Exploring Shorrocks Mobility Indices Using European Data*

Paul Gregg and Claudia Vittori†

February 2009

Abstract

Starting from the approach proposed by Schluter and Trede (2003) we develop a continuous and alternative measure of mobility which first, allows to identify mobility over different parts of the earnings distribution and second, to distinguish between mobility that tends to reduce or increase the level of permanent inequality.
This paper focuses on four European countries, Denmark, Germany, Spain and the UK. In a global perspective, mobility tends to equalize the level of inequality over a six-year period. Six-year changes comparing the average between 1994 and 1995 with the average of 2000 and 2001, suggest that Denmark has the highest mobility mainly from higher mobility at the middle and top of the distribution. Germany has the lowest overall mobility. Overall mobility over six years produces only a modest reduction in inequality patterns (5 to 10%) adopting the Gini index and there is no clear correlation between mobility and inequality levels. Exploiting the decomposability of the mobility index developed, we carry out a local analysis by earnings quintiles which draws some general key facts. It emerges that it is the bottom 20 percent of the earnings distribution that makes the largest contribution to the global mobility pattern and that mobility, with the exception of Denmark, does not lead to clear convergence to the mean but at points around 0.7-0.8 and 1.5 to 2 times the mean.

Key Words: Earnings, mobility, inequality
JEL Classification: D31, J31, J60.

*Claudia Vittori would like to thank the ESRC and the University of Rome La "Sapienza" for financial support.

†The authors are affiliated to the University of Bristol. Correspondence: P.Gregg@bristol.ac.uk, claudia.vittori@bristol.ac.uk.

1 Introduction

Measures of earnings or income mobility assess the extent to which individuals or families are moving in the earnings/income distribution between two periods. The degree of movement over time has an absolute component, how much income has changed and a relative component reflecting how far the individual has to travel to move to the average person. Hence mobility is affected by the level of inequality, reflecting the distances between individuals. When mobility takes place the contribution that an individual makes to overall inequality will change. So whilst inequality and mobility are quite distinct concepts, they are closely related to each other and they often tend to be confused in public economic discussions, Gottschalk (1997). There is a large and well known literature on inequality and an array of inequality measures has been developed. There is also a reasonably large array of mobility measures (see Atkinson, Bourguignon and Morrisson 1992, Maasoumi, 1998, Solon, 1999, and Fields and Ok, 1999) and this literature often produces a confusing set of somewhat contradictory results which hampers the drawing of clear conclusions. Each measure of mobility analyses "different underlining entities" (Fields, 2007) therefore it is of extreme importance that an analyst adopts an index of mobility according to the specific concept he intends to study. Recently Ayala and Sastre (2008) find that "Cross country income mobility comparisons largely depend on the type of indices used". Measures of mobility can be summarized into two categories: measures of time independence and measures of movements.[1] The former category particularly adopted in the intergenerational framework, explores the extent to which the current income is related to lagged income (beta coefficient in the log regression or partial correlation coefficient). The second category seeks how much income movement has taken place between one year and another (or in the intergenerational framework between parents and children).

This paper aims in part to focus the attention on those measures of movements that tend to affect inequality over a longer-term period[2] So the concept of mobility we are interested in is mobility as a source of equalization of longer term income. We will study this concept starting from the class of measures introduced by Shorrocks in 1978 and generalized by Maasoumi and Zandvakili (1986). This class, also called stability indices, has generated particular attention in literature firstly because they act as a natural bridge between the inequality and the mobility framework and second because of their global nature. They allow an assessment of mobility as a summary of the contribution of all individuals in the distribution rather than those that cross arbitrary boundaries as in the transition matrix approach. [3]

[1] For an extensive discussions see Fields 2007.)

[2] Within this class there are measures of positional movement, share movement, non-directional and directional movement.

[3] From now on we will refer to the Shorrocks index to mean the class of indices of

Whilst this index has clear advantages over the transition matrix approach, it also presents some drawbacks. Its limitations come in part from its global nature, which whilst an asset suffers from a lack of decomposability to show where in the distribution and for whom mobility occurs. Furthermore, a range of possible inequality measures on which the index can be based lead to a lack of clarity about mobility across countries or across time, as emerging patterns vary across these alternatives. For such reasons the analysis of the Shorrocks measure has often been matched in literature with more standard techniques such as transition matrices and/or other mobility indicators with the aim of providing a more consistent picture of mobility (OECD, 1996). Schluter and Trede (2003) point out that whilst the alternative Shorrocks indices are global measures of mobility, as equalization of longer term incomes over time, they summarize the mobility of each individual in the distribution with different weights according to where the person lies in the distribution. Thus they show that Shorrocks Indices can be approximated within a Kernel Density approach, that shows the extent to which mobility is occurring in any part of the distribution.

This paper has two main aims, to explore the potential of the Shorrocks based indices and the Schluter and Trede approximation so as to arrive at a useful global measure of mobility, as equalization of permanent inequality, which shows mobility patterns across the distribution of earnings inequality. Second the paper applies this to explore mobility patterns across European countries and to overcome the lack of clarity due to alternative measures to create a clear set of stylized facts about mobility across a number of European countries. Section 2 provides a review of the literature on Shorrocks indices and evidence of mobility patterns across countries. Section 3 gives a technical discussion of the Shorrocks Indices and the Schluter and Trede decomposition. Section 4 discusses the data used and Section 5 explores these approaches using data from four European countries.

