0.0358	25.97	74.03
1992**	0.0588	0.0112	0.0475	19.09	80.91
1993**	0.0547	0.0104	0.0443	19.04	80.96
1994**	0.0458	0.0101	0.0357	21.99	78.01
1995**	0.0429	0.0102	0.0327	23.74	76.26
1996**	0.0422	0.0103	0.0319	24.39	75.61
1997**	0.0418	0.0106	0.0313	25.23	74.77
1998**	0.0401	0.0110	0.0291	27.51	72.49
1999**	0.0394	0.0113	0.0281	28.66	71.34
2000**	0.0390	0.0117	0.0273	30.04	69.96
2001**	0.0378	0.0120	0.0259	31.59	68.41
2002**	0.0367	0.0120	0.0246	32.83	67.17

* Results refer to 162-regions sample

** Results refer to 203-regions sample, where we have been able to include regions belonging to East Germany, Poland, Hungary and Czech Republic.

Table 2: Evolution of inequality in Europe over the period 1977-2002.

	1982*	1988*	1996**	2002**
Austria	0.0193	0.0126	0.0102	0.0076
Belgium	0.0242	0.0218	0.0221	0.0230
Czech Republic			0.0138	0.0232
Germany	0.0061	0.0063	0.0078	0.0086
Spain	0.0079	0.0091	0.0109	0.0113
France	0.0100	0.0107	0.0129	0.0126
Greece	0.0055	0.0060	0.0059	0.0044
Hungary			0.0196	0.0339
Ireland	0.0018	0.0031	0.0045	0.0071
Italy	0.0178	0.0176	0.0185	0.0173
Netherlands	0.0050	0.0035	0.0035	0.0045
Norway	0.0156	0.0123	0.0123	0.0148
Poland			0.0072	0.0158
Portugal	0.0230	0.0170	0.0112	0.0130
Sweden	0.0008	0.0023	0.0030	0.0065
Uk	0.0053	0.0048	0.0044	0.0064

* Results refer to 162 regions

** Results refer to 203 regions, where we have been able to include regions of East Germany, Poland, Hungary and Czech Republic.

Table 3: Internal national Theil index, selected years

	OLS 1977-02	OLS 1991-02	OLS 1977-02	OLS 1991-02
	162 nuts-2	203 nuts-2	162 nuts-2	203 nuts-2
	(1)	(2)	(3)	(4)
constant	0.068*** (0.008)	0.069*** (0.008)	0.055*** (0.007)	0.069*** (0.009)
ln(gva)	-0.015*** (0.002)	-0.015*** (0.002)	-0.013*** (0.002)	-0.015*** (0.002)
Theil			0.272*** (0.074)	-0.028 (0.136)
W_Theil				
W_growth				
speed of convergence[6]	0.019	0.019	0.016	0.019
Goodness of fit				
Adjusted R^2	0.30	0.23	0.35	0.23
Schwartz criterion	-1141.91	-1197.09	-1150.03	-1191.82
Regression diagnostics (*p*-values in parenthesis)				
Jarque-Bera	5.095 (0.078)	35.072 (0.000)	22.328 (0.000)	35.827 (0.000)
Heteroskedasticity bp: Breush-Pagan test kb: Koenecker-Basset test	16.418 (0.000) bp	25.244 (0.000) kb	5.206 (0.074) kb	31.391 (0.000) kb
Moran's I (error)	8.506 (0.000)	5.516 (0.000)	8.485 (0.000)	5.599 (0.000)
LM (error)	67.201 (0.000)	27.610 (0.000)	4.868 (0.000)	27.380 (0.000)
Robust LM (error)	16.047 (0.000)	1.200 (0.273)	21.447 (0.000)	1.111 (0.292)
LM (lag)	51.423 (0.000)	26.655 (0.000)	44.799 (0.000)	26.541 (0.000)
Robust LM (lag)	0.270 (0.603)	0.245 (0.620)	1.378 (0.240)	0.272 (0.602)

Table 4: Dependent variable is the average growth rate[7] of per-capita GVA (in logarithm). Standard errors in parenthesis. The statistic significance of the parameters is indicated by ***,**, and *, referring respectively to the 1%, 5% and 10% level.

