JEL Classification: D31, O15,O18
Keywords: income inequality, regions, Exploratory Spatial Data Analysis, Europe, urbanization, EU North-South divide

Mapping Regional Personal Income Distribution in Western Europe: Income Per Capita and Inequality*

Andrés RODRÍGUEZ-POSE (a.rodriguez-pose@lse.ac.uk)
Vassilis TSELIOS (v.tselios@lse.ac.uk) both: London School of Economics

Abstract
Past studies of regional economic disparities in the EU are fundamentally based on the information provided by macroeconomic variables. This paper considers regional disparities using microeconomic data aggregated at the regional level, paying attention not only to the average, but also to the inequality levels of individual incomes within regions. It maps regional personal income distribution in Western Europe, using data from the European Community Household Panel (ECHP) data survey covering more than 100,000 individuals, for 102 regions, and over the period 1995–2000. The Exploratory Spatial Data Analysis on income per capita and inequality reveals a rich set of findings. (1) There is a strong U-shaped relationship between income per capita and inequality which is highly robust across inequality measurements. (2) 80 percent of the income inequality in Europe takes place among individuals living in the same region. (3) Regions with similar income conditions tend to cluster, not only within national borders, but also across nations. (4) There is a North-South and an urban-rural divide where northern regions and city--regions have the highest economic development, as well as the lowest levels of inequality.

1. Introduction

There is a vast theoretical and empirical literature on spatial economic disparities in the European context (for instance, (Barro, Sala-i-Martin, 1992), (Armstrong, 1995), (Quah, 1996), (Rodríguez-Pose, 1998, 1999), (European Commission, 1999), (Martin, 1999), (Cuadrado-Roura, 2001), (Ezcurra et al., 2005a, 2005b)). However, this literature is almost entirely based on information provided by macroeconomic variables, such as GDP per capita. Because of a lack of data, the microeconomic perspectives of inter- and intraregional disparities have been largely overlooked. The studies which consider both income per capita and inequality in an international or regional setting are few and far between (i.e., (Ram, 1992), (Sala-i-Martin, 1996), (Forbes, 2000), (Tselios, 2008), (Rodríguez-Pose, Tselios, 2009a, 2009b)). We know much more about the distribution of GDP per capita – with all the potential

* The authors are grateful to the European Commission [DYNREG Programme, contract no. 028818 (CIT5)], PROCIUDAD-CM and Eurostat for granting access to the European Community Household Panel (ECHP). The work was also part of the research program of the independent UK Spatial Eco-nomics Research Centre funded by the Economic and Social Research Council (ESRC), Department for Business, Enterprise and Regulatory Reform, Communities and Local Government, and the Welsh Assembly Government. The support of the funders is acknowledged. The views expressed are those of the authors and do not represent the views of the funders or of Eurostat.

problems related to the use of such indicator, especially in relatively small geographical units – than we know about the distribution of income across regions in Europe. And the geography of interpersonal income inequalities within and across European regions is virtually a black box. We hardly know anything about which is the most important geographical scale for interpersonal inequalities or about the level of difference in interpersonal inequalities among regions.

The scarcity of adequate data at the regional level and problems of comparability have prevented this sort of analysis to date. However, in recent years, the European Community Household Panel (ECHP) has provided a rich microeconomic dataset that can be regionalized in order to map income inequalities both within and across regions in Europe. The aim of this paper is to contribute to our knowledge of the geography of regional income and regional income inequalities in Europe by using the ECHP income indicators in order to explore territorial imbalances in personal income per capita and income inequality distribution in Western Europe and their relationship, putting emphasis on the role of spatial effects and income agglomeration.

The core methodology of this paper is Exploratory Spatial Data Analysis (ESDA). Although ESDA has been used in a number of regional studies so far (Ertur, Le Gallo, 2003), (Dall'erba, 2005), (de Dominicis et al., 2007), this paper differs from these analyses in that it explores the spatial distribution of income per capita and inequality, by using the information contained in the European Community Household Panel (ECHP). The ECHP was conducted between 1995 and 2000 and surveyed between 104,953 and 124,663 Europeans living in 102 NUTS I or II regions from 13 countries in the EU.[1] This spatial economic analysis encompasses a set of techniques aimed at describing and visualizing spatial distributions of income per capita and inequality, both for the whole of the population and for normally working people. It detects patterns of global and local spatial association and suggests spatial regimes and forms of spatial heterogeneity (Haining, 1995), (Unwin, Unwin, 1998), (Baumont et al., 2003). The focus of attention is on identifying income differences across space rather than similarities. More specifically, the first step of our analysis is to map the data in order to obtain a visual image of them, and then to apply boxplots which indicate the shape of the income distribution. The next step is to include tests for, and visualization of, both global (test for clustering) and local (test for clusters) statistics (Anselin et al., 2004). We use three different spatial weights matrices which contain information on the "neighborhood" structure for each region: the rook first-order contiguity, the 3-nearest neighbors, and the threshold distance (Rodríguez-Pose, Tselios, 2007). We test for unevenness in regional income distribution using the global and local variant of Moran's contiguity ratio (Moran, 1950). We then suggest forms of spatial heterogeneity to investigate the underlying geographical factors behind income per capita and inequality. Finally, we explore the non-linear relationship between income per capita and income inequality.

[1] NUTS – an acronym for *Nomenclature d'Unités Territoriales Statistiques* or Nomenclature of Statistical Territorial Units – is the regional division defined by the European Union (EU) for statistical purposes and is generally based on comparable levels of national administrative subdivisions in the EU member states. The spatial unit of our analysis is that defined in the ECHP and includes NUTS I for Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Spain, Sweden, and NUTS II for Portugal and the UK (see *Appendix 1*).

This paper is structured in six sections. Section 2 analyses the European personal income distribution, not only for the whole of the population, but also for normally working people. Section 3 presents ESDA on income per capita between 1995 and 2000. Section 4 applies ESDA on inequality indices to the European regions. It also contains the measurement of income inequality within and between regions in the EU and looks at whether the within-region income inequality constitutes the major portion of the income inequality in Europe. Section 5 explores the non-linear relationship between income per capita and income inequality within a region, and finally Section 6 concludes.

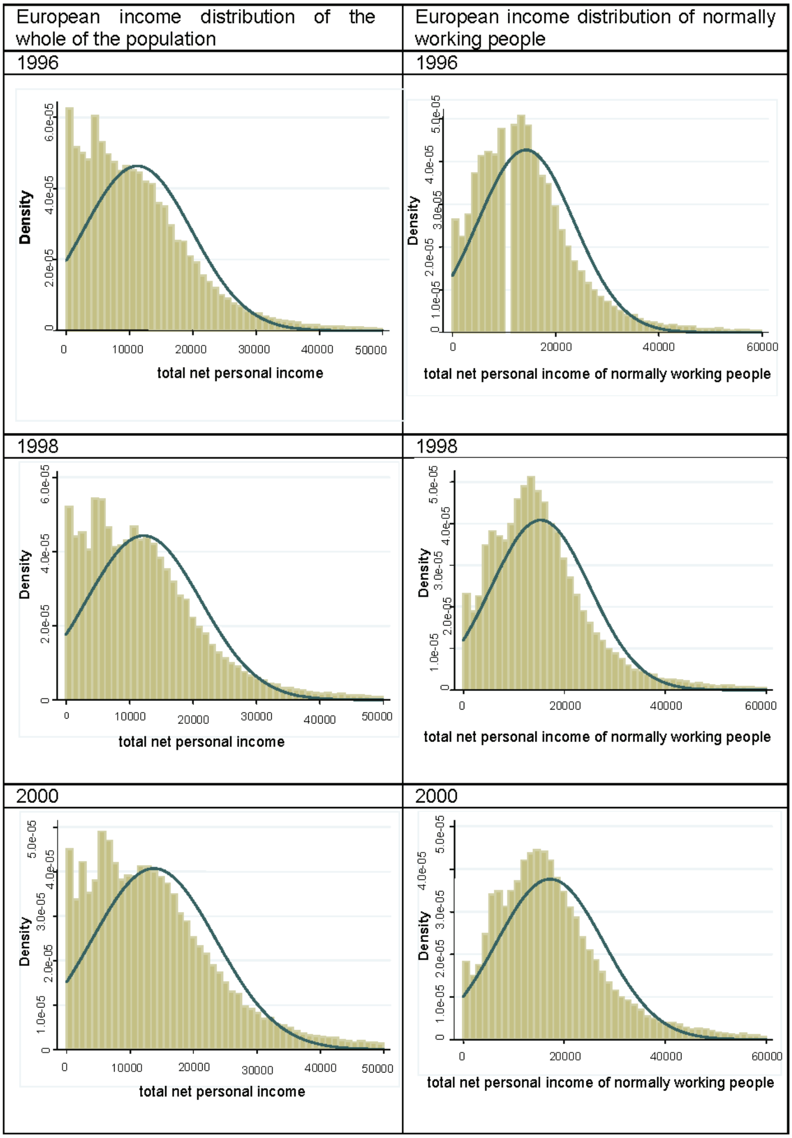
2. European Personal Income Distribution

Information on personal income is collected using the variable "*Total net personal income (detailed, NC, total year prior to the survey)*", which is extracted from the ECHP data survey.[2] Data on income are collected not only for each individual in the household, so as to measure the income of any given individual, but also for each normally working (15+ hours/week) individual in the household – using the variable "*Main activity status-Self defined (regrouped)*", which is also extracted from the ECHP data set – in order to measure the income of normally working people. We do so to control for unemployment and inactivity, and for household size.

Figure 1 illustrates the income distribution in Europe in 1996, 1998, and 2000, for individuals whose personal income is not zero and smaller than 99 percent of the total income distribution. Hence, the income distributions below exclude persons who have no income from any source and the extremely wealthy. Each histogram also overlays a normal distribution for a comparable performance. The histograms show that income distribution in Europe hardly changed between 1996 and 2000. Between 1996 and 1998, the income distribution of the whole of the population moved to the right, showing some improvement at the lower levels of income. However, the density of the income distribution at very low income levels was very high, as individuals who were unemployed or inactive are included in this distribution. In 1998 and 2000, the European income distribution hit its highest point when the total personal income was 5,000 euros; while, in 1996 the European distribution reached a peak at around 1,000 euros. For all histograms of the first column (income distribution of the whole of the population), when the total net personal income is 10,000 euros, the European income distribution meets the normal distribution at the highest point. When income per capita is larger than 10,000 euros, the European income distribution follows the normal distribution. The density of the income distribution at the very low income levels of normally working people is lower than that for the whole of the population. The income distribution also moved somewhat to the right between 1996 and 1998, marking an improvement in the economic position of the low income strata and a decrease in income inequality. Income distribution in Europe for this sample reaches a peak when income is approximately 12,000 euros and then follows the normal distribution.