2 Literature Review

Over the last 35 years or so a number of developed countries like US and UK have seen sizable increases in earnings inequality which has contrasted with many other, mainly European, OECD countries. A number of studies have complemented the analysis of inequality with analysis of mobility mainly to investigate these differences across countries and whether inequality differences are substantially offset in the longer-run by mobility differences. The general evidence is that despite different inequality patterns, similar and substantial levels of mobility prevails across countries. An OECD study suggests

Shorrocks based on different inequality measures. This index as we will discuss in the technical section is just able to spot mobility that tends to reduce the level of permanent inequality.

that Denmark, the UK, the US and Finland have somewhat higher rates of earnings mobility than France, Germany Italy and Sweden but "the overall picture is nevertheless one of considerable similarity", (OECD 1996). [4]

In Spain over a span of eight years starting from 1985, Canto'(2000) finds a strong trade-off between income inequality and mobility. Income mobility was increasing until the end of 1989 while inequality was decreasing and for the rest of the period a decrease in mobility was associated with a stagnation in inequality. The author analyses the Shorrocks stability index in order to investigate this link. The analysis is based on short-run comparisons (mobility from one year to the following) and the results of the measure turn out to differ depending on the index of inequality adopted. For instance in the analysis of yearly income, mobility seems to reduce inequality by 5 percent using the Gini index, while using an index sensitive to the observations at the bottom of the distribution (the Theil index), this effect is more or less doubled (11 percent of inequality reduction). Furthermore, the global index is not able to address the question of where mobility occurs in the distribution. To address the latter question the author adopts the immobility ratio (Lillard and Willis, 1978 or Gottoshalk, 1982), this measure indicates the percentage of movers by quintiles, deciles and thus shows different mobility levels across deciles.[5] More persistence in the income in Spain is found at the poorest and the richest deciles.

A contribution on mobility in Britain was given by Jarvis and Jenkins in 1998. The analysis is focused on the first four waves of the BHPS. They adopt different methods: transition matrices, longitudinal income associations with the Pearson correlation coefficient and finally the Shorrocks stability index to explore the link between longitudinal mobility and reduction in longer-period income inequality. They use a range of five different inequality indices from the bottom to the top sensitive ones and the inequality reducing impact appears to be very small for the middle sensitive indices. In fact over the first two years of the panel, mobility reduces inequality by just 5% adopting the Gini against a reduction of 13% using the Theil. Their results suggest that measures that focus on the tails of the distribution show greater mobility compared to the situation in which more weight is given to the observations around the mean. In the short run analysis the inequality reducing impact of income mobility from the first to the second wave of the panel seems to be pretty similar to the results obtained by Canto' for the Spanish dataset.

Burkhauser and Poupore (1997), compare permanent inequality in US and Germany. They analyze the Shorrocks index based on individual data containing retrospective information of full-time labour earnings (after and

[4]Results on mobility are mainly based on transition matrix analysis while results on inequality are obtained using measures of earnings dispersion such as deciles ratios.

[5]the measure of Shorrocks based on the information on the diagonal of the transition matrix $M = [n - trace(P)]/(n-1)$ (Shorrocks, 1978b) indicates the percentage of people who changes decile

before government taxes and transfers) from 1983 to 1988. Basing the analysis of the Shorrocks index on the inequality index of Theil, they suggest that the degree to which mobility reduces inequality is bigger in Germany than in US, for all time periods. A six years estimate suggests 24 percent of inequality reduction for Germany and just 10 for US.

Divergent results on the mobility reducing effects on inequality are found also by Hofer and Weber in 2002 in the analysis of wage mobility in Austria. They adopt different measures starting from the traditional transition matrix analysis to the Shorrocks mobility measure. In analyzing the Shorrocks stability index they compare their results with the ones by OECD (1996,1997). The Shorrocks measure is calculated adopting the inequality indices of Gini, Theil and Mean log deviation. The percentage reduction in single year wage inequality when wages are averaged over the span 1986-1991 is around 8.2 percent for the mean log deviation for annual wages of all continuously employed workers but takes a value of 3 percent for the Gini index.[6] They suggest that Austria shows a weak equalizing effect on wage mobility compared to Denmark, France Germany, Italy, UK and US but they conclude that "excepting the Austrian case, country rankings in this panel depends on the chosen inequality index and there emerges no clear picture which countries are the most mobile or most immobile ones".

Aaberge at al. in 2002 compare mobility over ten years (1980 to 1990) between Scandinavian countries and the United States respectively placed at the top and at the bottom in terms of equality. They adopt the Shorrocks stability measure based on the Gini inequality index. They suggest that mobility of earnings turns out to be lower in US than in the Scandinavian countries (6.5% for US, 7.3% for Sweden, 8% in Denmark and 6.9% in Norway), by contrast mobility of market and disposable income appears to be higher in the US (9.7 and 9.2 percent) than in Denmark (7.6, 7.8 percent) despite this the US is by far the most unequal country. To assess the similarity of the pattern of mobility across countries at different parts of the earnings distribution, given the very different levels of inequality, the authors resort to a micro-level analysis based on the changes in relative income by the 25th, 50th and 70th quintile for each of the countries.[7]

From all the studies of mobility mentioned a general lack of clarity from the results of the Shorrocks stability indices. This is due to different parts of the distribution contributing differently to the alternative global mobility indices so that there is widespread use of other tools. Hence whilst Shorrocks Indices are useful measures of summary statistics of mobility there is a need for them to be easily decomposable into the building blocks which show the contributions of absolute and relative mobility, and where in the distribu-

[6] for the mean log deviation Denmark shows 19.7, France 19, Germany 22.3 and Italy 26.6 percent of inequality reduction.

[7] $d_{i,t-1,t} = \frac{y_{i,t}}{y_t} - \frac{y_{i,t-1}}{y_{t-1}}$ where $i = 1, ..n$ is the individual

tion mobility is occurring. Schluter and Trede in 2003 offer an advance lease. They show that the class of mobility measures of Shorrocks (1978a) can be approximated with a continuous form, revealing the extent to which each part of the distribution contributes to the global mobility measure and how the alternative versions of this index, based on different inequality measures, stem from an implicit weighting of the contribution of parts of the distribution. It is these differences in the weights used which lead to the lack of clarity of mobility patterns across countries or across time (this explained more fully in the next section).

