Economic Modelling 26 (2009) 733–739

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/econbase

Structural shifts in the dynamics of the European income distribution ☆

María Hierro *, Adolfo Maza

Department of Economics, University of Cantabria, Av. Los Castros s/n, 39005 Santander, Spain

ARTICLE INFO

Article history:
Accepted 6 February 2009

JEL classification:
O15
O18
C21

Keywords:
Intra-distribution dynamic
Non-stationary transition probabilities
Causative matrix model
Structural shift
European regions

ABSTRACT

This paper aims to evaluate structural shifts in the regional per capita income distribution in Europe between the periods 1980–1993 and 1993–2005. After a brief analysis of several aspects of the distribution (inequality, external shape, polarisation and spatial dependence), we focus on intra-distribution dynamics by applying a novel causative matrix model that reveals strong structural shifts. In particular, increase in relative persistence during the second period has been the major change, especially for regions around the average and those at the upper end of the income distribution.

1. Introduction

There has been abundant literature on per capita income distribution in the European Union (EU) over the last few decades, with particular emphasis on spatial mobility and regional income disparities as linked to the process of regional convergence (López-Bazo et al., 1999; Magrini, 1999; Cheshire and Magrini, 2000; Fingleton, 2003; Le Gallo, 2004; Maza and Villaverde, 2004; Ezcurra et al., 2005, 2006a; Ertur et al., 2006). Part of this empirical literature has focused, additionally, on the existence of convergence clubs or multiple equilibria, being especially interesting some papers that employ novel techniques, such as Canova (2004) and Funke and Niebuhr (2005).[1]

Whatever the approach adopted, a relevant portion of this research has emphasized the need for capturing intra-distribution dynamics, since the relative positions of regions can change over time. In fact, according to Quah (1997), movements within a particular distribution are more important than changes in its external shape. As a result, key theoretical and empirical advances have been made over the last decade in the study of intra-distribution dynamics, trying this paper to continue in this direction.

The most popular advance has been the distribution dynamics approach based on computing the well-known transition matrices (Quah, 1993, 1996).[2] However, although this methodology is informative, it is not without problems. The primary drawback is the arbitrary nature of selecting the partition of the distribution, that is, the per capita income states[3]; in fact, the results obtained by using this approach depend critically on the number and length of the intervals considered for the distribution. In addition, another commonly forgotten drawback is the assumption that per capita income distribution can be modelled by a Markov process with stationary transition probabilities; that is, a region's likelihood of transiting from one income state to another is the same for today as for tomorrow. Therefore, Quah's methodology does not consider the possibility of time-dependent transition matrices.

Consequently, papers following the above approach have implicitly ignored (to the best of our knowledge) the possibility of changes in the intra-distribution dynamics. This is the main issue of the present study. The objective of this paper is to analyse the EU per capita income intra-distribution dynamics and explore what main shifts have occurred at the regional level since the 1980s; in doing this, we allow for time-dependent transition matrices.

The originality of this paper lies in the type of model we use for that purpose: the causative matrix model. This is a novel non-stationary Markov chain approach in income distribution literature that supposes, contrary to the spirit of Quah (1996), that the probability of a given

☆ The authors wish to thank two anonymous referees for their valuable comments and suggestions.

* Corresponding author. Tel.: +34 942 202228; fax: +34 942 201603.
E-mail address: maria.hierro@unican.es (M. Hierro).

[1] This last paper does not analyse EU but West Germany regions. There are also other interesting papers that focus only on regions of a specific EU country, as for example Funke and Strulik (1999), Tortosa-Ausina et al. (2005), Villaverde (2006) and Hierro and Maza (forthcoming).

[2] The stochastic kernel approach has also been used to deal with this issue, as can be seen in papers such as López-Bazo et al. (2005) and Maza and Villaverde (forthcoming).

[3] According to Mora (2005), "the best criterion for discretising Markov chain states, as well as identifying the ideal number of states, needs to be established beforehand".

0264-9993/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.econmod.2009.02.003

region moving to an income state j from an income state i may change over time; in other words, the model permits time-dependent transition matrices. Through this analysis, we can obtain insight into changes occurred in relative mobility and relative persistence and, as another added value of such an approach, a stability measure to assess the amount of change in intra-distribution dynamics.

The data employed in this study consist of relative per capita income (Gross Added Value) in Purchasing Power Standards (PPS) of 196 European regions (NUTS2)[4] for the period between 1980 and 2005; these are regions belonging to the fifteen-member EU (EU-15).[5] Although there are merits to using absolute per capita income values, it is more usual in the literature on income distribution to take relative variables, in this case regional per capita incomes normalised by the European average (EU-15 = 100). This is because relative values allow us to correct for the effects of business cycles and trends in the European average income. The periods to be compared are from 1980–1993 and 1993–2005. We have chosen these two periods for several reasons. First, data availability; second, they are periods of similar length; third, the economic growth rates in Europe during these two periods are quite different: the former registered a relatively slow growth (an annual rate of 1.67% in the EU-15) while the latter recorded a much faster rate (2.21).

