Regional mobility in the European Union*

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Abstract

This article examines mobility in the regional distribution of per capita income in the European Union between 1977 and 1999. The applied methodology to investigate this issue combines the estimation of a series of measures taken from the literature devoted to the dynamic study of personal income distribution with a non-parametric analysis. Results show limited mobility in the distribution considered, and a decline in mobility over time. The empirical evidence presented indicates, moreover, that mobility patterns vary as a function of the regional development level. In addition, the analysis carried out highlights the importance of the role played by variables such as growth in sectoral productivity and per capita employment or spatial location in explaining the changes in the relative positions of the various regions.

Key words: Mobility, per capita income, regions, European Union.
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1 Introduction

In recent years, the issue of territorial imbalances in the European Union (EU) has been examined in numerous studies from a variety of different approaches\(^1\). There are various reasons for the amount of interest surrounding this question. Among them is the fact that economic growth theory has advanced greatly over the last two decades, coinciding with the introduction of endogenous growth models in the mid eighties. Another, the need to reduce disparities in terms of development levels across the various European regions, is directly related to some of the basic principles behind the forming of the Union, especially since the introduction of the Single Act and the Maastricht agreements. In particular, one of the specific assumptions of the European integration programme is that it will drive the growth of all Member States, thereby increasing economic and social cohesion\(^2\).

Most of the articles dealing with the analysis of regional per capita income disparities in Europe apply the concepts of *sigma convergence* and *beta convergence*, introduced by Barro and Sala-i-Martin (1991, 1992), combining the information provided by various dispersion statistics with the estimation of convergence equations. However, as Quah (1993, 1996a, 1997) has repeatedly pointed out, not only does this approach raise a number of econometric problems, it also fails to capture a series of potentially interesting issues relating to the dynamics of the distribution in question. In particular, this type of analysis does not consider the possibility of regions modifying their relative positions over time, and thereby neglects the whole issue of intradistributional mobility.

As an illustration of the relevance of questions relating to the analysis of distribution dynamics, let us consider the following example. Let us assume that we have information for a period of several years on regional incomes and populations in two given countries, A and B, each of which is in turn divided into two regions with exactly the same size of population. To eliminate from the analysis the effects of population shifts, let us also suppose that there is no change over time in the distribution of the population share in either of the two countries considered. In both A and B, the per capita income of one of the two regions is exactly twice that of the other region, and this situation remains unaltered for the whole of the period considered. There is, however, one major difference between these two countries. A is characterized by a high degree of regional mobility, such that, every year, its two regions switch positions. The situation in B, however, is different in that the relative positions of its regions remain constant year on year. The type of analysis commonly found in the literature is essentially static in its approach, since it is based on cross sectional information, so that it will reveal no appreciable

\(^1\)A review of the main results can be found in Armstrong (2002) or Terrasi (2002).

\(^2\)Article 2 of the Treaty of the EU specifically states that “The Community shall have as its task (...), to promote (...) a harmonious, balanced and sustainable development of economic activities, (...) sustainable and non-inflationary growth, (...)a high degree of competitiveness and convergence of economic performance (...).”
difference between A and B. In fact, given that there is no change over time in the cross sectional structure of the per capita income distribution of either of the countries, any inequality index that satisfies the properties of symmetry and scale independence will give exactly the same value for A and B throughout the period considered.\(^3\)

This example highlights the need to supplement standard inequality studies with additional data relating to the mobility of the distribution under analysis. It is precisely this issue that the present article aims to address. Our objective is to analyse mobility in the regional distribution of per capita income in the EU from 1977-1999. By this we hope to contribute to the knowledge of the nature of observed territorial imbalances in the European context, with a view to drawing some type of conclusion that might be of use to regional policy makers within the Community. For indeed, if a given level of inequality were found to be associated with a low degree of mobility, this might indicates that regions are becoming set in their relative positions. If so, this would reinforce the need for an active policy to reduce disparities. If, however, the results of the analysis suggest that existing inequality can be largely explained by the variability of regional incomes, regional policy makers would need to take steps to offset adverse economic cycle effects, and let traditional convergence policies take second place.

One of the main innovations in this study relates to the instruments it uses to analyse regional mobility. In contrast to the few articles that have so far dealt with this issue in the European context, our working method is fundamentally based on the calculation of a set of measures of the kind used in the dynamic study of personal income distribution. However, since our unit of reference is the region and not the individual, we will proceed by introducing population as a further dimension of the analysis. Thus, the indicators resulting from our calculations will be statistics weighted by the population share of each region, though, in theory, we could take into consideration any variable that were representative of the economic size of the various geographical areas under analysis (income share, surface area, etc.)\(^5\). Surprisingly, this is an approach that has so far received very little attention in the literature devoted to the analysis of territorial imbalances. This is no doubt due, in part, to the obvious limitations of the theoretical and empirical basis for the analysis of intradistributional mobility\(^6\). In any event, in

\(^3\)The properties of symmetry and scale independence do not constitute a major limitation. Indeed both are basic properties that any inequality index can be reasonably expected to fulfil (Cowell, 1995). In any event, for the purposes of our example, we can overcome the need for the inequality index to satisfy the property of scale independence by simply assuming the per capita incomes of A and B to be equal.

\(^4\)Two exceptions worth mentioning are the contributions made by López-Bazo et al. (1999) and Cuadrado et al. (2002).

\(^5\)Save for a few exceptions, the recent literature on convergence does not take into account differences in population across territorial units, and uses almost exclusively unweighted statistics. See, for example, Salas (2002) or Goerlich (2003).