3 Technical discussion on the Shorrocks indices

The stability index introduced by Shorrocks (1978a) and generalized by Maasoumi and Zandvakili (1986) explores a specific concept of mobility. For any given inequality index the measure indicates the degree to which lengthening the accounting period tends to reduce the level of inequality over a longer term period. The index compares long-run or "permanent" inequality measured over several periods with a weighted sum of single-period income inequalities.
Let's focus the analysis on the two years case. Let Y_1 and Y_2 be the random variables of the "personal income received in period" $t = 1, 2$, drawn from the marginal distributions F_1 and F_2. $G = (F_1 + F_2)/2$ is the time-averaged income over the two years[8] expressing the distribution of longer-term income. $\lambda = \mu(F_1)/[\mu(F_1) + \mu(F_2)]$ and $(1 - \lambda)$ are the weights attached to the single period inequalities with $\mu(F_t) = \int y dF_t(y)$ mean of the distribution F_t;

$$m = \frac{I(G)}{\lambda I(F_1) + (1 - \lambda) I(F_2)} \tag{1}$$

m is a measure of "longer-term" inequality over two periods expressing the degree of inequality that is still present in the distribution once the period is lengthened. Therefore m is an indicator of the rigidity of the income distribution. The associated mobility index is its complement to one and measures the inequality reducing impact of income mobility:

$$M = 1 - \frac{I(G)}{\lambda I(F_1) + (1 - \lambda) I(F_2)} \tag{2}$$

Mobility will be higher if more inequality has been reduced looking at a longer rather than a short term period. If extending the accounting period removes all the original inequality, the index will take the maximum value of 1. By

[8] G might as well be defined as the inequality of total income over the periods considered since I is scale invariant. F_1 and F_2 are referred to the same individuals so for the analysis of the index there is need for a panel dimension.

contrast the state of no mobility will occur if inequality over a longer period equals the original single year inequality, in which case the index will assume the minimum value of 0.[9] For instance a value of M equal to 0.10 indicates that over a span of two years, mobility has reduced inequality by 10 percent. The analysis of this index allows us to understand whether in a given society income inequality will be partly offset by the presence of income mobility. If this is the case, a country who experiences high levels of single year inequality associated with high level of mobility, will tend to assume a more equal picture in a longer-term perspective. Jarvis and Jenkins (1998) stress that inequality is more tolerable if accompanied by mobility because it tends to smooth transitory variations in income, so that permanent inequality is less than observed inequality. The study of short and long run inequality and the degree of movements that affect the level of inequality (through the index of Shorrocks) over time gives a more complete understanding of the income distribution. This and its conceptual simplicity are some of the reasons why the stability index has been widely used in literature[10], although there are also some drawbacks that need further investigation.

- First of all, the estimates of M are strictly dependent on the choice of the inequality index $I(.)$ used. The inequality measures vary in their sensitivity to incomes in different parts of the distribution, therefore using a top sensitive index rather than a middle sensitive one can possibly lead to different mobility results.[11]

- Second, the mobility measure M is not informative about how local income changes are aggregated into the single index number; and whether the mobility measure M inherits its welfare properties from the inequality index on which it is based.

The first point tells us that we need to justify the choice of the inequality index we are going to adopt in the measure of Shorrocks. This is because we will implicitly tend to give more importance to the movements in the distribution of some groups of people rather than others. Consequently they may tell a different story of mobility. The second point is related to the kind of information the index contains. It summarizes local changes into a global

[9]The index exploits the fact inequality over a longer term period can never exceed the weighted sum of single year inequality: $G \leq \sum_{t=1^T} \frac{\mu_t}{\mu_1+\ldots\mu_T}$ (Rao, 1996) and the underlying logic is that multi-period inequality smoothes out temporal fluctuations unless the cross-section distributions are identical over time.

[10]see review section

[11]The mean log deviation, the Theil index, and half the coefficient of variation squared are members of the Generalized Entropy (GE) family of inequality indices $I(\alpha)$ with $\alpha = 0, 1$ and 2 respectively. In general larger values of alfa correspond to greater sensitivity to income differences at the top of the income distribution rather than the bottom. The Gini coefficient does not belong to this family, but is known to be relatively sensitive to income differences in the middle (mode) of the distribution. Details on each index are provided in the Appendix.

scalar according to some rules (given by the inequality measure adopted). This seems to be a step forward to the classical transition matrix techniques for which it is not possible to assess a global summary, but on the other hand the index lost one of the nice features of these techniques e.g. the possibility of understanding where mobility occurs in the distribution. Another limit of this index is that it does not adequately distinguish between income changes that tend to have equilizing or disequalizing effects over a longer-term period. This weak point has been highlighted by Benabou and Ok (2001) and widely discussed later by Fields (2007).[12] Fields (2007) recently proposed an alternative form of the Shorrocks index that compares inequality over a longer term period with inequality of the base year rather than with an hypothetical path $\lambda I(F_1) + (1-\lambda)I(F_2)$[13], thus under the assumption of $\lambda = 1$. In this way the measure of Shorrocks is able to explore both mobility that tends to be equalizing and disequilizing in a longer term perspective, although it is still showing the drawbacks of the class of Shorrocks indices early discussed.

$$\varepsilon = 1 - \frac{I(G)}{I(F_1)} \tag{3}$$

The index 3 has a threshold of zero and it will assume positive values if longer term incomes are more equal than base year incomes, while negative values will imply the opposite.
In the next section I will introduce a continuos and alternative form of (3) starting from the method developed by Schluter and Trede (2003)[14]. This approach will help in the understanding of the results an analyst can expect from applications of the measure () and more in general of the class of stability indices of Shorrocks. The contiunuos approach will also allow to put forward a local analysis of mobility.

3.1 A continuous approach for the analysis of mobility

In this section I will introduce a continuous form of the Shorrocks measure as expressed by Fields (eq.3) and then I will explore step by step how the index is built up.

The alternative expression of 3 adopting a continuos approach, is the following:

$$M_1 = \int w_M(x; I, F_1)(F_1(x) - G(x))dx. \tag{4}$$

where x is the vector of incomes of a sample of n individuals followed over time, $I(.)$ is the inequality index and $F_1(x)$ and $G(x)$ are respectively the kernel density of the distribution of the reference year and the one obtained

[12] the index of Shorrocks does not satisfy the equalization properties.