[2] Two basic characteristics of this variable are that it is lagged and that it is measured in national currency. Personal income data are thus not comparable over time, because they are not in constant prices. They are adjusted to the same price level using the Harmonised Indices of Consumer Prices (HICPs). Income data are converted into euros in order to make them comparable across countries and regions.

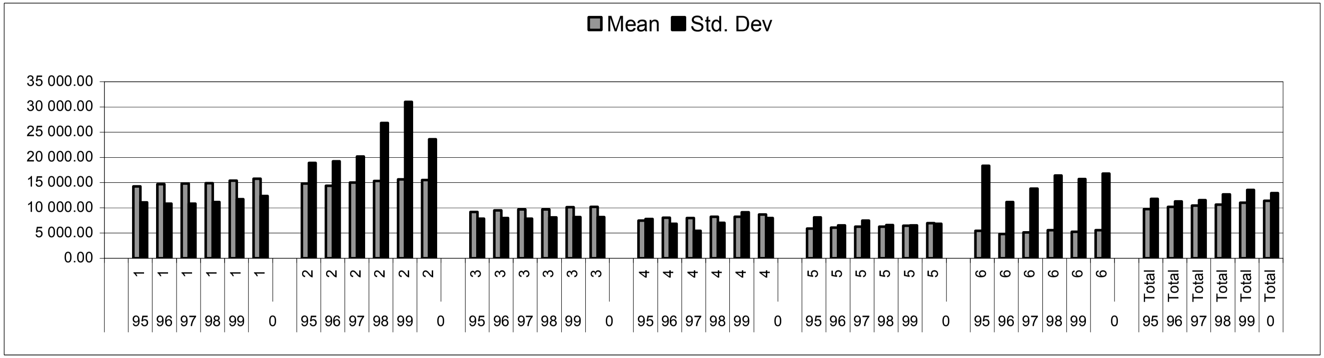
Figure 1 European Income Distribution

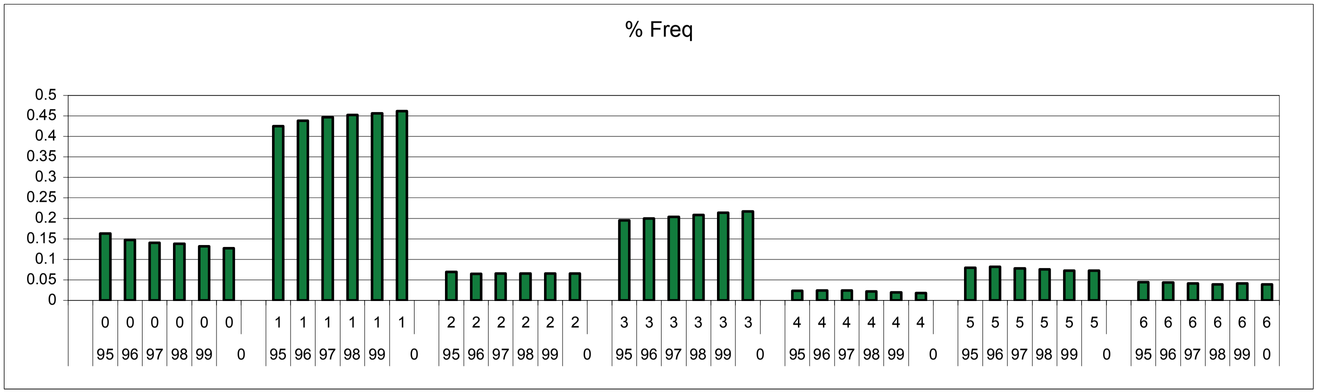


In order to gain a more accurate picture of the European personal income distribution, income is decomposed according to its sources. The main sources of personal income are collected from the variable “*Main sources of personal income*” of the ECHP. According to this variable, the main sources of personal income are: wages and salaries, income from self-employment or farming, pensions, unemployment and redundancy benefits, any other social benefits or grants, and private income.

Figure 2 Mean and Standard Deviation of the European Income Distribution

Income for the population as a whole

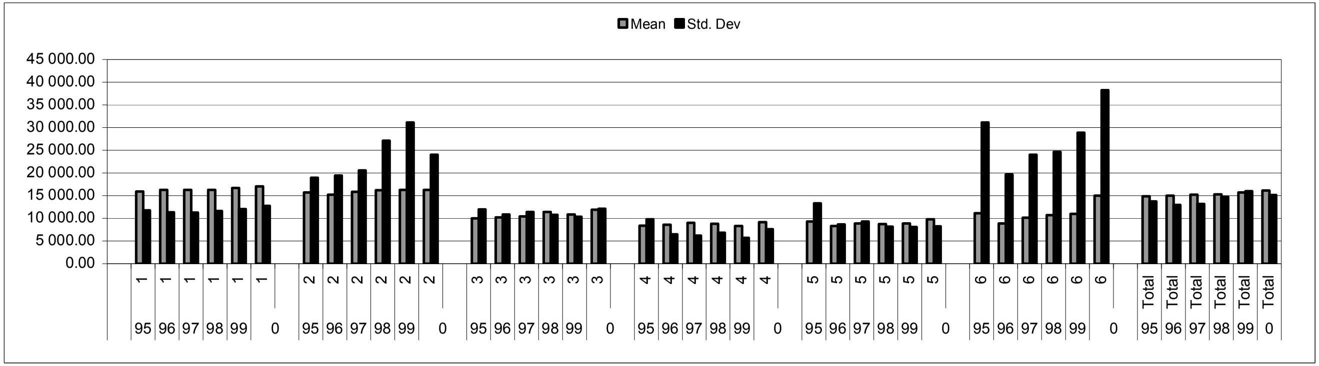


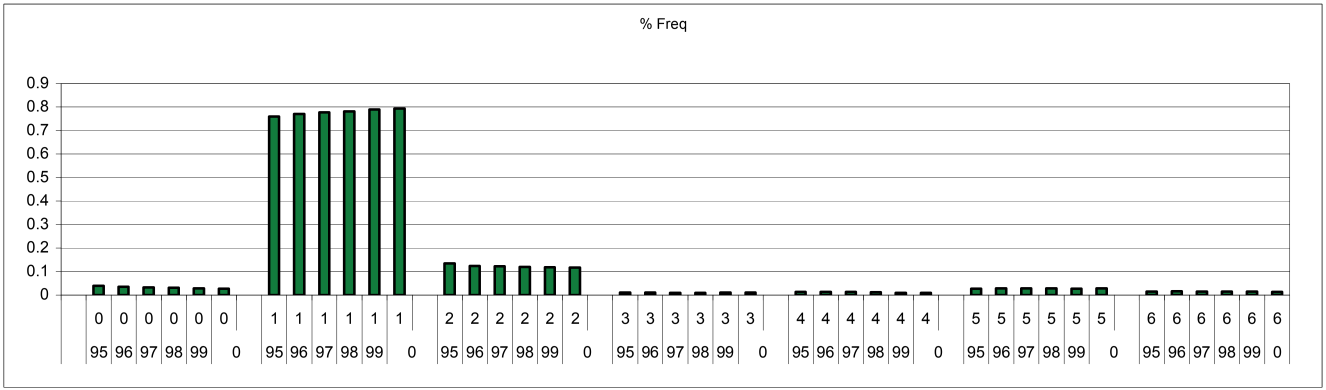


Note: 0: person has no income from any source; 1: wages and salaries; 2: income from self employment or farming; 3: pensions; 4: unemployment and redundancy benefits; 5: any other social benefits or grants; 6: private income; total: total income

Figure 2 *(continued)*

Income for normally working people





Note: 0: person has no income from any source; 1: wages and salaries; 2: income from self employment or farming; 3: pensions; 4: unemployment and redundancy benefits; 5: any other social benefits or grants; 6: private income; total: total income

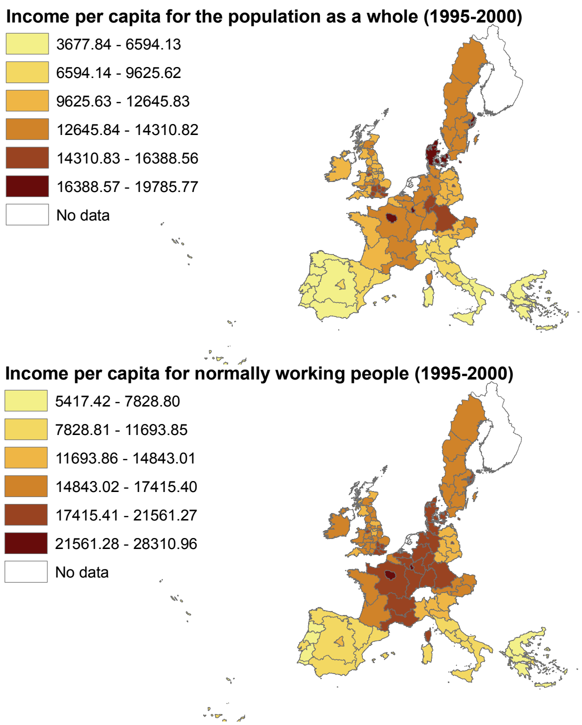
Figure 2 shows the fluctuation in the mean and the standard deviation of the European income distribution according to sources of personal income for the years 1995 to 2000. For the income distribution of the population as a whole, the mean of wages and pensions increased slightly, while their standard deviation remained constant. The evolution of personal income per capita coming from self-employment or farming remained stable. In contrast, there was a considerable variation in standard deviation, which reached the highest point in 1999. Between 1995 and 2000, the evolution of both the mean and the standard deviation of the unemployment and social benefits remained constant. The evolution of private income was also stable, while its standard deviation, which started from a high value in 1995, reached its lowest point in 1996 and rose steadily since 1998. The standard deviations of income coming from self-employment and of private income are much higher than their average values. The figure also shows the percentage of the European income distribution per source of personal income. Income from wages and salaries represented the largest percentage. For the income distribution of normally working people, the evolution of income per capita in Europe and its sources remains the same. However, the amount of private income per capita increased considerably between 1999 and 2000. There was also considerable variation in the standard deviation of income coming from self-employment or farming and private income. Finally, income from wages and salaries accounted for the highest percentage (78 percent) of personal income. That percentage was far higher than the respective percentage for the whole of the population (45 percent).