\(^6\)Indeed, as stated in Fields and Ok (1999), considerably different approaches are currently taken in the study of inequality and mobility. Nevertheless, over the course of the last decade, major theoretical
order to test the robustness of our results, we will perform a parallel study of mobility in the regional distribution of per capita income using the non-parametric methodology presented by Quah (1996a, 1997). Finally, we will examine the explanatory elements of detected patterns by means of different regression models.

For an analysis of the kind we wish to conduct, it is necessary, furthermore, to obtain a representative sample of the various economies within the context under study while also covering a long enough time period. We have accomplished this by using the Cambridge Econometrics regional database which has enabled us to employ statistical data on 197 NUTS2 regions for the period between 1977 and 1999.7

This article is structured into six sections as follows. Sections 2 and 3, which follow this introduction, examine the level and evolution of mobility in the regional distribution of per capita income in the EU using several complementary approaches. Then, in section 4 and in order to complete the results obtained previously, we perform a non-parametric analysis based on the various instruments proposed by Quah (1996a, 1997). Subsequently, in section 5 we perform a preliminary study of the explanatory factors involved in regional mobility. The main conclusions are briefly presented in section 6.

2 Mobility as compensation for inequality

We will begin our analysis of mobility by investigating its role in compensating for inequality. Traditionally a high degree of mobility has been linked with lower long term inequality levels than tend to be detected in more reduced periods. One way of testing mobility, therefore, is to observe the relationship between cross-sectional and longitudinal inequality. Therefore, following common practice in the literature devoted to the dynamic analysis of personal income distribution, in this section we will examine the family of indices proposed by Shorrocks (1978a).

Let us consider a society with a population of \( H \) individuals, each of whom receives a given income over \( T \) periods, such that \( y_{ht} \) denotes the income received by individual \( h \) in period \( t \), where \( h = 1, 2, \ldots, H \), and \( t = 1, 2, \ldots, T \). If \( \mu^t = \frac{1}{H} \sum_{h=1}^{H} y_{ht} \) is the average income of the \( H \) individuals in period \( t \), the average accumulated income over the \( T \) periods considered will be given by \( \mu = \sum_{t=1}^{T} \mu^t \). Likewise, let \( Y \) be the vector of income accumulated by the \( n \) individuals over the \( T \) periods. That is, \( Y = (Y_1, Y_2, \ldots, Y_H) \), advances have been made in the analysis of intradistributional mobility. In particular, there have been proposed a series of measuring procedures with similar axiomatic contents to those used in the study of inequality.

7Lack of complete series, however, has obliged us to eliminate from the analysis the member States newly admitted to the European in May 2004, the Länder of former East Germany, The French overseas departments and the Spanish territories in North Africa. Nevertheless, the appendix includes a complete list of all the regions considered in this study.
where \( Y_h = \sum_{t=1}^{T} y_h^t \). Finally, \( Y^t \) denotes the vector of the incomes of the \( n \) individuals in period \( t \). That is, \( Y^t = (y_1^t, y_2^t, \ldots, y_H^t) \).

We will now denote by \( I(Y) \) the set of inequality measures that are convex functions of the relative incomes. Then, given the convexity of the function, it can be written as:

\[
I(Y) = h \left( \frac{Y}{\mu} \right) = h \left( \frac{\sum_{t=1}^{T} Y^t}{\mu} \right) = h \left( \sum_{t=1}^{T} \omega^t \frac{Y^t}{\mu^t} \right) \leq \sum_{t=1}^{T} \omega^t h \left( \frac{Y^t}{\mu^t} \right) \tag{1}
\]

where \( \omega^t \) is the ratio of average incomes over period \( t \) to the average accumulated income, such that \( \omega^t = \frac{\mu^t}{\mu} \). Thus from expression (1) we have that:

\[
I(Y) \leq \sum_{t=1}^{T} \omega^t I(Y^t) \tag{2}
\]

That is, the inequality index of the incomes accumulated during the \( T \) periods considered can not exceed the weighted sum of the inequality indices for each of the individual periods. The rigidity index proposed by Shorrocks (1978a) is therefore defined as:

\[
R(Y, Y^t) = \frac{I(Y)}{\sum_{t=1}^{T} \omega^t I(Y^t)} \tag{3}
\]

with \( R(Y, Y^t) \leq 1 \). Note that the above expression is valid only for inequality measures that are convex functions of the relative incomes. This constraint does not impose a major drawback, however. Indeed, most of the indices commonly used (the Gini index, the family of Theil indices, Atkinson’s indices, etc.) fulfill this property.\(^8\)

The index \( R(Y, Y^t) \) gives the value at which inequality diminishes as the time period considered is extended. Thus, for example, if \( R(Y, Y^t) = 0.90 \), income inequality over a given period will be 90% of the average inequality corresponding to the set of subperiods contemplated. In other words, this index measures the stability of inequality as the sample period progresses. Indeed, if inequality remains stable as the period is extended, we will have:

\[
I(Y) = \sum_{t=1}^{T} \omega^t I(Y^t) \tag{4}
\]

with \( \frac{Y^t}{\mu^t} \) independent of \( t \), such that \( R(Y, Y^t) = 1 \). In other words, relative incomes will not vary at all over time, a feature that is characteristic of a completely immobile society. In a society with a certain degree of mobility, however, it is to be expected that