[13] As in the classical measure of Shorrocks M, see eq.2

[14] Schluter and Trede (2003) develop a similar approach as alternative to the classical measure of Shorrocks M (2)

as an average of the marginal distributions $F_1(x)$ and $F_2(x)$. The term $w_M(x; I, F_1)$ reflects the dependence of the mobility index on the inequality index and is of the form:

$$w_M(x; I, F_1) = \frac{IF(x; I, F_1)}{I(F_1)} \tag{5}$$

where $IF(x, I, F)$ is the influence function of the inequality index $I()$ that measures the sensitivity of the inequality index to point x.

$$IF(x, I, F) = \frac{d}{d\epsilon}(I(F + \epsilon(1_x - F)) \mid_\epsilon = 0 \tag{6}$$

where $1_x(z)$ denotes a point mass distribution at x, i.e., $1_x(z) = 1$ if $z \geq x$ and $1_x(z) = 0$ otherwise.[15] The weighting function changes according to the inequality index on which it is based (which can more or less sensitive to the bottom, middle or upper tails) and is inversely proportional to the inequality index thus weighting function of a high inequality ranked country will be lower for any x than the weighting function of a low inequality ranked country. The mobility index M_1 is therefore an *integrated weighted local distributional change*. It is graphically representable and reveals exactly the contribution to the global index of each part of the distribution.[16] The weights $w_M(x; I, F_1)$ are the expression of inequality and are attached to the term $(F_1(x) - G(x))$ indicating the movements of the individuals over time from one year to another in the distribution in exam. The distributional change term $(F_1(x) - G(x))$ can be simply considered a measure of absolute mobility as distance between the base single year income and the longer-term income. It measures the change of the population at any point in the distribution considered, as the functions $F_1(x)$ and $G(x)$ and are respectively the kernel estimates of the the reference distribution and the time-averaged distribution. The combined effect of these two components, the weights and the distributional change term, generates the measure of mobility as equalization or disequalization of longer term incomes M_1 (4). This measure compared to the discrete expression (3), retrieves one important characteristics of the

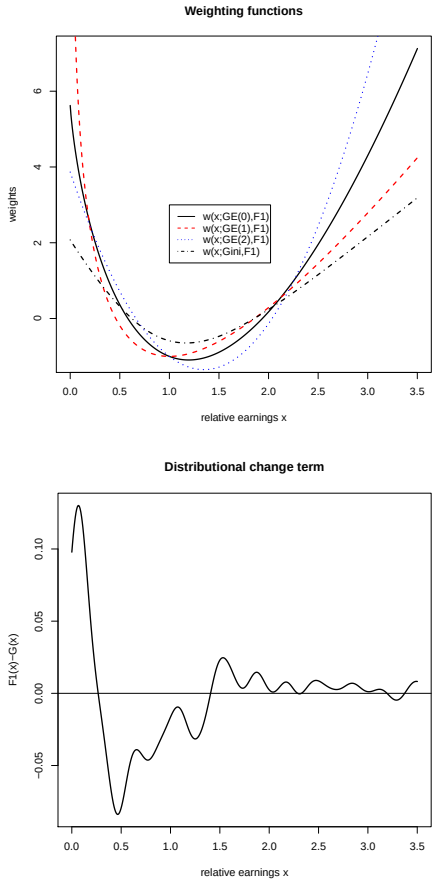
[15]The influence function $IF(x, I, F_1)$ represents the relative variation of the inequality index I caused by the infinitesimal variation of the value of the distribution function F in x (Monti, 1991).

[16]Schluter and Trede propose a measure an alternative and equivalent form of the generic index of Shorrocks (2) in which mobility is expressed in terms comparing longer term income with a distribution $H(x) = \lambda(F_1) - (1 - \lambda)(F_2))$ that is a mixture of the two marginal distributions $F_1(x)$ and $F_2(x)$:

$$M = \int w_M(x; I, H)(H(x) - G(x))dx. \tag{7}$$

In general the specific choice of H and G is governed by the aspect of mobility that one seeks to implement. It is the benchmark case that determines H, while G will be determined by the actual mobility process (Schluter and Dirk Van de gaer, 2003).

transition matrix approach, but as a step forward can spot mobility within boundaries and even more so in each point of the distribution. This is an important advance as now the global mobility index M_1 can be seen as the sum of movements in different parts of the distribution (reflected by Kernel Density differences across the two distributions). Using the data of full year earnings in UK in 1994 and 1995 including both people working full and part time, I will show, step by step, how the "global" index (M_1) 3 is built up. [17] Earnings are expressed in purchased power parity and relative to the mean (see Figure 1 below).



The upper left panel shows the alternative weighting functions for the distributional change term, upper right, whilst the lower left shows how these combine to give values for each part of the distribution for each inequality measure.

[17] This can be applied more in general at the class of stability indices of Shorrocks as expressed in (2). The only difference will be in distributional change term.

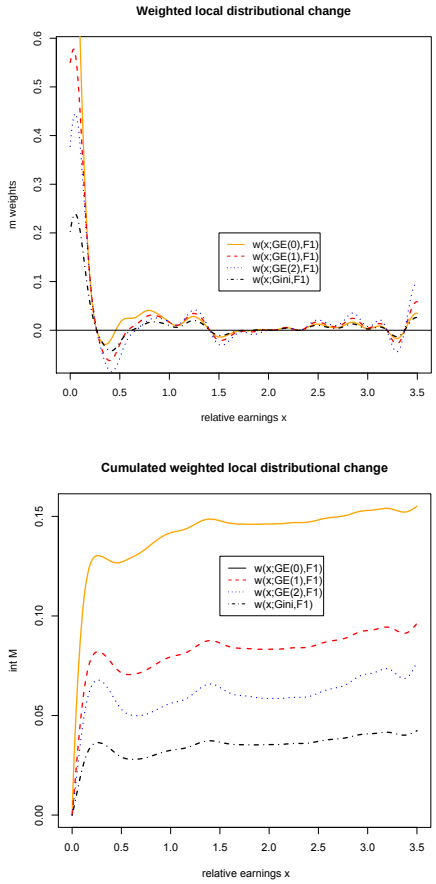


Figure 1: The decomposition of the Shorrocks stability index M_1 in UK in 1994-1995

Let's first focus on the upper left panel thus the weighting functions. There are significant differences in the weighting functions according to the inequality index chosen. Each of the weighting functions displays a u-shaped pattern. Thus positive weights will be attached to both changes in the proportions with very low and very high levels of earnings, whilst the middle part of the distribution is weighted negatively. This is because the effect on the inequality level of a new individual entering in the distribution will be higher if his income is far from the mean. However, some measures are more tail sensitive ($GE(0)$, $GE(2)$) and the balance of sensitivity to the lower and upper tails also differs.