[6] Speed of convergence is measured as: $b = -\ln(1+\beta T)/T$.

[7] The growth rate is measured as $growth = \frac{1}{T}\left[\ln(y_t) - \ln(y_0)\right]$, where *T* is the number of time periods, y_t is the value in the final period, and y_0 the value in the first period.

	Spatial cross-regressive OLS		Mixed regressive-spatial autoregressive lag	
	1977-02 162 nuts-2	1991-02 203 nuts-2	1977-02 162 nuts-2	1991-02 203 nuts-2
	(1)	(2)	(3)	(4)
constant	0.055*** (0.009)	0.069*** (0.009)	0.045*** (0.008)	0.048*** (0.009)
ln(gva)	-0.013*** (0.002)	-0.015*** (0.002)	-0.010*** (0.002)	-0.010*** (0.002)
Theil	0.388*** (0.146)	0.381 (0.305)	0.459*** (0.122)	0.413* (0.281)
W_Theil	-0.160 (0.174)	-0.531* (0.354)	-0.408*** (0.149)	-0.520* (0.327)
W_growth			0.512*** (0.070)	0.371*** (0.078)
speed of convergence	0.016	0.016	0.012	0.012
Goodness of fit				
Adjusted R^2	0.35	0.23		
Shwartz criterion	-1145.80	-1188.79		
Regression diagnostics (*p*-values in parenthesis)				
Jarque-Bera	22.128 (0.000)	37.891 (0.000)		
Heteroskedasticity bp: Breush-Pagan kb: Koenecker-Basset	5.748 (0.125) kb	33.857 (0.000) kb		
Moran's I (error)	8.520 (0.000)	5.701 (0.000)		
LM (error)	65.638 (0.000)	28.535 (0.000)		
Robust LM (error)	14.056 (0.000)	1.749 (0.186)		
LM (lag)	52.162 (0.000)	26.886 (0.000)		
Robust LM (lag)	0.580 (0.446)	0.100 (0.752)		
Likelihood ratio test on LAG			42.883 (0.000)	22.01 (0.000)
LM on spatial error			6.036 (0.014)	0.283 (0.594)

Table 5: Dependent variable is the average growth rate of per-capita GVA (in logarithm). Standard errors in parenthesis. The statistic significance of the parameters is indicated by ***,**, and *, referring respectively to the 1%, 5% and 10% level. Column (7) and (8) are Maximum likelihood estimates of mixed regressive-spatial autoregressive lag model.