3. Exploratory Spatial Data Analysis on Income Per Capita (1995–2000)

An initial step of ESDA is to map income per capita for 102 regions in order to gain a spatial view of the data and, among other aims, to see whether incomes per capita are randomly distributed over space or there are similarities between regions. *Figure 3* shows the spatial distribution of the average income per capita between 1995 and 2000 both for the whole of the population and for normally working people. The wealthiest regions were Île de France, Luxembourg, Belgium, and Denmark. There were striking disparities in income per capita among different parts of Europe, particularly between northern and southern regions. Income per capita was typically half of the average in the southern periphery, stretching from Greece to southern Italy (Sicilia, Sud, Campania, and Abruzzo-Molise), western Spain (Canarias, Sur, Centro, and Noroeste) and Portugal. The economic conditions of surrounding regions seemed to influence the economic development perspectives of this region. Baumont et al. (2003) argue that a poor region surrounded by poor regions will remain in a low economic development trap, whereas a poor region surrounded by richer regions has a greater probability of reaching a higher state of economic development. Another important feature displayed this figure is the high average income in city-regions. The figures represent the distribution of income per capita without any information about the existence and extent of spatial autocorrelation. However, they illustrate the "unevenness" in income per capita, which appeared to be concentrated in particular areas. This may indicate a positive spatial autocorrelation phenomenon.

A better picture of income per capita within regions can be obtained by using the boxplot technique. The boxplots for income per capita in European regions between 1995 and 2000 are shown in *Figure 4*. The median income increased gradually

Figure 3 Spatial Distribution of Income Per Capita

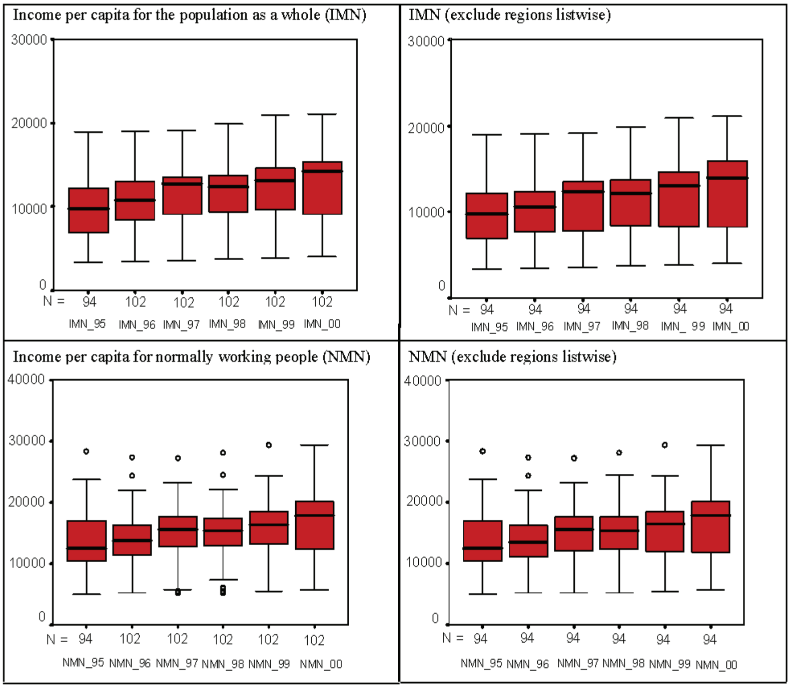


from 1995 to 2000. The distributions of income per capita were fairly compact. The interquartile range was longer in 2000 than from 1995 to 1999. Furthermore, the variation in the whiskers was greater in 1999 and 2000 than in 1996, 1997, and 1998. Looking behind the boxplots, Luxembourg had the highest average income among the European regions. In contrast, Portuguese, Greek and Spanish regions registered the lowest level of income per capita: the income per capita of the Greek regions was approximately one third that of Luxembourg. The variation in average income among regions in the United Kingdom was greater than that found across the rest of the EU. The distribution of income per capita among normally working people was less compact than for the whole population. In 1998, Luxembourg and Île de France were outliers at the upper end of the distribution, while the Portuguese regions (Centro, Algarve, Madeira, and Alentejo) were outliers at the lower end.[3] The interquartile range was greater in 2000 than from 1995 to 1999, as was also the case for income per capita of the whole of the population. The distributions fail to reject normality over the period 1996–2000, but reject it in 1995.

A spatial autocorrelation for income per capita identifies the relationship behind the similarity of income per capita and spatial proximity. First, constructing the rook first-order contiguity spatial weights for income per capita, Moran's I statis-

[3] Outliers are defined as cases with values between 1.5 and 3 box lengths from the upper or lower edge of the box.

Figure 4 Boxplot for Income Per Capita



Note: 'Exclude regions listwise' deletes observations which are not available from 1995 to 2000 (balanced data set).

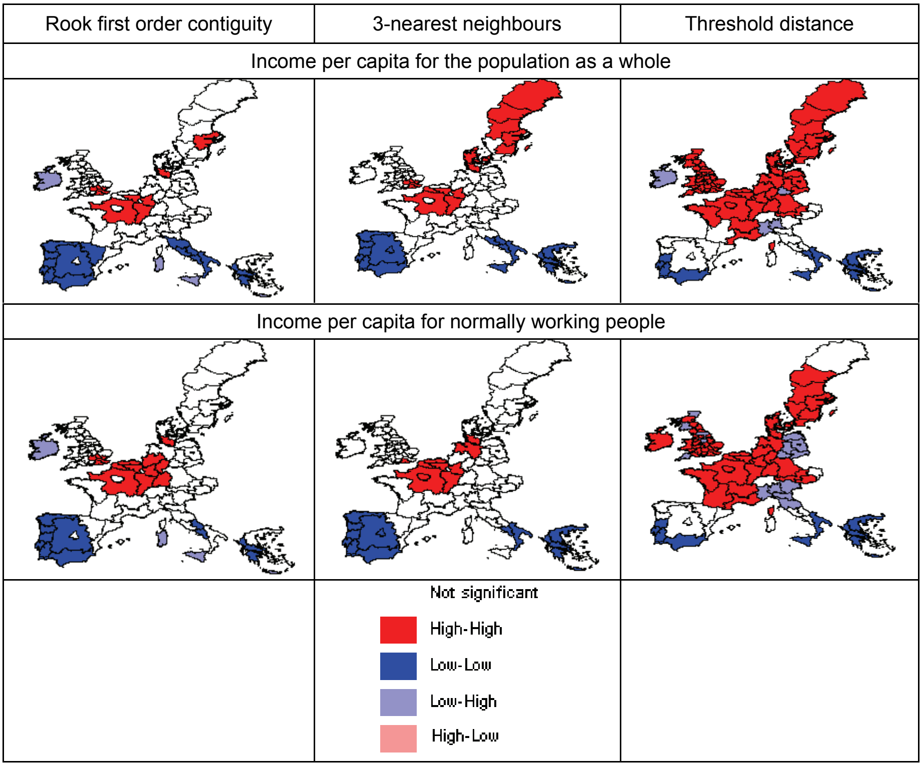
tic is positive and statistically significant, which suggests that the null hypothesis of no spatial autocorrelation should be rejected (*Table 1*).[4] The distribution of income per capita was, indeed, clustered throughout the period of study. Over the period 1995–2000 rich regions were generally located in close proximity to one another. The bivariate Moran's I statistic between a region's income per capita in 1998 and the neighboring regions' income per capita in 1996 (which is the space-time correlation of income per capita in 1998) was 0.6149. Second, the short evolution of the standardized values of Moran's I statistics when we consider the 3-nearest neighbors weights schemes was similar to that of the rook first-order contiguity. Third, the spatial autocorrelation of the threshold distance schemes was lower than for the previous schemes. Briefly, Moran's I statistics for any spatial weights schemes reject the hypothesis that income per capita was randomly distributed over space. Moran's I statistics lead to the same results for the sign (positive) and significance of global spatial dependence, highlighting the robustness of the results with regard to the choice of the spatial weights matrix. The univariate and bivariate Moran's I statistics for income per capita of normally working people were similar to those for the whole of the population (*Appendix 2*). Overall, income inequality in any given

[4] To assess the significance of the univariate and bivariate Moran's I statistic against a null hypothesis of no spatial autocorrelation, a 999 permutation procedure is used. Computations were performed with software package GeoDa 0.9.5-i.

Table 1 Moran's I for Income Per Capita of the Population as a Whole

		13 countries (E[I] = -0.0099)											
		rook first order contiguity				3-nearest neighbours				threshold distance			
		Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value
Spatial auto-correlation	1995												
	1996	0.6605	-0.0106	0.0739	9.0812	0.7830	-0.0050	0.0768	10.2604	0.4288	-0.0107	0.0224	19.6205
	1997	0.6565	-0.0103	0.0747	8.9264	0.8024	-0.0069	0.0719	11.2559	0.4699	-0.0110	0.0225	21.3733
	1998	0.6499	-0.0079	0.0765	8.5987	0.7968	-0.0092	0.0742	10.8625	0.4602	-0.0111	0.0213	22.1268
	1999	0.6644	-0.0151	0.0750	9.0600	0.8100	-0.0093	0.0705	11.6213	0.4669	-0.0104	0.0220	21.6955
	2000	0.7027	-0.0040	0.0757	9.3355	0.8345	-0.0115	0.0739	11.4479	0.4736	-0.0093	0.0221	21.8507
Space-time correlation	1998	0.6149	-0.0081	0.0733	8.4993	0.7358	-0.0081	0.0698	10.6576	0.4267	-0.0095	0.0217	20.1014
	2000	0.6535	-0.0086	0.0736	8.9959	0.7846	-0.0083	0.0726	10.9215	0.4580	-0.0098	0.0214	21.8598
		Excluded SE (E[I] = -0.0108)											
		rook first order contiguity				3-nearest neighbours				threshold distance			
		Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value
Spatial auto-correlation	1995	0.6713	-0.0048	0.0755	8.9550	0.7646	-0.0131	0.0784	9.9196	0.3506	-0.0120	0.0223	16.2601
	1996	0.6513	-0.0113	0.0750	8.8347	0.7641	-0.0135	0.0753	10.3267	0.3934	-0.0114	0.0226	17.9115
	1997	0.6629	-0.0104	0.0719	9.3644	0.7981	-0.0118	0.0768	10.5456	0.4695	-0.0106	0.0229	20.9651
	1998	0.6578	-0.0079	0.0778	8.5566	0.7983	-0.0074	0.0785	10.2637	0.4597	-0.0101	0.0227	20.6960
	1999	0.6751	-0.0053	0.0762	8.9291	0.8134	-0.0096	0.0761	10.8147	0.4712	-0.0089	0.0238	20.1723
	2000	0.7145	-0.0091	0.0758	9.5462	0.8387	-0.0058	0.0784	10.7717	0.4834	-0.0109	0.0226	21.8717
Space-time correlation	1998	0.6193	-0.0108	0.0758	8.3127	0.7338	-0.0088	0.0699	10.6237	0.4146	-0.0106	0.0224	18.9821
	2000	0.6620	-0.0091	0.0756	8.8770	0.7866	-0.0152	0.0736	10.8940	0.4595	-0.0110	0.0221	21.2896

Figure 5 Cluster Map for Income Per Capita



region seemed to depend on the weighted average of the lagged and the current income inequality in neighboring regions. Economic diffusion was higher among regions that were geographically close to one another and decayed with distance. Hence income inequality within regions cannot be considered as an isolated factor without accounting for space across regions of Europe.