The upper right panel displays the distributional change term, thus the discrepancy between the earnings distribution of the reference year $F_1(x)$ (1995) and the distribution of the timed averaged earnings 1994 and 1995 $G(x)$. Where the difference $F_1(x) - G(x)$ is positive thus $F_1(x) > G(x)$ which is true for $x \leq 0.5$, earnings below 0.5 the mean, or for $x \geq 1.5$, this means that the proportion of population in this part of the distribution has diminished. This will reflect that more people who were in this group in 1994 are not so on the average of the two periods earnings than the reverse is true for. Over the middle range $0.5 < x < 1.5$ there is an increasing proportion of the population in $1994 - 1995$ combined, compared to 1994 and this appears as negative in the figure. This reflects either mobility from the top or the bottom of the initial distribution. Hence, the exact patterns of movement are still not visible.

The lower left panel shows the combined effect of the weighting functions (inequality) and the distributional change term (mobility). It clearly strikes one feature. High weights are attached to distributional changes at the top and bottom but high weights at the bottom are associated with greater differences in this part of the distribution thus the combined effect at the top, will not be big enough to outweigh the combined effect of the weights and the distributional change term at the bottom. Indeed the changes occurring in the bottom part of the distribution (thus mobility for earnings below the mean) tend to dominate across all the measures, see the cumulative values for each measure in the bottom right picture, but the extent to which this is true and the overall value of the indices shows a lot of variation. The lower right panel displays the cumulated weighted local distributional change obtained integrating the product between the the weighting functions and the distributional change term. Even focusing on the curve based on the Gini (thus less sensitive to the tails) it emerges that people with earnings well below half the mean contributes for more than the 50 percent of the global index.

Two important characteristics emerge from the analysis. The class of Shorrocks indices are strongly influenced by mobility occurring at the bottom (first 20 percent of the observations) and different values for mobility using the Shorrocks approach derive entirely from the weighting functions

from a common distributional change term. As we show later the use of alternative Shorrocks based measures creates a lot of confusion as to the extent of mobility across different time periods, regions, countries etc. and that it is the weighting functions that create this lack of clarity.

Focusing on the distributional change term (up right panel) as we discussed earlier, this is a visual representation of a mobility measure, expressed as distance between the first year distribution and the time averaged distribution over two years. Any distance measure explores different aspects of mobility (see for instance Fields and Ok, 1996, 1999b). Therefore, the analysis of mobility in the Shorrocks stability indices, can be isolated simply focusing on the distributional change term. In particular we could think at a more intuitive measure of mobility as distributional change term, as the difference between the time-averaged distribution and the reference distribution $G(x) - F(x)$. [18] This change in the sign of the classical form of the distributional change term, allows for a more intuitive analysis of mobility. This is because the measure depicts the "points of attraction" (the areas to which people are moving to over time) as positive peaks. On the other hand, the groups from where these people are moving out will be represented with negative peaks.[19]

$$M^* = G(x) - F_1(x) \tag{8}$$

If we want to make a comparison of mobility across countries it is useful to normalize the absolute measure by the proportion of individuals in the reference year in any part of the distribution. [20] To do this we normalize the absolute distance by dividing the difference $G(x)-F(x)$ by the kernel density of the base year distribution. M^* and m^* can be respectively considered as absolute and relative measures of mobility as distributional change term.

$$m^* = \frac{G(x) - F_1(x)}{F_1(x)} \tag{9}$$

where m^* becomes a measure of relative mobility based on the difference between the kernel estimates of the time-averaged distribution and the reference distribution weighted by the information on the variability in each point of the distribution of the reference year. This offers a visual representation of relative mobility where the weights are based on the real information provided by the data: $\frac{1}{F_1(x)}$. The advantage of this procedure is that it controls for the dispersion of the data. This relative measure allows to precisely spot

[18] A commonly used distance measure is for instance the absolute change in the income from one year to another |y-x|. Where y is the vector of incomes of the second year and x the one of the base year. In the particular class of Shorrocks indices y is the time averaged income.

[19] Of course if this change in the sign wants to be applied we have simply to change the sign of the weighting function **??** in the measure 4.

[20] Relative and absolute measures of mobility based as distance are discussed in Field and Ok (1996)

the most "active" groups and furthermore will allow to depict a picture of mobility across countries.

In our analysis of mobility we will explore the mobility index 4 based on four different inequality measures, the class of generalized entropy measure based on $\alpha = 0, 1, 2$ and the Gini coefficient. We will also draw a picture of mobility across countries using the absolute and relative measure just mentioned. The Figure 2 below displays an example of the Absolute and Relative measure of mobility for the data used in 1.