\(^8\)The most outstanding exception is the variance of log of incomes.
there will be more frequent and wider variations in relative incomes, which would mean
that the value of $R(Y, Y^t)$ would be less than one. Thus, $R(Y, Y^t) = 0$ would indicate a
case of perfect mobility in which $I(Y) = 0^9$. Therefore, $R(Y, Y^t)$ gives us the following
measure of mobility:

$$RM(Y, Y^t) = 1 - \frac{I(Y)}{\sum_{t=1}^{T} \omega^t I(Y^t)} \quad (5)$$

In contrast to the literature devoted to the study of personal income distribution,
however, we are concerned in this study with regions, each of which contains a variable
set of individuals. We will therefore denote per capita income in region $i$ over the period
t by $x^t_i$, where $x^t_i = \frac{X^t_i}{N^t_i}$, and $X^t_i$ and $N^t_i$ are respectively the income and population
of region $i$, $i = 1, 2, \ldots, n$. Likewise, let $p^t_i$ be the relative frequency of region $i$ over
period $t$, $p^t_i = \frac{N^t_i}{N^t}$, with $N^t = \sum_{i=1}^{n} N^t_i$. The associated per capita income and population
distributions will therefore be given by $x^t = (x^t_1, x^t_2, \ldots, x^t_n)$ and $p^t = (p^t_1, p^t_2, \ldots, p^t_n)^{10}$. Finally, let us assume that $x^t \in \mathbb{R}_+^n$, while $p^t \in \mathbb{R}_+^n$.

Given, however, that our unit of reference is not the individual, we must consider
the specific characteristics of regional mobility, where, over time, each region registers
variations in per capita income, which, in turn, are known to be the result of changes in
income and population. Thus, the evolution of the various inequality measures reflects
variations both in per capita income and in the population share of each region. However, if we consider mobility as the capacity of regions to modify their relative positions
in terms of development over time, we must focus our analysis exclusively on per capita
income variations, and eliminate the impact of population shifts. To better comprehend
this idea, let us consider the following example. Let us imagine that we have data for a
period of several years on the regional per capita income distribution in a country with
two regions. Further, let us suppose that the per capita incomes remain unaltered over
time. However, a variable share of the population moves from one region to the other
each year. In a situation such as this, Shorrocks’ rigidity index would vary over time, as
a consequence of the modification in the inequality indices in the different periods. Never-
theless, according to our chosen definition of mobility, we would in theory have to say
that per capita income distribution in the country in question is completely immobile.

In order to overcome this problem, we will from now on consider that the population
remains constant, taking as reference the average population over the time pe-
riod considered. That is, $p^t_i = \bar{p}_i$, where $\bar{p}_i = \frac{1}{T} \sum_{t=1}^{T} p^t_i$. Likewise, for the $n$ regions
$\bar{p} = (\bar{p}_1, \bar{p}_2, \ldots, \bar{p}_n)^{11}$. We will also use the $n$-dimensional vector $\hat{x}$ to denote aggregate

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9 If $I(Y) = 0$, we have that $Y_1 = Y_2 = \ldots = Y_h$.
10 Obviously, $\sum_{i=1}^{n} p^t_i = 1$.
11 Again, $\sum_{i=1}^{n} \bar{p}_i = 1$. 5
per capita incomes over the $T$ periods considered. Thus, \( \hat{x} = (\hat{x}_1, \hat{x}_2, \ldots, \hat{x}_n) \), where \( \hat{x}_i = \sum_{t=1}^{T} x_t^i \) is the aggregate per capita income of region $i$ over the $T$ periods.

From now on, therefore, we can define Shorrocks’ rigidity index (1978a) adapted to the specific characteristics of regional mobility as

$$ R^*(\hat{x}, x^t, \bar{p}) = \frac{I(\hat{x}, \bar{p})}{\sum_{t=1}^{T} \omega^t I(x^t, \bar{p})} $$

(6)

where \( \omega^t = \frac{\mu^t}{\mu} \) and \( \mu = \sum_{i=1}^{n} \bar{p}_i \hat{x}_i \).

Thus, the corresponding measure of mobility will be\(^{12}\):

$$ RM^*(\hat{x}, x^t, \bar{p}) = 1 - \frac{I(\hat{x}, \bar{p})}{\sum_{t=1}^{T} \omega^t I(x^t, \bar{p})} $$

(7)

Figure 1 shows the results of the calculation of $RM^*(\hat{x}, x^t, \bar{p})$ for the EU regional distribution of per capita income between 1977 and 1999, taking different time periods ($m = 1, 2, \ldots, 23$). However, to check the sensitivity of the results to the choice of inequality index used to calculate $RM^*(\hat{x}, x^t, \bar{p})$, we have opted to incorporate into the analysis various measures of inequality, since each index features a different way of aggregating the information contained in the distribution\(^{13}\). Following this approach, we selected the following measures: the variation coefficient, $CV(x)$, the family of Theil indices, $T(\beta)$ with $\beta = 0, 1$, and the normative Atkinson index for different levels of inequality aversion, $A(\varepsilon)$ with $\varepsilon = 0.5, 2$.

The results obtained show values of the mobility measure based on Shorrocks’ rigidity index (1978a) that increase gradually as the period of reference is extended, independently of the inequality measure that is used (note that the ordinate axis has a scale of 0 to 0.1). This reveals that regional inequality in Europe declines very slowly when longer time intervals are considered. Therefore, the influence of transient variability in regional disparities within the EU appears to be quite limited, so that most of the observed inequality in this respect can be considered permanent. To illustrate this, Figure A1 displays the $R^*(\hat{x}, x^t, \bar{p})$ indices for the whole period 1977-1999. According to these, depending on the inequality index used to calculate $R^*(\hat{x}, x^t, \bar{p})$, regional inequality in per capita income in the European context over the twenty-three years considered falls within the range of 93 to 98 per cent of average inequality for the set of subperiods considered. This suggests that, according to $RM^*(\hat{x}, x^t, \bar{p})$, regional per capita income distribution in the EU is quite rigid and, therefore, barely mobile.

Nevertheless, detailed analysis of the information supplied in Figure 1 enables us to observe that the results obtained differ slightly according to the inequality index used

\(^{12}\)Note that in the previous example $R^*(\hat{x}, x^t, \bar{p}) = 1$, therefore $RM^*(\hat{x}, x^t, \bar{p}) = 0$.