The use of LISA allows us to assess the regional structure of spatial auto-correlation (Anselin, 1995). *Figure 5* presents the income per capita cluster maps (average between 1995 and 2000) for three spatial weights schemes.[5] The schemes show that clusters of poorer regions were found in the southern periphery. Income was concentrated in specific areas, which are characterized by the presence of financial and business services and are the centers of public administration, such as London, Paris, and Luxembourg. For example, income per capita was well above average in central areas stretching from eastern France (Bassin Parisien, Centre-Est, and Mediterranee) through Belgium and Germany. Activity in those regions was concerned with services and manufacturing. The cluster of the southern United Kingdom was characterized by a high level of urbanization. In addition, core regions (north-eastern France, Belgium, Luxembourg, and north-western Germany) with a re-

[5] A 999 permutation procedure at the 0.05 significance level (*p*-value) was chosen in order to provide stability to the results (Anselin, 1995).

latively high income per capita were and remained located close to other core regions with a relatively high income per capita, while peripheral regions (Portugal, western Spain, southern Italy, and Greece) with a relatively low income per capita tended to be in the pull of other core regions with a relatively low income per capita. Taking into account the threshold distance weights schemes, the core clusters could be further expanded to include, among others, southern British and Swedish regions. Overall, regions in the vicinity of any European region seem have influenced the economic development perspectives of that region (Rodríguez-Pose, Crescenzi, 2008). A poor person living in a low income per capita region surrounded by other poor regions will probably remain at that level of income; whereas a rich person living in a region surrounded by richer regions should remain at a high income level. Hence local economic (pecuniary and technological) externalities influence European economic development.

All the six cluster maps in *Figure 5* revealed the presence of spatial heterogeneity in the form of at least two spatial clusters of rich and poor regions. The geographical distributions of income per capita firstly exhibited a pattern of income polarization between rich regions in the North, on the one hand, and poor regions in the South, on the other. This evidence can, in fact, be linked to several results of the New Economic Geography theories, to the possibility of multiple spatial equilibria (Krugman, 1991), and to the club convergence theories of Azariadis and Drazen (1990), Durlauf and Johnson (1995), or Baumont et al. (2003). Secondly, the results show the persistence of income disparities among the European regions, following an urban-rural divide. In any case, the EU North-South pattern seemed to be stronger than the EU urban-rural pattern. For instance, in the rook first-order contiguity scheme, the Comunidad de Madrid region (city-region) was a spatial outlier, because it was surrounded by regions with low income per capita and high income inequality levels. As a whole, spatial autocorrelation and spatial heterogeneity are inevitable features of regional income per capita variation analysis.

Finally, the Pearson correlation between the income per capita of the whole population and the income per capita of normally working people was positive, statistically significant, and very high (above 0.955).

4. Exploratory Spatial Data Analysis on Income Inequality (1995–2000)

We use several indices for measuring income inequalities. Different indices yield somewhat different estimates of income inequality, because they use a different distance function (Firebaugh, 2003). The four most well-known indicators of income inequality are: the relative mean deviation index, the Gini index, the generalized entropy index (the Theil index and the squared coefficient of variation), and the Atkinson index (see *Appendix 3*). We employ all the above inequality indices because inequality analyses can lead to a variety of sometimes significantly different results (Sen, Foster, 1997). *Figure 6* shows the evolution of European income inequality from 1996 to 2000. The variation in the Atkinson indices, the Theil index, the Gini coefficient, and the relative mean deviation index remained the same, showing that income inequality in Europe decreased slightly. The fluctuation in the squared coefficient of variation indicated a different trend. There was a considerable increase between 1997 and 1999 with a peak of 0.754. After this, the coefficient fell sharply by 0.112.

Figure 6 The Evolution of Income Inequality in Europe

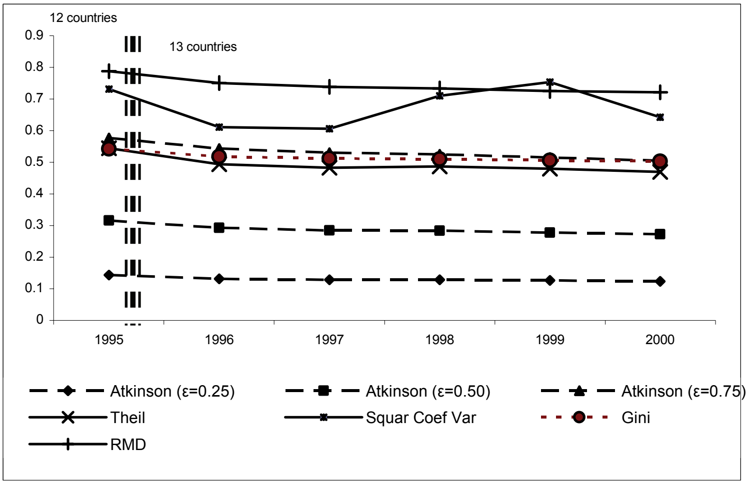
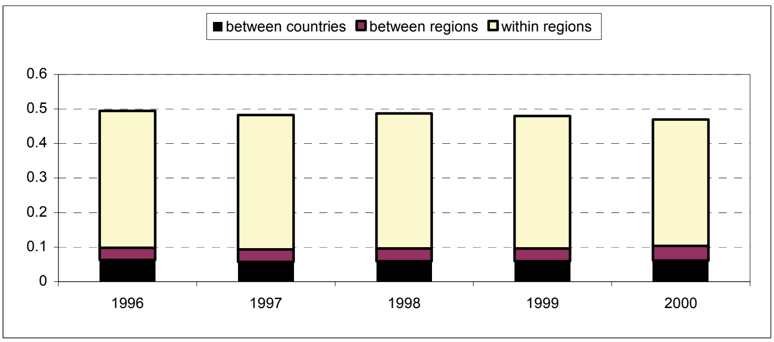
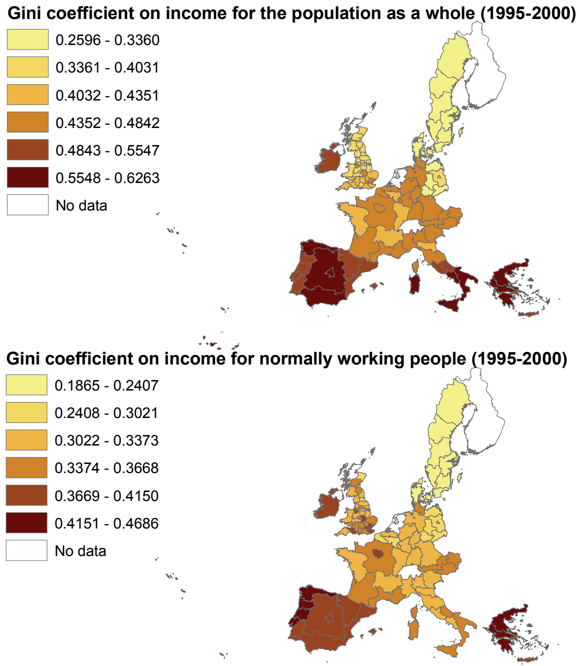


Figure 7 Three-level Income Decomposition by Theil Index for the EU from 1996 to 2000



We then apply the multilevel decomposition of the Theil index of income inequality (Cowell, 1985), (Akita, 2003), (Arbia et al., 2005) to explore which level (individual, regional, or national) is the most prominent. *Figure 7* illustrates the contribution of the within-region inequalities for the whole of the population, as well as those of the between-region and between-country inequalities to the overall level of income inequality in Europe. The decomposition of the overall income inequality in Europe reveals that the contribution of all components to overall inequality was relatively stable between 1996 and 2000. In 1996, for example, 80.23 percent of the overall inequality was due to the within-region component. The between-region and between-country components accounted for, respectively, 7.07 percent and 12.70 percent. In 2000, the overall income inequality was 77.97 percent, 8.97 percent, and 13.06 percent due to the within-region, between-region, and between--country components, respectively. Hence, the within-region component accounted for a large proportion of all European income inequality. Additionally, the analysis in-

Figure 8 Spatial Distribution of the Gini Coefficient on Income

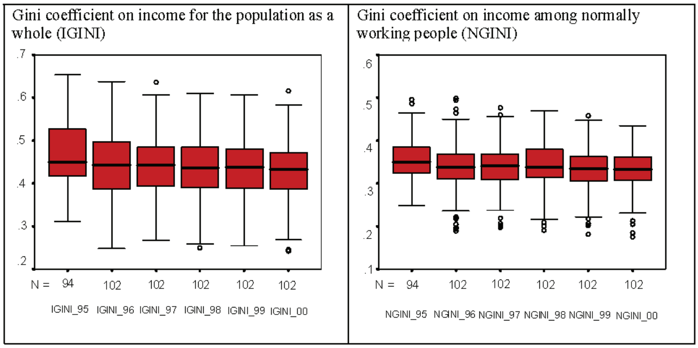


dicates that the between-country component was to some extent more significant than the between-region component. However, both between-region and between-country inequality in the EU remained stable at a low level. European regions tended, over time, to maintain their relative positions in terms of income inequality, as a consequence of a low level of intradistributional mobility (Ezcurra, Pascual, 2005). As Arbia et al. (2005), using one-stage decomposition of inequality (within-country and between-country components), show, inequality in EU15 regions over the period 1997–2002 was mainly due to within-country disparities, while inequality in the EU15 and eastern European regions over the period 2001–2002 was mainly the result of between-country disparities. In general, inequalities based on an average level of income distribution (i.e., national income distribution) were much lower than inequalities based on total net personal income. Overall, the within-region inequalities are much more prominent than the between-region and between-country inequalities.