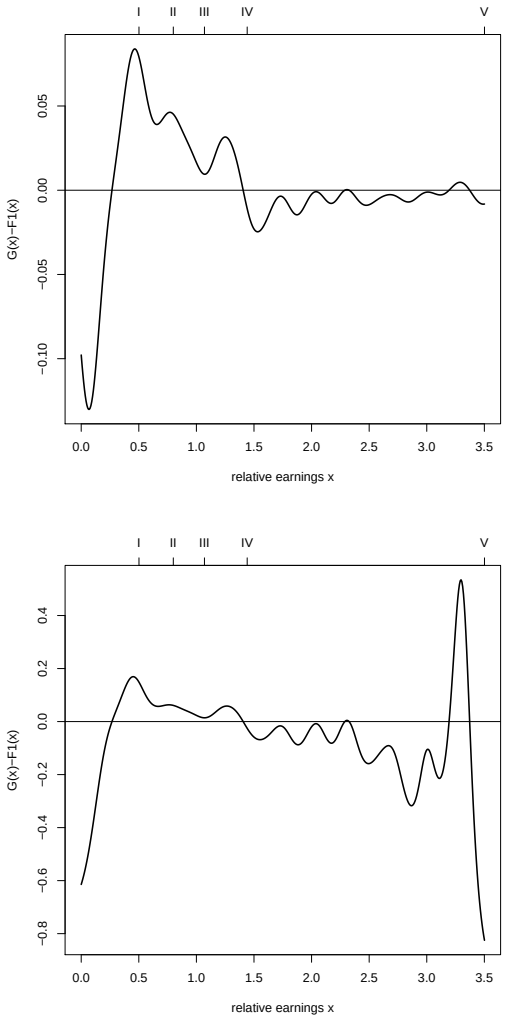


Figure 2: Absolute and relative measure of mobility in UK in 1994-1995

4 Data description: The ECHP

Data are drawn from the survey of the European Community Households Panel from 1994 to 2001. The ECHP dataset is a standardised multi-purposes annual longitudinal survey carried out at the level of the European Union and designed and coordinated by the statistical office of Eurostat. The survey covers a wide range of economic and socio-demographic information such as: labour force, income, employment poverty and social exclusion, housing, health, migration, education and training, social indicators. It represents the population of the EU both at households and individuals levels giving a cross-sectional and longitudinal perspective, with changes in the population over time reflected by the continues evolution of the sample through births to sample households and the formation of new households from the split off of existing ones.

The target population of ECHP is composed by all the resident persons living in private houses inside the EU and hence with the exclusion of persons living in institutions (also in old age home) and population without fixed residence. The units of analysis are the families and, within the households, all individuals older than 16.

In the analysis we restrict the attention on people at working age (people aged 20-64, Peracchi 2006). The units of observations are the individuals and the underlining source of income is the annual earning observed on the last calendar year. We select only those individuals who have been working over all the months of the last calendar year[21]

We restrict the analysis to positive earnings, restriction quite standard in the mobility literature (see Gottscholk and Moffit, 1994) and we drop the observations below the first and above the last percentile especially because as Cowell and Schluter (1999) pointed out, mobility measures are very sensitive to data contamination. We select 4 countries with a different labour market structures: Denmark, Germany, Spain and the UK. This choice is partly driven by data limitations described above and partly to give an assessment across the range of labour market regimes in the pre-accession EU. Denmark is a low inequality Scandinavian country with a system of relative high taxation and generous welfare benefits, widespread use of active labour market policies but also has a lightly regulated labour market in areas of employment protection etc. As such it is an archetypal country for the Flex-security model, see Kvist (2007). Germany has the archetypal Bismarkian Social Insurance system, that has widespread use of earnings re-

[21]this paper abstracts from entry and exit from employment. This issue will be addressed in later work. More in details, we select people who have been in: Paid employment, whether full or part time, Paid apprentiship or training under special schemes related to employment, Self employment with or without employee. Amongst them we select only those classified as "normally working" (working 15+ hours/week) using the information on the ILO main activity status at the time of the interview

lated benefits with low activational requirements on job seekers. It also has a strong system of employer/trades union industry level pay bargaining and tri-partite institutions. Hence Germany is seen as having substantial social and employment protection. The costs of unification in 1989 and substantial demographic pressures from an ageing workforce has driven reforms since 2000 with the Hartz process. Spain is a southern European country with a history of strong employment protection making the laying off of covered workers both difficult and costly. Over the data period here a system of temporary jobs was created with far weaker employment protection regulation, creating a dual labour market of secure and insecure workforces. More recently there has been an attempt to reduce the differences between these two groupings. The two tier system over this period maybe very important for earnings mobility in Spain. Finally, the UK is an Anglo-Saxon model of high inequality, very weak employment protection and no minimum wage system in this period until 1999. Welfare benefits were very ungenerous (apart from the support of children again since 1999) and based on a residualised means-tested social assistance model rather than linked to previous earnings and employment history. Despite this levels of dependency on out of work benefits was very high by international standards until the late 1990s. (see Gregg and Wadsworth, 2008 and Gregg, 2008). This set of countries thus offers a wide span of welfare models used in Europe and patterns of employment protection and inequality.

For all countries the earnings amounts are originally in national currencies and current prices and are net of social security contributions and income taxes. To allow for a cross sectional comparison we use the information contained in the country file on the Purchasing power parities. Dividing the earnings amounts by the PPP for each country we will get a common currency that eliminates the impact of price level differences.[22] In the study of mobility measurement error is a major problem, because as Cowell and Schluter (1999) pointed out, mobility measures are very sensitive to data contamination. This can produce a false impression of the extent to which mobility reduces long-term inequality and potentially in which countries and where in the earnings distribution occurs. In this study we aim to focus on annual earnings for those in full-year employment working more than 15 hours per week. This reduces the need for hours information (hourly wages derived from weekly wages divided by weekly hours are prone to higher measurement error, see Dickens and Manning (2004)) and abstracts from mobility caused by movements in and out of work. We average two years at the beginning and end of the data periods considered to reduce measurement error and drop observations below the first and above the last percentile.

[22] $PPPs$ are a fictitious currency exchange rate, which eliminate the impact of price level differences. Thus 1 PPS will buy a comparable basket of goods and services in each country. they are scaled at EU level. Hence the PPP can be thought of as the Euro in real terms.

Further we focus on longer term mobility (6 years) to allow great signal to emerge against noise from measurement error and transitory mobility. Jenkins and Van Kerm (2006) follow an analogous procedure averaging over a three year period (see also Gottschalk and Danziger, 2001). This means that in the long run (6 years mobility) we will compare the average of the first two years (1994 and 1995) with the average of the last two years of the panel (2000-2001). For the short run analysis we will only draw the results on mobility between 1996 and 1997 averaged and 1998 and 1999 averaged. Figure 3 below gives a graphical proof of how averaging couple of years tends to smooth transitory variations of earnings.[23]. The top panel displays the trend of mobility in Spain when mobility is measured over single years (one year mobility: 1994 with 1995, two years mobility: 1994 with 1996, up to 7 years mobility comparing 1994 with 2001). The bottom panel displays the trend in mobility when data are averaged over a two years period. So, in this case, one year mobility is calculated as the average between 1994 and 1995 and the one between 1996 and 1997, up to a 5 years mobility in which the average of 1994 and 1995 is compared with the average of 2000-2001.