\(^{13}\)For further details relating to this issue, see Chakravarty (1990) or Cowell (1995).
in the calculation of $RM^*(\hat{x}, x^t, \bar{p})$. Both Theil indices follow a similar trend, though there appears to be a slight reduction in mobility as $\beta$ increases. It is worth recalling, in this respect, that the $\beta$ parameter captures the sensitivity of $T(\beta)$ to transfers between individuals at different points in the distribution. Following Shorrocks (1980), it can actually be shown that, as $\beta$ increases, $T(\beta)$ becomes more sensitive to transfers in the upper end of the distribution. Also, as might be expected from the above results, mobility becomes greater as the value of $\varepsilon$ increases. In fact, as is known, the higher the value of the inequality aversion parameter, the greater the sensitivity of Atkinson’s index to what happens in the lower end of the distribution. The empirical evidence presented so far, therefore, appears to suggest that the reduction in inequality that takes place as the time interval is extended is greater in the European regions with lower per capita income levels.

3 Regional mobility: an analysis based on transition matrices

The measure of mobility considered in the previous section may in certain circumstances present some drawbacks relating to the significance of changes in the relative positions of the regions according to per capita income. To illustrate this problem, let us consider another example that highlights the multidimensional nature of mobility. Let us imagine a country with two regions, one of which enjoys some comparative advantage over the other, in terms, say, of its spatial location. In a situation of this kind, the region in question will, ceteris paribus, systematically register higher growth rates, giving

Figure 1: $RM^*(\hat{x}, x^t, \bar{p})$ index for various inequality measures.
rise to an increase in regional disparities, even after an initial situation of hypothetical equality. In other words, the rank ordering of the two regions will remain unaltered over time. In a context such as this, \( RM^*(\bar{x}, x', \bar{p}) \) will present positive values, though it could be argued that there is no mobility in the regional income distribution.

Keeping this fact in mind, in this section we have considered a new approach to the analysis of intradistributional mobility, based on the observation of changes experienced by relative positions of the various regions.

One of the most intuitive options when approaching mobility studies in this way is to construct transition matrices. In order to define the concept of transition matrix, let us now suppose that we have classified the different regions in the distribution into \( m \) exhaustive and mutually exclusive classes according to their per capita income level. Further, let us imagine that we have information on the distribution of interest for two moments in time, \( t_0 \) and \( t_1 \). In a case such as this, the matrix that summarises the probabilities of regions shifting from one class to another between \( t_0 \) and \( t_1 \) is known as a transition matrix. Supposing, therefore, that the probabilities can be reasonably estimated from the corresponding relative frequencies, the transition matrix associated with the transformation experienced by the distribution between \( t_0 \) and \( t_1 \) (\( x_{t_0} \rightarrow x_{t_1} \)), will be the square matrix \( (x_{t_0}; x_{t_1}) = \sum_{j=1}^{m} \pi_{jk}(x_{t_0}, x_{t_1}) \) where \( \pi_{jk}(x_{t_0}, x_{t_1}) \) denotes the proportion of regions that belonged to class \( j \) in \( t_0 \) and have shifted to class \( k \) in \( t_1 \). According to this definition, we have that \( \sum_{k=1}^{m} \pi_{jk}(x_{t_0}, x_{t_1}) = 1 \) for any \( j = 1, 2, \ldots, m \), so that \( \Pi(x_{t_0}, x_{t_1}) \) is a stochastic matrix.

The literature devoted to the dynamic study of personal income distribution have designed numerous measures of mobility based on transition matrices\(^{14}\). From this wide range of options we have begun by considering the following index based on Shorrocks (1978b)\(^{15}\):

\[
SM^*(\Pi, \rho) = \frac{1 - \sum_{j=1}^{m} \rho_j \pi_{jj}}{1 - \frac{1}{m}}
\]

where \( \rho_j \) denotes the population share in relation to the total of class \( j \). That is, \( \rho_j = \frac{N_j}{N} \).\(^{16}\)

\(^{14}\)In relation to this, see, for example, Prais (1955), Bartholomew (1973), Bibby (1975), Shorrocks (1978b), Sommers and Conlisk (1978) or Conlisk (1985, 1990).

\(^{15}\)The mobility measure proposed by Shorrocks (1978b) is given by:

\[
SM(\Pi) = \frac{m - tr(\Pi)}{m - 1}
\]

where \( tr(\Pi) \) denotes the trace of the matrix \( \Pi \). Note that, in contrast to what occurs with \( SM^*(\Pi, \rho) \), this index assigns identical weight to each of the \( m \) classes. Indeed, if \( \rho_j = \frac{1}{m} \) for any \( j = 1, 2, \ldots, m \), it is obtained that \( SM^*(\Pi) = SM(\Pi) \).

\(^{16}\)Given that matrix \( \Pi \) is stochastic and \( N_i > 0 \) for any \( i = 1, 2, \ldots, n \), then \( \rho_j > 0 \) for any \( j = 1, 2, \ldots, m \).
This measure captures those aspects of the mobility concept that refer to the independence with regard to the initial situation. Nevertheless, $SM^*(\Pi, \rho)$ is of limited validity if the aim is to highlight that dimension of mobility that is related to movement \textit{per se}\textsuperscript{17}, since it is calculated exclusively from those elements that form the main diagonal of the transition matrix, thereby ignoring the rest of the elements in $\Pi$. To overcome this problem associated with the use of $SM^*(\Pi, \rho)$, we opted to consider in addition the following index proposed by Bartholomew (1973):

$$BM^*(\Pi, \rho) = \sum_{j=1}^{m} \sum_{k=1}^{m} \rho_{jk} |j - k|$$

The next step is to select an appropriate definition for each of the various classes. Faced with this problem, we decided to adopt a solution that enables us to obtain reasonably accurate information on regional movements across a sufficiently large number of groups, without risking any loss of representativity of the results. Thus, we divided the regions that make up the distribution under analysis into five exhaustive and mutually exclusive classes, according to their per capita income in relation to the European average, which was assigned a value of 100: $[0, 75)$, $[75, 90)$, $[90, 110)$, $[110, 125)$ and $[125, +\infty)$\textsuperscript{18}.