Generally, the correlations among all inequality indices were high and statistically significant, with the exception of the correlations between the squared coefficient of variation and the remaining indices.

As has been mentioned, the first step of ESDA is to map data. When mapping these data, the distributions of the Gini coefficients on income for the population as a whole and for normally working people are cut from the same cloth (*Figure 8*). There are prominent differences in income inequality within regions between different parts of Europe, predominantly between northern and southern Europe. Income

Figure 9 Boxplot for Income Inequality



inequality is greater in the southern periphery, extending from Greece to southern Italy (Lazio, Sicilia, Sud, Campania, and Sardinia) and western Spain (Canarias, Sur, Centro, and Noroeste). By contrast, northern Europe (Sweden, Denmark, and the southern United Kingdom) had the lowest level of income inequality, with the exception of Ireland. The findings, as in *Figure 7*, show that between-region and within-country income inequalities were lower than between-country inequalities. Income inequality within German regions was lower in the East (Mecklenburg-Vorpommern, Brandenburg, Sachsen, Sachsen-Anhalt, and Thüringen) than in the West, demonstrating a German East-West divide. Additionally, the results substantiated the existence of the well-known Italian North-South divide. Italian income inequality was higher in the South than in the North. It is also clear that income inequality was higher in the southern periphery than in central Europe, which, in turn, is higher than in northern Europe (Denmark and Sweden). Summing up, the spatial distributions presented here show that there were disparities in income inequality within regions between different parts of Europe, particularly among the South, the Centre, and the North of Europe. The geographical distributions of other measures of inequality such as the relative mean deviation index, the Theil index, the squared coefficient of variation, and the Atkinson index yielded similar results.

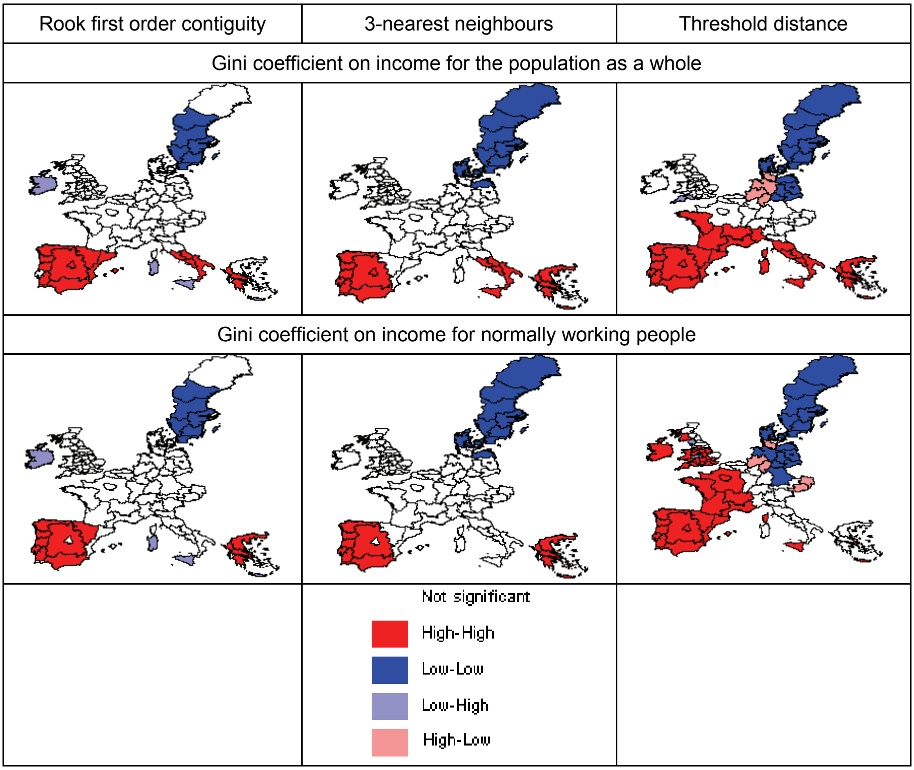
Figure 9 presents the boxplot for the Gini coefficient on income. Considering the distribution for the whole of the population, Sicilia was the upper outlier in 1997 and 2000, while Mellestra Norrland and Norra Mellansverige, and Övre Norrland were the lower outliers in 1998 and 2000. The whiskers and box length were wider in 1996 than in 2000. Generally, the distribution of the Gini coefficient is quite compact and failed to reject the normality assumption. Looking behind the boxplots, the descriptive statistical analysis shows that income inequality was lower in city-regions. For instance, although Spain had a high level of income inequality, the Comunidad de Madrid had a lower level of inequality than the remainder of the country.

Due to the high correlation among income inequality indices, only the spatial autocorrelation analysis for the Gini coefficient is explored. The univariate and bivariate Moran's I statistics computed using different spatial weights matrices were positive and statistically significant, highlighting the robustness of the results (see *Table 2* for the whole population, and *Appendix 4* for normally working people).

Table 2 Moran's I for the Gini Coefficient on Income for the Whole Population

		13 countries (E[I] = -0.0099)											
		rook first order contiguity				3-nearest neighbours				threshold distance			
		Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value
Spatial auto-correlation	1995												
	1996	0.7179	-0.0085	0.0745	9.7503	0.8151	-0.0066	0.0751	10.9414	0.4303	-0.0103	0.0217	20.3041
	1997	0.7093	-0.0072	0.0761	9.4152	0.8067	-0.0128	0.0720	11.3819	0.4301	-0.0101	0.0221	19.9186
	1998	0.7182	-0.0133	0.0758	9.6504	0.7942	-0.0131	0.0740	10.9095	0.4186	-0.0108	0.0214	20.0654
	1999	0.6743	-0.0063	0.0734	9.2725	0.7512	-0.0091	0.0744	10.2191	0.4041	-0.0092	0.0219	18.8721
	2000	0.6733	-0.0127	0.0756	9.0741	0.7492	-0.0069	0.0741	10.2038	0.4143	-0.0087	0.0217	19.4931
Space-time correlation	1998	0.7120	-0.0062	0.0729	9.8519	0.8043	-0.0122	0.0703	11.6145	0.4273	-0.0095	0.0218	20.0367
	2000	0.6906	-0.0126	0.0715	9.8350	0.7763	-0.0094	0.0718	10.9429	0.4156	-0.0093	0.0206	20.6262
		Excluded SE (E[I] = -0.0108)											
		rook first order contiguity				3-nearest neighbours				threshold distance			
		Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value
Spatial auto-correlation	1995	0.6332	-0.0085	0.0761	8.4323	0.7367	-0.0112	0.0807	9.2677	0.3395	-0.0104	0.0232	15.0819
	1996	0.6405	-0.0102	0.0738	8.8171	0.7556	-0.0076	0.0770	9.9117	0.3513	-0.0114	0.0229	15.8384
	1997	0.6252	-0.0118	0.0745	8.5503	0.7457	-0.0067	0.0754	9.9788	0.3425	-0.0113	0.0215	16.4558
	1998	0.6173	-0.0117	0.0760	8.2763	0.7176	-0.0135	0.0753	9.7092	0.3193	-0.0116	0.0219	15.1096
	1999	0.5761	-0.0114	0.0754	7.7918	0.6998	-0.0044	0.0765	9.2052	0.3206	-0.0102	0.0225	14.7022
	2000	0.5684	-0.0093	0.0776	7.4446	0.6959	-0.0087	0.0785	8.9758	0.3279	-0.0114	0.0222	15.2838
Space-time correlation	1998	0.6227	-0.0064	0.0759	8.2885	0.7361	-0.0098	0.0744	10.0255	0.3389	-0.0097	0.0220	15.8455
	2000	0.5849	-0.0097	0.0746	7.9705	0.6992	-0.0083	0.0749	9.4459	0.3209	-0.0093	0.0225	14.6756

Figure 10 Cluster Map for the Gini Coefficient on Income

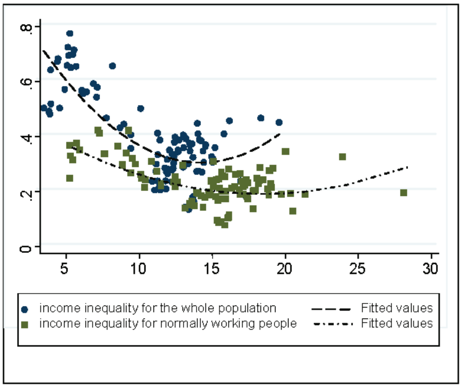


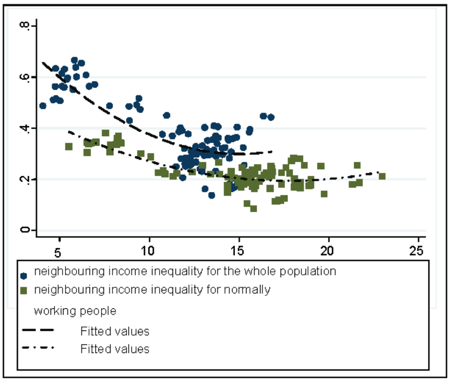
Once more, the standardized values of the statistics were approximately the same throughout the period between 1995 and 2000.

Local spatial autocorrelation analysis shows that there were clusters of high income inequality in southern Europe (Greece, southern Italy, Spain, and Portugal), while clusters of low income inequality could be found in northern Europe (Sweden, Brandenburg, and Mecklenburg) (*Figure 10*). For the distance band weights schemes, clusters of low income inequality expanded further to include Denmark, northern and eastern regions of the United Kingdom, and the French region Est. Although Spain and Portugal represented clusters of high income inequality, the regions of Lisboa and Madrid were not in the rook first-order contiguity, showing, once again, that income inequality was lower in city-regions.

No matter which income distribution is considered, the results emphasize a certain kind of spatial heterogeneity hidden within the spatial autocorrelation pattern. The spatial effects may perform differently between rural and urban areas, as well as between the northern and southern European regions. Income inequality was also lower in agglomerated urban areas and in northern regions. The homogeneity was higher within the northern and southern regions of the EU than between both groups. Hence, income inequality in each region depended not only on its own characteristics, but also on those of the regions that form the neighborhood to which

Figure 11 Non-Linear Relationship between Income Per Capita and Inequality





it belongs, with marked differences within agglomerated and rural areas rather than between them, as well as within southern and northern areas rather than between them.