[23]Mobility results are drawn adopting the measure M_1 in equation (4)

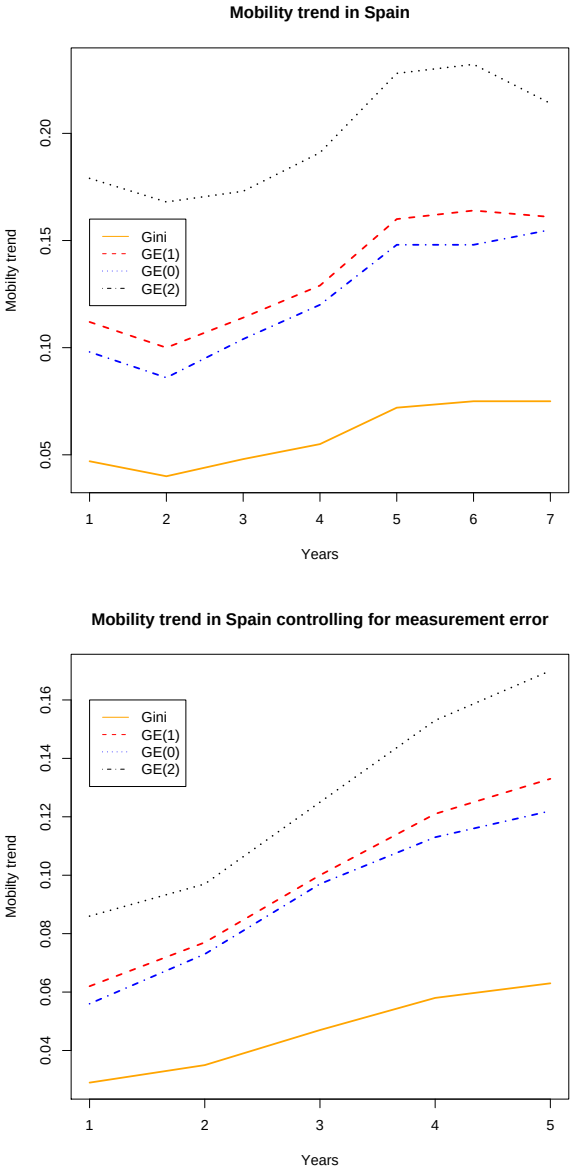


Figure 3: Mobility trend in Spain

Figure 4 shows the earnings distributions in PPP across the countries for the beginning and the end of the panel when 1994 with 1995 and 2000 with 2001 are averaged. Table 1 provides some descriptive statistics and lays out the sample size for the balanced panel.

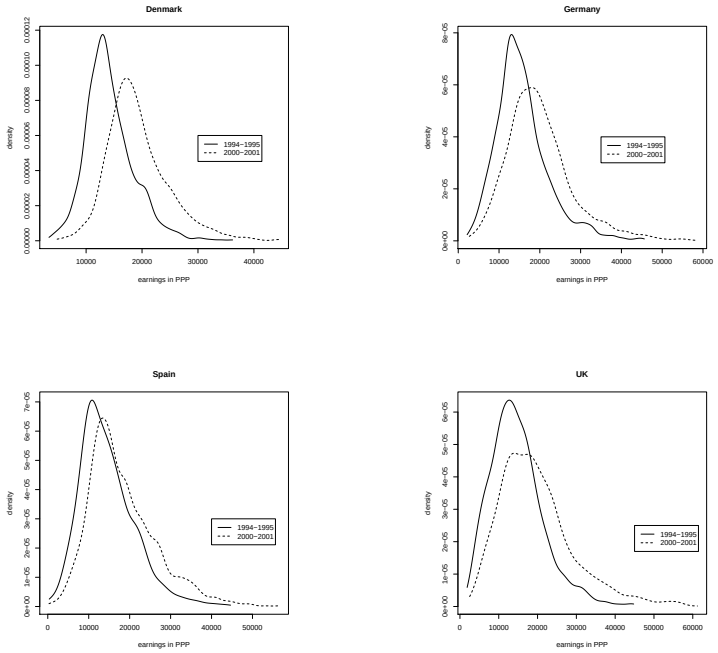


Figure 4: Earnings distribution across countries in 1994-1995 and 2000-2001 averaged

Table 1: Summary measures of Earnings in 1994-1995 and 2000-2001

	1994-1995			2000-2001			
	mean	*median*	*std*	*mean*	*median*	*std*	*balanced panel*
Denmark	14230	13500	4353	15660	18280	5496	1104
Germany	14750	15720	6567	18830	19970	8128	2485
Spain	13440	14550	6758	16440	18210	8264	1560
UK	13810	14650	6878	18170	19740	9597	1833

5 International Evidence on Shorrocks Indices of Mobility

We start by presenting alternative measures of inequality and mobility and show the aggregate Shorrocks measures based on alternative inequality concepts can be both confusing and uninformative about key aspects of mobility. It then progresses to show how we can develop both intuitive and informative measures which can be easily decomposed to facilitate exploration of different dimensions of mobility that are of interest to analysts.

Figure 5 shows the pattern of inequality as measured by alternative Generalised Entropy measures of inequality and the Gini coefficient for annual earnings of full-year workers for 1996. The ordering is clear, the UK has the highest inequality, closely followed by Spain, especially for the Gini based measure, Germany is in the middle and Denmark has by far the lowest value. In the analysis of mobility we will mainly focus on the long run case but we will also draw some results for the shorter run. We considered full-year employment for people working more than 15 hours per week here to focus on earnings mobility away from hours and unemployment variation. This, of course, can be relaxed. The alternative of hourly wages is often considered but measures constructed from dividing weekly earnings by reported hours of work induces considerable extra measurement error (Dickens and Manning, 2004). Table 3 reports global indices of six year mobility comparing an initial period of 1994 and 1995 averaged with 2001 and 2001 averaged. The sample does not require the person to have been in full-year working (working more than 15 hours per week) in the interim years.

Table 5 reports the proportion reduction in initial period inequality that

results from mobility of this period. Although mobility is clearly reducing the level of permanent inequality in each of the country considered, the extent to which inequality is reduced differs across countries and according to the measure of inequality adopted. The GE measures suggest well over twice as much reduction in inequality through mobility than the Gini based measure across all countries. We will explain why this is the case below. Hence alternative measures give very different pictures of the extent to which mobility reduces inequality.