Figure 2 shows the calculations of $SM^*(\Pi, \rho)$ and $BM^*(\Pi, \rho)$ after estimating the corresponding transition matrices. In addition, in order to isolate the effect of transient per capita income fluctuations associated with annual changes, we opted to use in our analysis time periods of different length, thus we were also able to distinguish between short and medium term mobility.

The results obtained reveal that regional per capita income distribution exhibits greater mobility, the longer the time interval taken as a reference. Thus on average, 91% of the regions considered continued in the same class after a year. Taking the period as a whole, however, the percentage drops to 63%.

It is also worth stressing that the two mobility indices considered follow very similar trends. Given that the main difference between them lies in the different valuation given to shifts between classes, this result suggests a relatively low degree of intradistributional mobility\textsuperscript{19}. Further confirmation of this is to be found in the various transition matrices estimated, which exhibit the highest values around the main diagonal\textsuperscript{20}.

Whatever index is used, the empirical evidence presented shows a reduction in the mobility of the EU regional per capita income distribution between 1997 and 1999. Nevertheless, since mobility has not fallen at an even rate over time, it is possible to

\textsuperscript{17}For further details regarding this issue, see Fields and Ok (1999).

\textsuperscript{18}This classification was adopted, for example, by López-Bazo \textit{et al.} (1999) or Cuadrado \textit{et al.} (2002).

\textsuperscript{19}Neven and Gouyette (1995) and López-Bazo \textit{et al.} (1999) reach a similar conclusion for a more reduced geographical area and a shorter time period than considered in this article.

\textsuperscript{20}The medium and full term transition matrices are included in the appendix. The rest, which are not shown for lack of space, are available from the authors upon request.
Figure 2: Regional mobility measured by $SM^*(\Pi, \rho)$ and $BM^*(\Pi, \rho)$, $m = 5$. 
identify a series of separate stages each with its distinguishing features. Thus, the main reduction in $SM^*(\Pi, \rho)$ and $BM^*(\Pi, \rho)$ took place between 1977 and the early eighties. From then onwards, however, there is a change of trend leading to an increase in regional mobility continuing until the end of that decade. During the early nineties, there was a further decrease in regional mobility, which, however, seemed to mark the beginning of a new stage, characterized by a new decline in $SM^*(\Pi, \rho)$ and $BM^*(\Pi, \rho)$\textsuperscript{21}.

In this context, however, it is necessary to stress that the above results cannot be valued normatively without taking into account the degree of inequality observed in the distribution under analysis. In this respect, a large number of studies have coincided in reporting a lack of regional convergence in per capita income in the European context from the mid-seventies onwards [Armstrong (1995), Neven and Gouyette (1995), López-Bazo \textit{et al.} (1999), Rodríguez-Pose (1999), etc.]. The analysis performed in this section, for its part, shows that this maintenance of territorial imbalances has coincided in time with a process of consolidation in the relative positions of the various regions, which stresses the need for an active regional policy at European level \textsuperscript{22}.

Finally, in light of the volatility of $SM^*(\Pi, \rho)$ and $BM^*(\Pi, \rho)$ in short term observations, we performed a preliminary analysis of the relationship between the economic cycle and regional mobility trends in the European context. To this end we estimated the statistical correlation between per capita income growth rates in the EU and annual fluctuations in the two mobility measures considered in this section. We then repeated the exercise incorporating the assumption that economic cycle influences on regional mobility with a lag\textsuperscript{23}. In both cases, however, the correlation coefficients, though positive, were not statistically significant\textsuperscript{24}.

4 A non-parametric analysis of intradistributional mobility

By means of the various tools employed in the preceding section, we have explored the level and evolution of regional mobility in the EU between 1977 and 1999. It is necessary to bear in mind, however, that $SM^*(\Pi, \rho)$ and $BM^*(\Pi, \rho)$ were calculated on the basis of the information supplied by various transition matrices, obtained by dividing the distribution of interest into a series of exhaustive and mutually exclusive

\textsuperscript{21}In order to test the robustness of the above results, we recalculated $SM^*(\Pi, \rho)$ and $BM^*(\Pi, \rho)$ for eight-category classification of the European regions, based on the following per capita income levels: [0,50), [50,75), [75,90), [90,100), [100,110), [110,125), [125,150) and [150,+$\infty$). The results, which are shown in the appendix, are very similar to those we have just discussed.

\textsuperscript{22}Note that, for a given level of inequality, high mobility would be a sign of strong cyclical variability in regional incomes. In this kind of context, regional policy should address the need to mitigate adverse cyclical effects before applying traditional convergence policies.

\textsuperscript{23}In relation to this, see Fischer and Nijkamp (1987).

\textsuperscript{24}Quah (1996b) obtains a similar finding for the United States.
classes. However, since there is no procedure for finding the optimal number of classes in each case, the researcher is obliged to make an arbitrary decision in this respect\textsuperscript{25}.

To address this problem, Quah (1996a, 1997) suggests substituting the transition matrix with a stochastic kernel that reflects the probabilities of transition between a hypothetically infinite number of classes, reducing their size infinitesimally\textsuperscript{26}. The stochastic kernel can be reached by estimating the density function of the distribution over a given period, \( t + k \), conditioned by the values of a previous period, \( t \). Specifically, the joint density function of the distribution at moments \( t \) and \( t + k \) is estimated non-parametrically and normalised by the implicit marginal distribution at \( t \) in order to obtain the corresponding conditional probabilities.