The remainder of the paper is organised as follows. In Section 2, as a starting point for later analysis, we present a brief overview on the dynamics of the EU income distribution at the regional level from 1980–2005. To do this, we only refer to years 1980, 1993 and 2005. In Section 3, we examine shifts in intra-distribution dynamics between the 1980–1993 and 1993–2005 periods using a causative matrix model. This approach, while already employed in other topics, is original in their use of income distribution analyses. Finally, in Section 4, we summarize our main conclusions.

2. Changes in the EU income distribution: some preliminary insights

We start our study by investigating how the European regional per capita income distribution changed over the period 1980–2005. For simplicity, and considering that the posterior analysis will cover the periods 1980–1993 and 1993–2005, we only examine the years 1980, 1993 and 2005 in what follows.

2.1. Regional inequality

First, we study the evolution of per capita income disparities across the European regions. Since there is no accepted best measure of income inequality, we consider here the most commonly used inequality indicators: the coefficient of variation (CV), the Gini index (G) and two versions of the Theil index ($T(0)$ and $T(1)$). All indices are independent of both scale and population size, and each fulfils the Pigou–Dalton transfer principle (Cowell, 1995).

Results from applying the above mentioned inequality measures are shown in Table 1. Two main conclusions can be drawn for the targeted years. First, the European regional inequality strongly declined between 1980 and 1993 regardless of the chosen index. Second, income inequality reached levels in 2005 similar to those in 1993, clearly indicating stagnation in the convergence process.

2.2. Regional per capita income distribution

Another approach for examining changes in the income distribution is to compute non-parametric kernel densities. To this end, we use a Gaussian kernel with optimal bandwidth according to Silverman's rule-of-thumb (Silverman, 1986). Fig. 1 plots the distribution of the European relative per capita income distribution for years 1980, 1993 and 2005. As the figure shows, shifts in the external shape of the distribution occurred between 1980 and 1993. More specifically, the income distribution strongly moved to the average values in this period. In addition, the long tail at the upper end of the distribution that existed in 1980 has disappeared in 1993. As it is intuitively obvious that multiple modes exist, we have identified them following the proposal by Salgado-Ugarte et al. (1997). The main mode in 1980 was located at 74.8% of the European average, while in 1993 it was at 94.1%; in addition, the European per capita income distribution displays a second mode in 1980 (137.1) and three additional modes in 1993 (62.7, 139.2 and 178.1).

Table 1
Inequality measures.

	CV	G	$T(0)$	$T(1)$
1980	0.552	0.290	0.155	0.135
1993	0.284	0.156	0.041	0.041
2005	0.269	0.146	0.035	0.034

However, several minor differences can be found when comparing the 1993 and 2005 per capita income distributions. First, the concentration of the distribution around its mean was slightly higher in 2005 (with the main mode at 93.5% of the average) than in 1993. Second, the mode around half the average existing in 1993 became much smoother in 2005, while additional small modes appeared in the upper extreme of the distribution (152.3 and 186.9).

2.3. Polarisation degree

Another important feature of income distributions (and closely related to the previous features) is the degree of polarisation (see, for example, Duró, 2005; Ezcurra et al., 2006b). Generally speaking, the polarisation of any regional income distribution reflects the degree to which regions cluster around a series of income poles (intervals of income). Following Esteban et al. (2007), the polarisation measure (EGR) can be expressed as[6]:

$$\mathrm{EGR}(\alpha,\beta)=\sum_{i=1}^{n}\sum_{j=1}^{n} p_i^{1+\alpha}\cdot p_j\cdot\left|\frac{y_i}{\mu}-\frac{y_j}{\mu}\right|-\beta\cdot(G-G_S), \qquad (1)$$

where α is a parameter denoting the degree of sensibility of the index to polarisation — by construction it takes on values between 1 and 1.6; p_i and p_j are the relative population sizes of groups i and j; y_i and y_j are the average per capita income of both groups; μ is the European average per capita income; β is a parameter reflecting the sensitivity of the index to the groups' level of cohesion; G and G_S are the Gini coefficients of the original and grouped distributions, respectively; and n is the number of groups or income poles considered.

Several points should be taken into account when computing the polarisation index. First, the number of groups needs to be considered; here we consider from 2 to 4 groups. Second, the demarcation between different groups needs to be addressed; to this end, we used the algorithm proposed by Davies and Shorrocks (1989). Third, the value of α must be determined; due to the lack of consensus on this issue, we have chosen values of 1 and 1.5. Fourth, the value of β must also be determined; in this case, there is general agreement that this parameter should be close to 1, so we have chosen $\beta=1$ (Esteban et al., 2007).

Taking these considerations in mind, Table 2 displays the results obtained after applying Eq. (1). Three main conclusions can be drawn when polarisation indices are compared. First, between 1980 and 1993, there was an intense decrease in the degree of polarisation within the regional European per capita income distribution,

[4] Although NUTS2 regions vary considerably in size, they are considered to be the most appropriate spatial units for carrying out economic analyses (Fingleton, 2001).

[5] Data is drawn from the Cambridge Econometrics regional database. The entire list of European regions considered in this paper is shown in the Appendix A.

[6] This index is an extension of the polarisation measure proposed by Esteban and Ray (1994).