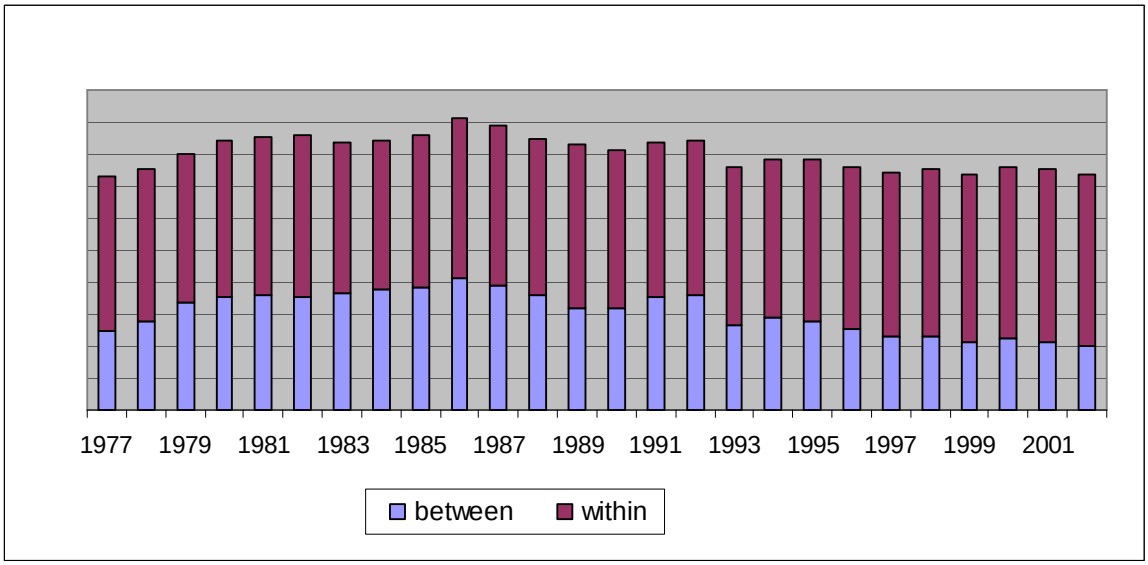

Figure 1: one-stage decomposition of the inequality of EU15 regions over the period 1977-2002.

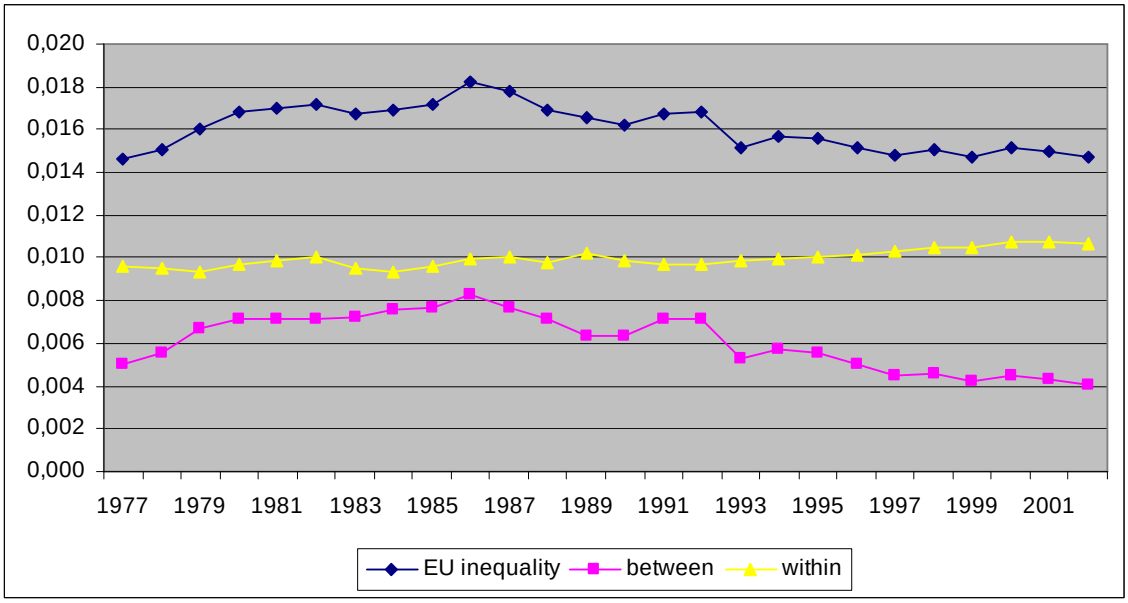

Figure 2: evolution of inequality in Europe, as overall inequality (EU line), *within* country (and then between regions) inequality and *between* countries inequality. EU15 regions, period 1977-2002