Figure 3: Stochastic Kernel and contour plot of regional per capita income distribution, 1977-1999.

Figure 3 shows the stochastic kernel estimated for the European regional per capita income distribution over a period of twenty-three years (\( t = 1977 \) and \( t + k = 1999 \))\textsuperscript{27}. This three-dimensional graph informs about the probabilities associated with each pair of values in the first and last years of the study period. In other words, the stochastic kernel provides, in a way analogous to that of a discrete transition matrix, the probability distribution of 1999 per capita income for regions with a given per capita income in 1999. The peaks on the graph represent high levels of probability. Thus, if the probability

\textsuperscript{25}In relation to this question, see Kremer \textit{et al.} (2001).

\textsuperscript{26}See Stockey and Lucas (1989).

\textsuperscript{27}Gaussian kernel functions are used in all cases, while the optimal smoothing parameter values have been selected following Silverman (1986, p. 47).
mass is concentrated around the main diagonal, the intradistributional dynamics are characterised by a high level of persistence in the relative positions of the regions over time and, therefore, low mobility. If, on the other hand, the density is located mainly on the opposite diagonal to the main diagonal, this would indicate that regions at each end of the distribution exchange their relative positions throughout the period. Finally, the probability mass could, in theory, accumulate parallel to the \( t \) axis. This would reflect the convergence of regional per capita incomes towards the European average. In order to aid interpretation of the graph, Figure 3 also includes a contour plot on which the lines connect points at the same height on the three-dimensional kernel.

The results obtained fully uphold the conclusions reached in the previous analysis based on the data from the discrete transition matrices. Indeed, as can be seen from Figure 3, the mass of probability is concentrated around the main diagonal. As we are already aware, this shows that there is little mobility in the distribution of regional per capita income between 1977 and 1999. There is a general tendency, therefore, for the European regions to maintain their relative positions throughout the twenty-three years contemplated. By means of this tools we are also able to detect the fact that mobility patterns vary in terms of economic development levels. It is possible to observe, for example, how regions with a per capita income close to the European average exhibit a relatively higher degree of mobility over time, while those located at each end of the distribution are characterized by a stronger persistence in their relative positions. Indeed, the information provided by Figure 3 in this respect confirms that there is comparatively less mobility among more highly developed regions than among regions with low levels of per capita income over the time period considered\(^{28}\).

In light of these results, we completed the above analysis with further data relating to the behavior of the regions situated at each end of the distribution under study, taking these to the ones in which per capita income fell outside the interval of 50 per cent to 150 per cent of the European average. Our calculations revealed that 27 per cent of the regions with a capita income below 50 per cent of the European average in 1977, continued in the same situation in 1999. In fact, of the 22 regions whose per capita income in 1977 was below 50 per cent of the European average, only the Portuguese regions of Norte, Centro, Alentejo, Algarve, Acores and Madeira remained in the same situation twenty-three years later. However, out of the other 16, only the Spanish regions of Aragón, Baleares, Madrid, Cataluña and La Rioja had succeeded in raising their per capita income above 75 per cent of the European average, which is further support for the results obtained earlier. There is a different situation at the upper end of the distribution, however, where out of the 13 regions who began the period with a per capita income above 150 per cent of the European average, only the Swedish

\(^{28}\)In order to test the robustness of the results, we decided to repeat the above analysis using data only for the subperiods 1977-1988 and 1988-1999. The results, shown in the appendix, are very similar to those discussed in this section.
regions of Norra Mellansverige, Mellersta Norrland and Ovre Norrland, together with Valle d’Aosta and Groningen had dropped from that level by 1999, though none of them had fallen below 125 per cent of the European average.

5 Some explanatory factors for regional mobility

To round off the results obtained in the previous sections, we will now investigate the role played by a series of factors in accounting for the observed level of intradistributional mobility in the EU from 1977 to 1999. Our specific aim will be to ascertain why some regions have improved their relative position, while others have worsen over the twenty-three years considered.

Thus, our first step will be to determine which dependent variable to use in the analysis. If, for the study period considered, we wish to use data deriving from one of the various mobility measures calculated in the preceding pages, we will have, at best, only twenty-two values for each index. Needless to say, even if we were willing to consider only interannual mobility, such a degree of freedom would be clearly insufficient for the analysis to be statistically significant. To address the problems surrounding this issue, we opted for the alternative of considering an individual measure of regional mobility, \( \Delta RANK_i(t_0, t_1) \), which assigns to each region its shift in the rank ordering in terms of per capita income over a given period. Under these conditions, it is worth noting that any upward shift in the ranking on the part of one region inevitably means a downward shift of the same magnitude for other regions. That is, \( \sum_{i=1}^{n} \Delta RANK_i(t_0, t_1) = 0 \). Certainly, the use of \( \Delta RANK_i(t_0, t_1) \) will involve some drawbacks that will need to be borne in mind when it comes to making an accurate interpretation of the results of the empirical analysis. The most obvious of these is the fact that this indicator only registers levels of mobility that bring about a change in the ranking of the regions. In other words, if throughout the course of the time period considered there are no changes in per capita income sufficient to cause an alteration in the ranking, \( \Delta RANK_i(t_0, t_1) \) will take a null value for any \( i = 1, 2, ..., n \), in spite of any movement that might have taken place in the distribution. Unlike standard mobility measures, however, \( \Delta RANK_i(t_0, t_1) \) provides information about the direction of regional shifts, so that it is possible to tell which regions have risen and which have fallen in the ranking over time. Likewise, as pointed out earlier, the use of this indicator will increase the robustness of the subsequent analysis, by addressing the problems arising from the lack of degrees of freedom.