Finally, the correlation between income inequality (Gini coefficient) for the population as a whole and income inequality among people normally in work was very high and statistically significant (above 0.667).

5. Non-Linear Relationship between Income Per Capita and Inequality

Figure 11 plots the relationship between income per capita and income inequality of the population as a whole and among normally working people. The figure shows a U-shaped relationship, with a more prominent declining segment, highlighting a negative linear relationship between both factors (see *Appendix 5*). This is highly robust across inequality measurements.[6] This figure also plots the relationship between neighboring income per capita and inequality for the 3-nearest neighbors weights matrix. This was also non-linear, following the same trend. Hence, spatial patterns are not neutral for the U-shaped relationship.

[6] The results are provided upon request.

6. Conclusion

This paper has mapped regional income distribution in Western Europe, using data extracted from the ECHP, covering more than 100,000 individuals for 102 regions and over the period 1995–2000. The ESDA and the spatial econometrics analysis yielded the following results. First, there was a strong U-shaped relationship between income per capita and income inequality which was highly robust across inequality definitions, with the declining segment being the most prominent. Second, the short evolutions of income inequality in Europe measured by the relative mean deviation index, the Gini coefficient, the Theil index, and the Atkinson index were cut from the same cloth. Income inequality followed a slight downward trend and seemed to be, in any case, a fundamentally within-region phenomenon. The within--region component of income inequality constituted 80 percent of the income inequality in Europe. Between-region and within-country as well as between-country inequalities were small in comparison. Third, the spatial distribution of income per capita and income inequality was not uniform and displays asymmetries. The application of global and local spatial association tests facilitates the detection of income patterns across European regions. Regions with similar income conditions tended to cluster, not only within national borders, but also across nations. Pecuniary and technological externalities spilled over the barriers of regional and national economies. The diffusion of economic development seemed to be higher among regions that are geographically close to one another and decayed with distance. Hence, income inequality in any given region depended not only on the initial income inequality in that region, but also on a weighted average of initial income inequality in neighboring regions. Income disparities are determined by region-specific characteristics, location, proximity, and linkages. Fourth, disparities in income per capita and inequalities between different parts of Europe were particularly evident between northern and southern regions, as well as between urban and rural areas. More specifically, there were clusters of high income inequality and low income per capita in southern Europe (Greece, southern Italy, and Spain) and in rural areas, while clusters of low income inequality and high income per capita were found in northern Europe (Germany, Belgium, Sweden, and Denmark) and in urban areas.

The analysis provides useful insights for the conduct of welfare and regional policies in the EU. It first begs the question as to why interregional GDP inequality has attracted so much attention and become a focal point of EU policy (Rodríguez--Pose, Fratesi, 2004), when the dimension of within-region income inequalities is much greater than that of between-region and between-country inequalities. It also raises the issue of proximity: income in neighboring regions is likely to matter for the development prospects of any given region. As a result, a poor southern region surrounded by other poor regions is likely to have greater difficulties in achieving economic dynamism than poor northern regions surrounded by richer regions. Evidence has been brought in the simulation exercises performed by Dall'erba and Le Gallo (2008) when shocking the economy of the EU regions with various levels of structural fund investments. Clusters of poor regions in southern Europe may act as a development barrier for those regions. The positive externalities generated by the more dynamic southern city-regions are, in contrast, likely to alleviate the EU North-South polarization. A city-region with higher income per capita and lower income inequality than neighboring areas will enhance the economic perspectives of surrounding poorer regions. Hence, the prevalence of interregional externalities can create or alleviate poverty traps. This depends on linkages and proximity, suggesting that it would be somewhat simplistic and not particularly helpful to consider income inequality within regions as an isolated factor without accounting for space.

Overall the description of inequalities presented in this paper provides a starting point for further analysis. How the intraregional and interregional inequalities detected in Western Europe affect issues such as the economic performance of territories, levels of activity and/or unemployment, innovation capacity, social exclusion and the like can only be hinted here. More sophisticated analyses will be needed in order to unveil the complex intricacies of how regional income inequalities affect the socio-economic trajectory of individuals and regions in Europe.

APPENDIX 1

Regions: Code and Name

NUTS_ _CODE	NAME	NUTS_ _CODE	NAME
be1	Région Bruxelles-capitale/Brussels hoofdstad gewest	at1	Österreich
be2	Vlaams Gewest	at2	Südösterreich
be3	Région Wallonne	at3	Westösterreich
dk	Denmark	pt11	Norte
de1	Baden-Württemberg	pt12	Centro (PT)
de2	Bayern	pt13	Lisboa e Vale do Tejo
de3	Berlin	pt14	Alentejo
de4	Brandenburg	pt15	Algarve
de5	Bremen	pt2	Açores (PT)
de6	Hamburg	pt3	Madeira (PT)
de7	Hessen	se01	Stockholm
de8	Mecklenburg-Vorpommern	se02	Östra Mellansverige
de9	Niedersachsen	se04	Sydsverige
dea	Nordrhein-Westfalen	se06	Norra Mellansverige
dex	Rheinland-Pfalz+Saarland	se07	Mellersta Norrland
ded	Sachsen	se08	Övre Norrland
dee	Sachsen-Anhalt	se03	Småland med öarna
def	Schleswig-Holstein	se05	Västsverige
deg	Thüringen	uk11	Cleveland, Durham
gr1	Voreia Ellada	uk13	Northumberland, Tyne and Wear
gr2	Kentriki Ellada	uk12	Cumbria
gr3	Attiki	uk81	Cheshire
gr4	Nisia Aigaiou, Kriti	uk82	Greater Manchester
es1	Noroeste	uk83	Lancashire
es2	Noreste	uk84	Merseyside
es3	Comunidad de Madrid	uk21	Humberside
es4	Centro (ES)	uk22	North Yorkshire
es5	Este	uk23	South Yorkshire
es6	Sur	uk24	West Yorkshire
es7	Canarias (ES)	uk31	Derbyshire, Nottinghamshire
fr1	Île de France	uk32	Leicestershire, Northamptonshire
fr2	Bassin Parisien	uk33	Lincolnshire
fr3	Nord - Pas-de-Calais	uk71	Hereford and Worcester, Warwickshire
fr4	Est	uk72	Shropshire, Staffordshire
fr5	Ouest	uk73	West Midlands (County)
fr6	Sud-Ouest	uk4	East Anglia
fr7	Centre-Est	uk51	Bedfordshire, Hertfordshire
fr8	Méditerranée	uk54	Essex
ie	Ireland	uk55	Greater London
it1	Nord Ovest	uk52	Berkshire, Buckinghamshire, Oxfordshire
it2	Lombardia	uk53	Surrey, East-West Sussex
it3	Nord Est	uk56	Hampshire, Isle of Wight
it4	Emilia-Romagna	uk57	Kent
it5	Centro (I)	uk61	Avon, Gloucestershire, Wiltshire
it6	Lazio	uk63	Dorset, Somerset
it7	Abruzzo-Molise	uk62	Cornwall, Devon
it8	Campania	uk91	Clwyd, Dyfed, Gwynedd, Powys
it9	Sud	uk92	Gwent, Mid-South-West Glamorgan
ita	Sicilia	uka4	Grampian
itb	Sardegna	uka1	Borders-Central-Fife-Lothian-Tayside
lu	Luxembourg	uka2	Dumfries and Galloway, Strathclyde

APPENDIX 2

Moran's I for Income Per Capita of Normally Working People

		13 countries (E[I] = -0.0099)											
		rook first order contiguity				3-nearest neighbours				threshold distance			
		Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value
Spatial auto-correlation	1995												
	1996	0.6314	-0.0090	0.0730	8.7726	0.7545	-0.0105	0.0732	10.4508	0.3392	-0.0116	0.0213	16.4695
	1997	0.6080	-0.0092	0.0741	8.3293	0.7679	-0.0084	0.0760	10.2145	0.4361	-0.0091	0.0231	19.2727
	1998	0.5868	-0.0053	0.0745	7.9477	0.7433	-0.0094	0.0740	10.1716	0.4095	-0.0099	0.0221	18.9774
	1999	0.6119	-0.0082	0.0747	8.3012	0.7618	-0.0079	0.0728	10.5728	0.4310	-0.0102	0.0231	19.0996
	2000	0.6668	-0.0159	0.0733	9.3138	0.8003	-0.0129	0.0729	11.1550	0.4590	-0.0093	0.0221	21.1900
Space-time correlation	1998	0.5586	-0.0113	0.0701	8.1298	0.6892	-0.0113	0.0693	10.1082	0.3551	-0.0094	0.0221	16.4932
	2000	0.5828	-0.0066	0.0730	8.0740	0.7216	-0.0106	0.0715	10.2406	0.4185	-0.0086	0.0212	20.1462
		Excluded SE (E[I] = -0.0108)											
		rook first order contiguity				3-nearest neighbours				threshold distance			
		Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value
Spatial auto-correlation	1995	0.6365	-0.0065	0.0746	8.6193	0.7237	-0.0122	0.0743	9.9044	0.2747	-0.0111	0.0234	12.2137
	1996	0.6304	-0.0106	0.0743	8.6272	0.7545	-0.0167	0.0754	10.2281	0.3221	-0.0106	0.0244	13.6352
	1997	0.6149	-0.0083	0.0768	8.1146	0.7745	-0.0107	0.0756	10.3862	0.4420	-0.0106	0.0227	19.9383
	1998	0.5929	-0.0093	0.0777	7.7503	0.7522	-0.0085	0.0771	9.8664	0.4150	-0.0098	0.0231	18.3896
	1999	0.6215	-0.0092	0.0762	8.2769	0.7719	-0.0108	0.0748	10.4639	0.4404	-0.0107	0.0224	20.1384
	2000	0.6770	-0.0109	0.0775	8.8761	0.8096	-0.0098	0.0770	10.6416	0.4707	-0.0107	0.0224	21.4911
Space-time correlation	1998	0.5648	-0.0093	0.0698	8.2249	0.6987	-0.0104	0.0738	9.6084	0.3530	-0.0096	0.0223	16.2601
	2000	0.5901	-0.0142	0.0735	8.2218	0.7305	-0.0067	0.0746	9.8820	0.4241	-0.0106	0.0217	20.0323

Note: All statistics are significant at p=0.001; E[I]: theoretical mean; Mean: observed mean

APPENDIX 3

Income Inequality Indices

A3-1 The Relative Mean Deviation Index

The relative mean deviation index (RMD) is defined as

$$RMD = \sum_i p_i \left| r_i - 1 \right|$$

The disproportionality function of this index is

$$f(r_i) = \left| r_i - 1 \right|$$

When the basic units are individuals, its minimum value is 0 for perfect equality, and its maximum value is $2\left(1 - \frac{1}{N}\right)$ for perfect inequality. The upper limit of the relative mean deviation index approaches 2 as N increases.