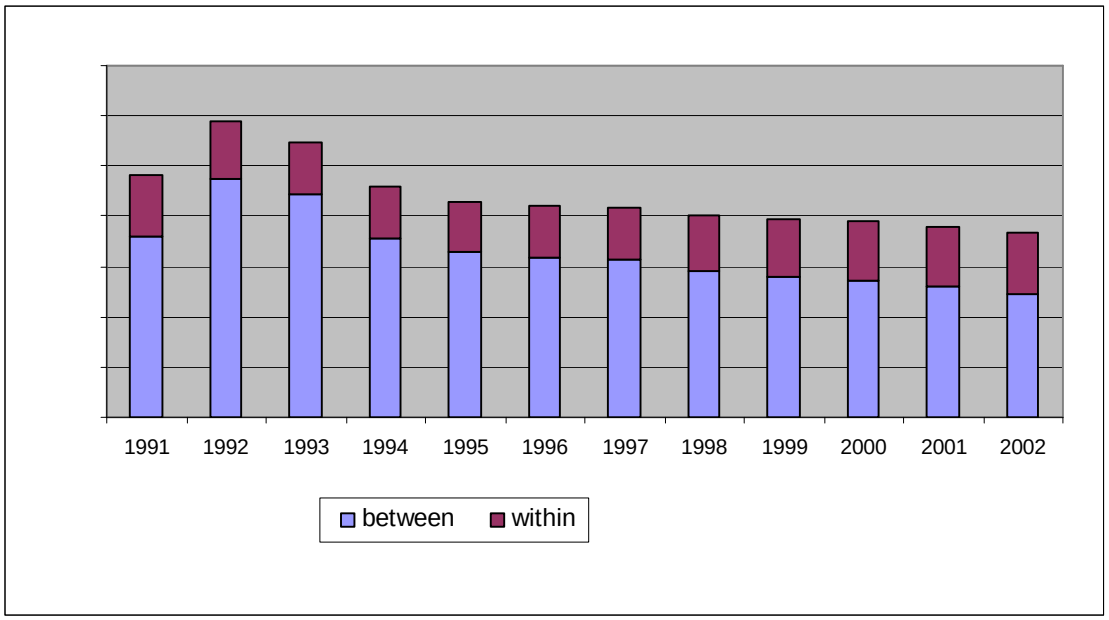

Figure 3: one-stage decomposition of the inequality of EU15 and eastern European regions over the period 1991-2002.

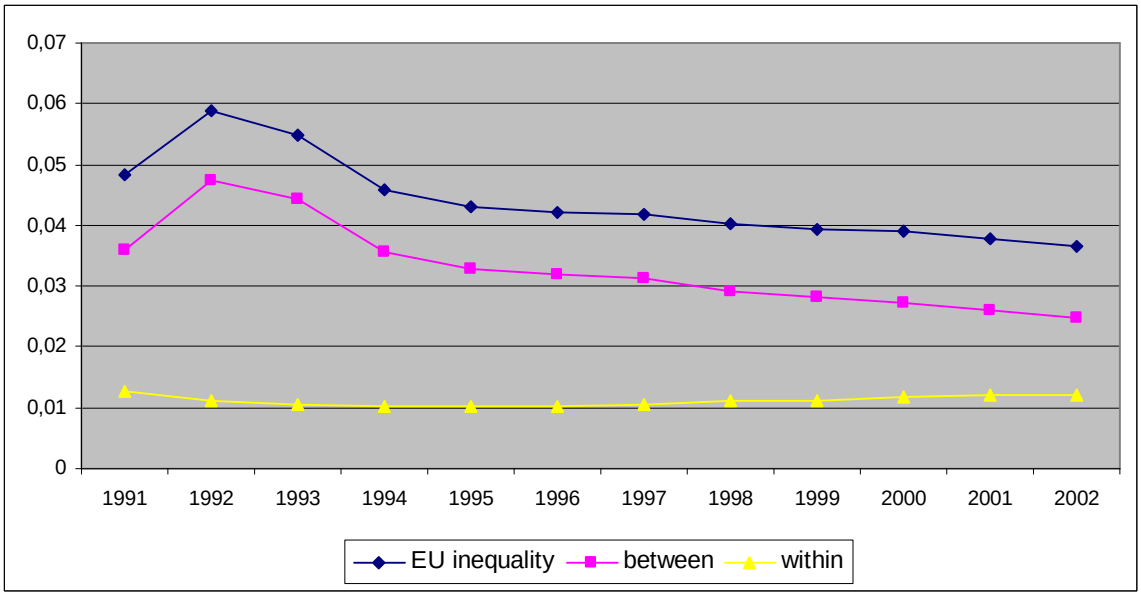

Figure 4: evolution of inequality in Europe, as overall inequality (EU line), *within* country (and then between regions) inequality and *between* countries inequality. EU15 and Eastern European regions, period 1991-2002