Meanwhile, it seems reasonable to assume, at least at first sight, that regional mobility in per capita income terms within the EU will be related with the various regions’ sectoral growth rates in productivity and per capita employment, in the different productive activities: agriculture (\( PRAGR_i(t_0, t_1) \), \( EPCAGR_i(t_0, t_1) \)), industry (\( PRIND_i(t_0, t_1) \), \( EPCIND_i(t_0, t_1) \)), construction (\( PR CON_i(t_0, t_1) \), \( EP CCON_i(t_0, t_1) \)) and services (\( PRSER_i(t_0, t_1) \), \( EPCSER_i(t_0, t_1) \)).
We also examined the role of the initial productive structure in regional mobility. For this, we calculated the agricultural sector’s share in total employment in the initial year for each region \(EAGR_i(t_0)\).

Various articles have highlighted the important role played by the spatial dimension in accounting for the territorial imbalances observed in the EU\(^{29}\). The results of these studies suggest the possible existence of some kind of geographical externality in the European context, in so far as physically adjacent regions tend to have similar levels of economic development. We investigated this issue in this section using two complementary procedures, each involving the definition of different dummy variables. Thus, we first considered the effect on any region of being geographically located next to other regions with per capita income levels above the European average for every year of the time period considered \((EXLEV_i(t_0, t_1))\). In addition, we explored the possibility of there being an externality associated with proximity to dynamic regions, defining the latter as regions with per capita income growth rates above the European average for every year of the study period \((EXRAT_i(t_0, t_1))\).

The model considered to explain observed regional mobility within the EU between 1977 and 1999, therefore, can be written as follows:

\[
\Delta RANK_i(t_0, t_1) = \beta_0 + \beta_1 PRAGR_i(t_0, t_1) + \beta_2 PRIND_i(t_0, t_1) + \\
+ \beta_3 PRCON_i(t_0, t_1) + \beta_4 PRSER_i(t_0, t_1) + \\
+ \beta_5 EPCAGR_i(t_0, t_1) + \beta_6 EPCIND_i(t_0, t_1) + \\
+ \beta_7 EPCCON_i(t_0, t_1) + \beta_8 EPCSER_i(t_0, t_1) + \\
+ \beta_0 EAGR_i(t_0) + \beta_{10} EXLEV_i(t_0, t_1) + \\
+ \beta_{11} EXRAT_i(t_0, t_1) + u_i(t_0, t_1) \quad (10)
\]

Following standard practice in most of the literature devoted to the analysis of regional disparities in the European Union by the estimation of convergence equations, we decided to introduce into the above model national dummy variables. This meant eliminating \(EXLEV_i(t_0, t_1)\) and \(EXRAT_i(t_0, t_1)\) from the analysis, because of problems arising from the high correlation between these two variables and various national dummy variables. In any case, this fact contribute to emphasize the importance of the role played by the national component in explaining the spatial distribution of geographical externalities within the European context throughout the time period contemplated\(^{30}\).

Table 1 shows the estimation results of the proposed model applied to the European case for different time periods. Thus, between 1977 and 1999, sectoral growth in productivity and per capita employment emerge as relevant factors when it comes to finding an explanation for upward shifts in the regional ranking. The only exception in this respect is the agricultural sector, given that neither \(PRAGR_i(t_0, t_1)\) nor \(EPCAGR_i(t_0, t_1)\) are

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\(^{29}\)In relation to this, see Fingleton (1999) or López-Bazo et al. (1999, 2004).

\(^{30}\)In relation to this, see Quah (1996c) and Rodríguez-Pose (1999).
Table 1: Explanatory factors of regional mobility.

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Note: Figures in parenthesis refer to Student’s $t$ statistic. * Statistically significant at the 10 per cent level. ** Statistically significant at the 5 per cent level. *** Statistically significant at the 1 per cent level. Standard errors were calculated by estimating the matrix of variances and covariances using White’s method.
statistically significant. This result suggests that the evolution of the agricultural sector, characterised by the important structural transformation that took place over the last few decades, has had little impact on the dynamics of regional mobility within the European context. This may be mainly due to the limited quantitative significance of the agricultural sector in the greater part of the EU. There is a different situation in the rest of the sectors considered, however. Thus, growth in productivity and per capita employment in industry appear to be positively correlated with regions making upward shifts in the ranking, in spite of the fact that over the period analysed this sector reduced its share in total value added and total employment in the EU. Much the same occurs in the construction sector. In fact, the traditional belief is that trends in the construction sector are closely linked to economic situation. In other words, periods of expansion and recession in the economic cycle tend to have a greater impact in boosting or slowing down activity in this sector. Finally, the growth of the services sector in terms of productivity and per capita employment also helps regions to improve their positions. However, to make a prudent assessment of this result it is necessary to keep in mind the importance of the tertiarization process that has affected most of the European regions over the twenty-three years contemplated.

As far as the role of the initial productive structure is concerned, $EAGRI_i(t_0)$ does not prove to be statistically significant in the model estimation. However, the situation changes somewhat with the introduction of national dummy variables, which enable us to see that regions with a high level of employment in agriculture in 1977 register a downward shift in the ranking over time.

Meanwhile, the dummy variables used to proxy the role played by spatial externalities are also statistically significant. Therefore, proximity to regions that either have a level of economic development or a per capita income growth rate above the European average, has a positive impact on regional mobility.