The relative mean deviation index is independent of income scale and population size, but does not obey the principle of transfers, since a rich-to-poor transfer may leave income inequality unchanged rather than reducing it (Cowell, 1995).

A3-2 The Gini Index

The Gini index or coefficient (G or $GINI$) is computed as follows (Cowell, 1995)

$$G = \frac{1}{2N^2\overline{Y}} \sum_{i=1}^{N}\sum_{j=1}^{N} \left| y_i - y_j \right| \text{ or } G = \frac{1}{N^2} \sum_{i=1}^{N}\sum_{j=1}^{N} \left| r_i - r_j \right| / 2$$

This index is one-half of the average distance between the income ratios for all pairs of individuals. Two individuals are randomly selected with replacement from the entire population; one-half of the distance between the individuals' income ratios is calculated, the process is repeated M times, and the average taken (Firebaugh, 2003). Each individual has the probability $1/N$ of being selected. The above index is an unweighted index. (Shankar, Shah, 2003), following (Kakwani, 1980), computed the weighted Gini index G_w as

$$G_w = \frac{1}{2\overline{Y}} \sum_i \sum_j \left| y_i - y_j \right| p_i p_j \text{ or } G_w = \frac{1}{2} \sum_i \sum_j \left| r_i - r_j \right| p_i p_j$$

When the basic units are individuals, it is also a weighted index. The Gini index varies from 0 for perfect equality to $\frac{N-1}{N}$ for perfect inequality. The upper limit of the Gini index approaches 1.0 as N increases.

The Gini index is the most popular measure of income inequality. However, it has some limitations. Although it satisfies the principle of transfers (Cowell, 1995), it is not consistent with the welfare principle that income transfers are more consequential among the poor than among the rich (Firebaugh, 2003). In addition, it is not additively decomposable (Bourguignon, 1979). From a technical point of view, it is harder to calculate than most other measures. One underpinning characteristic of the Gini index is that it provides non-redundant information about income inequality, because it is relatively more sensitive to change around the median of the income distribution and less sensitive to transfers among the very rich or the very poor (Allison, 1978), (Firebaugh, 2003). Hence the Gini forms are acceptable to test theories regarding the relationship between national income inequalities and economic growth such as political economy models.

A3-3 The Generalized Entropy Index: The Theil Index and the Squared Coefficient of Variation

The generalized entropy index (GE) is defined as

$$GE(a) = \frac{1}{N}\frac{1}{a(a-1)}\sum_{i=1}^{N}(r_i^a - 1)$$

where a is a sensitive parameter which measures the weight given to distances among values taken by y at different parts of the distribution of y (Brulhart, Traeger, 2005).

The distance function of the generalized entropy index is

$$f(r_i) = \frac{1}{a(a-1)}(r_i^a - 1)$$

The generalized entropy index is decomposable by population subgroups. We define an exhaustive partition of the population of basic units $i \in \{1,2,...,N\}$ into mutually exclusive subgroups of basic units $j \in \{1,2,...,L\}$, such as regions. This index can be decomposed additively as:

$$GE(a) = GE_b(a) + GE_w(a)$$

where $GE_b(a)$ and $GE_w(a)$ stand for the between-subgroups and the within-subgroups of the generalized entropy index, respectively.

A3-3.1 The Theil Index

The case where $a = 1$ yields the Theil index (T or $GE1$) of inequality (Theil, 1967), (Brulhart, Traeger, 2005). The Theil index is defined as

$$T = \sum_i p_i r_i \log(r_i) \text{ or } T = \sum_i y_i \log(y_i / p_i)$$

(The Theil index can be defined using logarithms to any base. We use the natural logarithm for simplicity throughout our empirical research.)

The disproportionality function of the Theil index is defined by the following expression

$$f(r_i) = r_i \log(r_i)$$

The Theil minimum value is 0 for perfect equality, and its maximum value is log$N$.

Consider the following two-level hierarchical structure of the EU: region--individual. Using the mutually exclusive subgroups of basic units, the overall level of income inequality can be measured using the following Theil index

$$T = \sum_j \sum_i p_{ji} r_{ji} \log(r_{ji})$$

where p_{ji} denotes population share, defined as n_{ji} / N (where n_{ji} is the weight of individual i in region j and N is the total population of all individuals such that $N = \sum_j \sum_i N_{ji}$), and r_{ji} is the income ratio of individual i in region j.

Thus, the Theil index (i.e., country inequality) can be decomposed additively as

$$T = \sum_j p_j r_j \log(r_j) + \sum_j p_j r_j T_j \text{ or } T = \sum_j y_j \log(y_j / p_j) + \sum_j y_j T_j$$

where $\sum_j p_j r_j \log(r_j)$ and $\sum_j p_j r_j T_j$ are the measures of between-region and within--region inequality, respectively. The between-regions component in the inequality identity is a population-weighted component that assumes that everyone within a region receives that region's mean income. This component shows the degree to which the levels of income converge with one another. The within-regions component in the inequality identity is a weighted average for each individual, where the weights add up to one. This component emphasizes the disparities within regions.

Following Akita (2003), we decompose the overall income inequality of the Theil index into three components. Now, consider the following hierarchical structure of the EU: country-region-individual. It is an extension of the two-level Theil decomposition method. This method is analogous to a two-stage nested design in the analysis of variance (Montgomery, 1984), (Akita, 2003). In this case, the regions $j \in \{1, 2, ..., L\}$ are mutually exclusive subgroups of countries $k \in \{1, 2, ..., M\}$. The Theil index (i.e., EU inequality) is defined as

$$T = \sum_k \sum_j \sum_i p_{kji} r_{kji} \log(r_{kji})$$

where p_{kji} denotes population share, defined as n_{kji} / N (where n_{kji} is the weight of individual i in region j in country k and N is the total population of all individuals such that $N = \sum_k \sum_j \sum_i N_{kji}$), and r_{kji} is the income ratio of individual i in region j in country k.

The Theil index can be decomposed additively as

$$T = \sum_k \sum_j p_{kj} r_{kj} T_{kj} + \sum_k p_k r_k T_k + \sum_k p_k r_k \log(r_k) \text{ or}$$
$$T = \sum_k \sum_j y_{kj} T_{kj} + \sum_k y_k T_k + \sum_k y_k \log(y_k / p_k)$$

where $\sum_k \sum_j p_{kj} r_{kj} T_{kj}$ is the within-region income inequality, $\sum_k p_k r_k T_k$ is the between-region and the within-country income inequality, and $\sum_k p_k r_k \log(r_k)$ is the between-country income inequality (or the European income inequality using countries as basic units). The within country inequality is a weighted average of inequality in each region and the component weights add up to one.

The Theil index satisfies all the criteria of income inequality indices. It is income scale and population size invariant, additively decomposable, and satisfies both the principle of transfers and the welfare principle. The relative sensitivities of the Theil index to population change and income change hold for within-region income as well as for the between-region inequalities (Firebaugh, 1999).

A3-3.2 The Squared Coefficient of Variation

Variance (VAR) is the most common statistical measure of dispersion for a distribution. The distance concept of variance is that of absolute differences. Variance is defined as

$$VAR = \sum_i p_i (y_i - \overline{Y})^2$$

This index is sensitive to extreme observations. Additionally, the variance is not scale independent. Conversely, the squared coefficient of variation (SCV or $GE2$) is scale independent, because it concentrates on relative variation. In a generalized entropy index, when the parameter $a = 2$, this index yields the squared coefficient of variation index (Sala-i-Martin, 2002), (Brulhart, Traeger, 2005).

The squared coefficient of variation is obtained by dividing the variance by the squared mean $\overline{Y}$. It is given by the following expression

$$SCV = \sum_i p_i (r_i - 1)^2$$

The disproportionality function of the squared coefficient of variation is

$$f(r_i) = (r_i - 1)^2$$

The squared coefficient of variation varies from 0 for perfect equality to $N-1$ for perfect inequality.

A3-4 The Atkinson Index

The Atkinson (1970) index (A) is defined as

$$A = 1 - \left(\sum_i p_i r_i^{1-\varepsilon} \right)^{\frac{1}{1-\varepsilon}}$$

where the parameter ε ($\varepsilon > 0$) denotes the relative sensitivity of the Atkinson index to transfers at different points in the income distribution.

The larger the parameter ε , the greater the weight given to the lower end of the income distribution (Firebaugh, 1999, p. 1619). To put this in a slightly different way, as the parameter rises, the Atkinson index becomes more sensitive to transfers among those on lower incomes and less sensitive to transfers among the top income recipients (Allison, 1978). The distance concept of the Atkinson index is measured in terms of the difference in marginal social utilities (Cowell, 1995). The Atkinson index is independent of income scale and population size (Cowell, 1995). Finally, the Atkinson index varies from 0 for perfect equality to $1 - N^{-\varepsilon/1-\varepsilon}$. The upper limit of the Atkinson index approaches 1.0 as N increases.