In order to check for any possible variations in behavior patterns over time, we will now consider a series of subperiods within the overall sample period. Thus, Table 1 also shows the results of the estimation of the previous model for different subperiods, namely, 1977-1988 and 1988-1999. At first sight, these two subperiods did not appear to exhibit any significant deviation from the sample period as a whole. However, the results of a series of statistical tests led us to reject the hypothesis that the estimated coefficients are the same for any time period. Nevertheless, the conclusions that can be drawn for the 1977-1988 subperiod differ little from those discussed above for the sample period as a whole. In particular, the growth of agricultural productivity appears to have a negative impact on $\Delta RANK_i(t_0, t_1)$ over that twelve years. Once dummy variables are introduced, however, $PRAGR_i(t_0, t_1)$ is no longer statistically significant. Likewise, regions in which agriculture accounted in terms of employment for a relatively

31 Readers interested in this question can find an account of the process of structural change that has taken place in the EU over the last decades in Paci (1997) and Gil et al. (2002).
large share in the economy in 1977, meanwhile, tend to fall in the ranking during this subperiod, independently of whether the analysis includes national dummy variables or not. Furthermore, in contrast to what occurs in the sample as a whole, geographical proximity to regions with per capita incomes above the European average does not contribute to explain the observed mobility of European regions between 1977 and 1988.

For the 1988-1999 subperiod, we introduced a minor modification into the model estimated so far, in order to make a preliminary examination of the relationship between EU regional policy and observed intradistributional mobility. This meant introducing a further dummy variable, $RO1_i$, to enable us to identify all those regions classified as Objective 1 in any of the programming periods$^{32}$. Thus, we will be able to see whether regions that received priority treatment under EU regional policy show a different pattern of behavior from the rest. In this respect, the information displayed in Table 1 suggests at first sight that $RO1_i$ is unrelated to variations in the dependent variable. If, however, national dummy variables are included in the model, Objective 1 regions can be seen to have suffered an overall deterioration in their situation with respect to other regions over this twelve year subperiod, despite having received the large amounts of grants from the EU. Caution must be exercised when evaluating this result, however. On the hand, it is worth recalling that the works of Boldrin and Canova (2001) and Rodríguez-Pose and Fratesi (2004) coincide in reporting very little mobility among the less developed European regions during the nineties$^{33}$. It would be too bold, however, to base our evaluation of a phenomenon as complex as the relationship between EU regional policy and the dynamics of Objective 1 regions over the last decade exclusively on the results of an analysis of this type.

Finally, with respect to the rest of the explanatory variables included in our analysis, the main differences between the results for the 1988-1999 subperiod and those of the period as a whole, without using national dummy variables, are that $EAGR_{i_{(t_0)}}$ had a positive impact on regional mobility during that twelve-year subperiod. Furthermore, $EXRAT_{i_{(t_0,t_1)}}$ is not statistically significant. In other words, no kind of connection can be made between shifts of the regions in the ranking and geographical proximity to regions with levels of economic growth above the European average between 1988 and 1999.

6 Conclusions

In this article we have examined mobility in the regional distribution of per capita income in the EU between 1977 and 1999 from several complementary perspectives.

$^{32}$Recall that Objective 1 regions became a key element in EU regional policy following the 1988 reform in the Structural Funds.

$^{33}$Among the obvious exceptions to this general trend, we might mention Southern and Eastern in Ireland or the Abruzzi in Italy, for example.
We began by calculating a wide range of measures based on the literature devoted to the dynamic analysis of personal income distribution. Our results show a decrease in mobility within the distribution under study over the period of observation. A further feature of note is relatively low level of intradistributional mobility. This conclusion is in fact confirmed when stochastic kernel and contour plot are estimated for a series time intervals of different length. With only a few exceptions, the European regions have therefore tended to maintain their positions in the ranking over the twenty-three years considered. All of this underlines the need for the EU to reinforce its regional development policies.

Our results also show that regional mobility patterns vary as a function of economic development. In fact, the regions with a per capita income close to the European average tend to register a relatively higher mobility degree over time, while those at either end of the distribution are characterised by a stronger persistence in their relative positions. However, less developed regions show greater mobility than regions located at the upper end of the distribution.

Finally, we carried out a regression analysis to try to identify some of the explanatory factors in European regional mobility. Results for the 1977-1999 period indicate that improvements in the ranking are directly related to the growth of productivity and per capita employment in industry, construction and services. When national dummy variables are introduced into the analysis, however, there appears a link between high employment in agriculture in the initial year and a region subsequently falling back in the ranking. Upward shifts of regions in the ranking, meanwhile, are linked to their geographical proximity to regions with levels of development and/or per capita income growth rates above the European average. This adds further weight to the importance of the spatial factor in this context. Finally, according to the results obtained, in general there was no overall improvement in the relative situation of Objective 1 regions during the 1988-1999 subperiod, despite their having received priority treatment under EU regional policy.

References


Rodríguez-Pose A, 1999, “Convergence or Divergence? Types of Regional Responses to Socio-Economic Change in Western Europe” Tijdschrift voor Economische en Sociale Geografie 90 363-378.

Appendix

The 197 territorial units considered in this paper are as follows:
Belgium: Bruxelles-Brussel, Antwerpen, Limburg, Oost-Vlaanderen, Vlaams Brabant, West-Vlaanderen, Brabant Wallon, Hainaut, Liège, Luxembourg and Namur. Denmark. Germany: Stuttgart, Karlsruhe, Freiburg, Tübingen, Oberbayern, Niederbay-

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Figure A1: $R^*(\hat{x}, x', \bar{p})$ index, 1977-1999.


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Figure A2: Regional mobility measured by $SM^*(\Pi, \rho)$ and $BM^*(\Pi, \rho)$, $m = 8$. 
Figure A3: Stochastic kernel and contour plot of regional per capita income distribution, 1977-1988.

Figure A4: Stochastic kernel and contour plot of regional per capita income distribution, 1988-1999.

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