APPENDIX 4

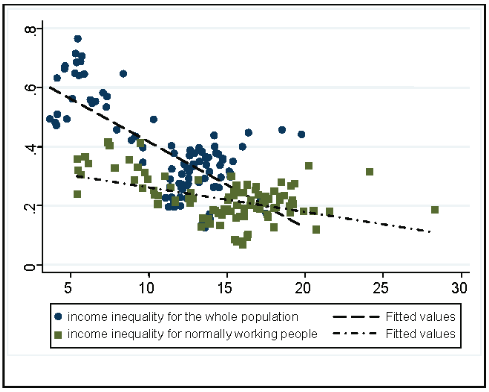
Moran's I for the Gini Coefficient on Income for Normally Working People

		13 countries (E[I] = -0.0099)											
		rook first order contiguity				3-nearest neighbours				threshold distance			
		Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value
Spatial auto- -correlation	1995												
	1996	0.7372	-0.0089	0.0740	10.0824	0.7605	-0.0091	0.0724	10.6298	0.4133	-0.0102	0.0211	20.0711
	1997	0.7494	-0.0094	0.0712	10.6573	0.7436	-0.0145	0.0746	10.1622	0.4077	-0.0096	0.0229	18.2227
	1998	0.7215	-0.0111	0.0743	9.8600	0.7219	-0.0084	0.0716	10.1997	0.3720	-0.0106	0.0220	17.3909
	1999	0.5768	-0.0092	0.0762	7.6903	0.5767	-0.0059	0.0717	8.1255	0.3232	-0.0109	0.0232	14.4009
	2000	0.6503	-0.0069	0.0725	9.0648	0.6080	-0.0121	0.0718	8.6365	0.3289	-0.0097	0.0222	15.2523
Space-time correlation	1998	0.7274	-0.0084	0.0706	10.4221	0.7387	-0.0081	0.0690	10.8232	0.3907	-0.0099	0.0214	18.7196
	2000	0.6610	-0.0087	0.0741	9.0378	0.6726	-0.0084	0.0730	9.3288	0.3567	-0.0093	0.0219	16.7123
		Excluded SE (E[I] = -0.0108)											
		rook first order contiguity				3-nearest neighbours				threshold distance			
		Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value	Moran's I	Mean	Sd	*Z*-value
Spatial auto- -correlation	1995	0.5389	-0.0074	0.0755	7.2358	0.6105	-0.0089	0.0769	8.0546	0.2588	-0.0113	0.0227	11.8987
	1996	0.6028	-0.0094	0.0774	7.9096	0.6615	-0.0120	0.0746	9.0282	0.2892	-0.0103	0.0235	12.7447
	1997	0.6108	-0.0097	0.0771	8.0480	0.6540	-0.0149	0.0785	8.5210	0.2839	-0.0098	0.0227	12.9383
	1998	0.5318	-0.0080	0.0767	7.0378	0.5729	-0.0141	0.0773	7.5938	0.2025	-0.0109	0.0223	9.5695
	1999	0.3565	-0.0096	0.0787	4.6518	0.4553	-0.0067	0.0755	6.1192	0.1891	-0.0114	0.0222	9.0315
	2000	0.4703	-0.0108	0.0756	6.3638	0.5062	-0.0094	0.0773	6.6701	0.2028	-0.0115	0.0221	9.6968
Space-time correlation	1998	0.5660	-0.0085	0.0727	7.9023	0.6179	-0.0081	0.0691	9.0593	0.2443	-0.0093	0.0212	11.9623
	2000	0.4675	-0.0070	0.0724	6.5539	0.5257	-0.0063	0.0718	7.4095	0.2014	-0.0099	0.0205	10.3073

Note: All statistics are significant at $p = 0.001$; E[I]: theoretical mean; Mean: observed mean.

APPENDIX 5

Linear Relationship between Income Per Capita and Inequality



REFERENCES

Akita T (2003): Decomposing Regional Income Inequality in China and Indonesia Using Two-Stage Nested Theil Decomposition Method. *Annals of Regional Science*, 37(1):55–77.

Allison PD (1978): Measures of Inequality. *American Sociological Review*, 43(6):865–880.

Anselin L (1995): Local Indicators of Spatial Association – LISA. *Geographical Analysis*, 27(2): 93–115.

Anselin L, Florax RJGM, Rey SJ (Eds.) (2004): *Advances in Spatial Econometrics: Methodology, Tools and Applications*. Springer, Berlin.

Arbia G, Dominicis L de, Piras G (2005): Regional Growth and Regional Inequality in EU and Transition Countries: a Spatial Econometric Approach. *ERSA Conference Papers,* ersa05p168, European Regional Science Association.

Armstrong HW (1995): Convergence among Regions of the European Union, 1950–1990. *Papers in Regional Science*, 74(2):143–152.

Atkinson AB (1970): Measurement of Inequality. *Journal of Economic Theory*, 2(3):244–263.

Azariadis C, Drazen A (1990): Threshold Externalities in Economic Development. *Quarterly Journal of Economics*, 105(2):501–526.

Barro RJ, Sala-i-Martin X (1992): Convergence. *Journal of Political Economy*, 100(2):223–251.

Baumont C, Ertur C, Le Gallo J (2003): Spatial Convergence Clubs and the European Regional Growth Process, 1980–1995. In: Fingleton B (Ed): *European Regional Growth*. Springer, Berlin, 131–158.

Bourguignon F (1979): Decomposable Income Inequality Measures. *Econometrica*, 47(4):901–920.

Brulhart M, Traeger R (2005): An Account of Geographic Concentration Patterns in Europe. *Regional Science and Urban Economics*, 35(6):597–624.

Cowell FA (1985): Multilevel Decomposition of Theil Index of Inequality. *Review of Income and Wealth*, 31(2):201–205.

Cowell FA (1995): *Measuring Inequality*. 2nd Ed. Prentice Hall/Harvester Wheatsheaf, London.

Cuadrado-Roura JR (2001): Regional Convergence in the European Union: from Hypothesis to the Actual Trends. *Annals of Regional Science*, 35(3):333–356.

Dall'erba S (2005): Distribution of Regional Income and Regional Funds in Europe 1989–1999: an Exploratory Spatial Data Analysis. *Annals of Regional Science*, 39(1):121–148.

Dall'erba S, Le Gallo J (2008): Regional Convergence and the Impact of Structural Funds over 1989–1999: a Spatial Econometric Analysis. *Papers in Regional Science*, 87(2):219–244.

Dominicis L de, Arbia G, Groot HLF de (2007): The Spatial Distribution of Economic Activities in Italy. *Tinbergen Institute Discussion Papers*, No. 07-094/3.

Durlauf SN, Johnson PA (1995): Multiple Regimes and Cross-Country Growth Behavior. *Journal of Applied Econometrics*, 10(4):365–384.

Ertur C, Le Gallo J (2003): An Exploratory Spatial Data Analysis of European Regional Disparities, 1980–1995. In: Fingleton B (Ed): *European Regional Growth*. Springer, Berlin, pp. 55–98

European Commission (1999): *The European Regions: Sixth Periodic Report on the Socio-Economic Situation in the Regions of the European Union*. Official Publication Office, Luxembourg.

Ezcurra R, Gil C, Pascual P, Rapún M (2005a): Inequality, Polarisation and Regional Mobility in the European Union. *Urban Studies*, 42(7):1057–1076.

Ezcurra R, Gil C, Pascual P, Rapún M (2005b): Regional Inequality in the European Union: Does Industry Mix Matter? *Regional Studies*, 39(6):679–697.

Ezcurra R, Pascual P (2005): Is There Convergence in Income Inequality Levels among the European Regions? *Applied Economics Letters*, 12(2):763–767.

Firebaugh G (1999): Empirics of World Income Inequality. *American Journal of Sociology*, 104(6): 1597–1630.

Firebaugh G (2003): *The New Geography of Global Income Inequality*. Harvard University Press, Cambridge, MA.

Forbes KJ (2000): A Reassessment of the Relationship between Inequality and Growth. *American Economic Review*, 90(4):869–887.

Haining RP (1995): Data Problems in Spatial Econometric Modeling. In: Anselin L, Florax RJGM (Eds): *New Directions in Spatial Econometrics*. Springer, Berlin-New York, pp. 156–171.

Kakwani N (1980): *Income Inequality and Poverty: Methods of Estimation and Policy Applications*. A World Bank Research Publication, Oxford University Press, New York.

Krugman PR (1991): *Geography and Trade*. MIT Press, Leuven University Press, Cambridge, Leuven, Belgium.

Martin P (1999): Public Policies, Regional Inequalities and Growth. *Journal of Public Economics*, 73(1):85–105.

Montgomery DC (1984): *Design and Analysis of Experiments*. Wiley, New York, Chichester.

Moran PAP (1950): Notes on Continuous Stochastic Phenomena. *Biometrika*, 37(1-2):17–23.

Quah DT (1996): Empirics for Economic Growth and Convergence. *European Economic Review*, 40(6):1353–1375.

Ram R (1992): Income Distribution and Welfare – an Inter-Country Comparison. *Economic Development and Cultural Change*, 41(1):141–145.

Rodríguez-Pose A (1998): *Dynamics of Regional Growth in Europe: Social and Political Factors*. Clarendon Press, New York.

Rodríguez-Pose A (1999): Convergence or Divergence? Types of Regional Responses to Socio-Economic Change in Western Europe. *Tijdschrift voor Economische en Sociale Geografie*, 90(4): 363–378.

Rodríguez-Pose A, Crescenzi R (2008): Research and Development, Spillovers, Innovation Systems, and the Genesis of Regional Growth in Europe. *Regional Studies*, 42(1): 51–76.

Rodríguez-Pose A, Fratesi U (2004): Between Development and Social Policies: The Impact of European Structural Funds in Objective 1 Regions. *Regional Studies*, 38(1):97–113.

Rodríguez-Pose A, Tselios V (2007): Mapping the European Regional Educational Distribution: Educational Attainment and Inequality. *Working Paper,* no. 2007/18. *IMDEA Ciencias Sociales*, Madrid. http://repec.imdea.org/pdf/imdea-wp2007-18.pdf..

Rodríguez-Pose A, Tselios V (2009a): Education and Income Inequality in the Regions of the European Union. *Journal of Regional Science*, 49(3).

Rodríguez-Pose A, Tselios V (2009b): Inequalities in Income and Education and Regional Economic Growth in Western Europe. *Annals of Regional Science*, 43, DOI 10.1007/s00168-008-0267-2.

Sala-i-Martin XX (1996): Regional Cohesion: Evidence and Theories of Regional Growth and Convergence. *European Economic Review*, 40(6):1325–1352.

Sala-i-Martin XX (2002): Disturbing 'Rise' of Global Income Inequality. *Discussion Paper Series*, no. 0102-44, Department of Economics, *Columbia University*.

Sen AK, Foster JE (1997): *On Economic Inequality*. Clarendon Press, Oxford University Press, Oxford-New York.

Shankar R, Shah A (2003): Bridging the Economic Divide within Countries: a Scorecard on the Performance of Regional Policies in Reducing Regional Income Disparities. *World Development*, 31(8):1421–1441.

Theil H (1967): *Economics and Information Theory*. North-Holland, Amsterdam.

Tselios V (2008): Income and Educational Inequalities in the Regions of the European Union: Geographical Spillovers Under Welfare State Restrictions. *Papers in Regional Science*, 87(3):403–430.

Unwin A, Unwin D (1998): Exploratory Spatial Data Analysis with Local Statistics. *Journal of the Royal Statistical Society,* Series D-the Statistician, 47(3):415–421.