On all the measures Denmark has the highest mobility. For the mean log Deviation, (GE(0)), six year mobility reduces inequality by 27%, for the other GE measures this is 24% but for the Gini just 11%. Spain and the UK have similar long-run mobility and they change ranking according to the measure of inequality used. Germany has the lowest level of mobility across all different inequality measures. So the alternative aggregate Shorrocks indices leave a reader somewhat unclear over the extent to which mobility reduces inequalities in earnings and to a degree of country rankings of mobility. The approach also cannot easily inform readers about where in the distribution of earnings mobility is occurring.

5.1 Decomposable Indices

The continuous form of the Shorrocks indices offers a way of allowing analysts to decompose the global index into contributions from different parts of the distribution. As we show in the technical discussion, all the Shorrocks based measures have a common building block that represents mobility. This is shown in Figure 6 for long run mobility in our four countries and represents the underlying in formation on mobility in these measures. It shows the change in the Kernel Density (we have inverted the scale as discussed in section 3 [24], to make the picture more intuitive) at each part of the distribution. Denmark shows a large reduction of the density for earnings slightly above half the mean. For UK and Germany this occurs for observations close to $0.3-0.4$ the mean but it is less marked for Germany. The first thinning in the distribution in Spain occurs for earnings levels just below half the mean. Spain and UK show a very strong and similar spike around 0.8 the mean, Germany has no single spike but a general increase in the density from 0.6 to 1.3 times the mean. While the increase in the distribution for Denmark is more closely focused on the mean, occurring from 0.9 to 1.3 times the mean. A further increase in the density occurs between 1.7 and 2.2 times the mean for all the countries except for Denmark which shows no areas of increasing density above 1.5 times mean earnings. This high end spike is more marked for Spain and the UK and is more modest for Germany.

All these differences across countries may reflect the differences in initial

[24] see equation 7

inequality, which gives differences in the densities at any particular point, so Figure 7 plots the changes in the Kernel Densities from Figure 6 but dividing through by the original density. Hence it shows the proportionate change in the density at each part of the distribution. Mobility means that the density falls by over half (-0.5) at the lowest wages across all countries. But notably this sharp reduction in the density at low wages is stronger in Denmark much further up the distribution occurring close to half mean earnings. The increases in the density near the middle are likewise closer to the mean for Denmark, then the UK, then Spain and then Germany. Finally, the sharp reductions in densities at higher incomes again starts first with Denmark at just over 1.5 times the mean, then Germany, UK and Spain together after 2.2 times the mean. Spain and the UK show sizable increases in the density at around 2 times the mean.

So the UK and Spain have notable increases in the density of earnings as a result of mobility at 0.7-0.8 of the mean and again at 1.7-2 times the mean and notable absence of thickening close to the mean. Hence these countries do not have a generalised shift towards the mean but one which is limited to thinning in the tails. Denmark has a more general picture of convergence on the mean spread over the range from 0.8-1.3 times the mean, Germany has a general thickening in the middle but spread over a much wider range.

This can be used to highlight how common underlying information on mobility becomes less clear through the use of alternative weighting systems based on alternative inequality measures. As the measure M [25] allows us to aggregate over different parts of the distribution, we can show more formally the contribution any part of the distribution has to Shorrocks based Indices and how the apparent conflicts in information occur. Tables 4 and 5 help to explain some of the patterns observed in the data. Table 4displays the decomposition of the Shorrocks indices by quintiles, giving the contribution to the overall mobility index and Table 5 expresses them as percentage contribution to the global index.

Across all the measures of inequality it clearly emerges that the bottom 20 percent of the distribution contributes for more than the 50 percent of the global index. This is more evident relying on bottom sensitive indices like GE(0) and GE(1) and particularly marked for the UK. Table 4 also shows how the vast bulk of the differences in measured mobility between the Gini, which suggests only 50% of the mobility of other measures, occurs in the tails especially the lower tail. This makes clear how the alternative weighting behind the different Shorrocks measures drives the alternative impressions of mobility. The differences between the GE based measures and the Gini come from the far higher weighting they give to the tails (Figure 1 showed the weighting). Now it is entirely possible for analysts to care more about the tails, especially the lower tail, mobility away from low pay, but the aggregate

[25] See equation 7

Shorrocks measures impose specific weighting and in ways that are unlikely to be clear to the lay analyst. We believe that it is better to provide the information to the analyst for them to make their own choices about parts of the distribution, as in Figures 6 and 7. In general we will appeal to the Gini based measure because this is the most accepted measure of inequality, it is symmetric in its weighting and least dependent on one or other of the tails. But by providing the information in each part of the distribution separately in Table 3, column 3, we allow any analyst to use their own interest in parts of the distribution rather than having it implicitly imposed by the weighting function.

So using the Gini based measure, over half of all mobility is generated at the bottom end of the distribution. This is most marked for the UK, where the bottom 20 percent contributes for about the 72 percent of the total Gini mobility measure. In contrast UK scores less well in the middle and to a less degree the top end. Denmark shows by far the highest level of mobility in the middle (across all the indices) with 29 percent of all total mobility coming from the 60% of the observations around the mean. This reflects the way, as noted above, Denmark has notable convergence on the mean whereas the UK has their areas of concentration at two points, one below and one above the mean. Hence it shows far less of their mobility occurring in the middle rather than the tails. The UK is particularly bottom heavy in its mobility, with a notably larger share of its total mobility occurring in the bottom 20% of the distribution where there is a ranking of Denmark, followed by the UK, Spain and Germany. In the middle section Denmark really dominates the other countries and is followed by Spain then Germany and finally the UK. Mobility differences at the top end contribute little to the overall picture but here again Denmark has the highest mobility, then Germany, the UK and Spain with the lowest.

Figure 8 makes the story even clearer, it shows the cumulative contribution to the overall mobility measure as you move from the bottom to the top of the earnings distribution using the Gini based measure. This makes clear that the UK and Spain have similar overall mobility but in different parts of the distribution, with the UK showing higher mobility at the bottom but weaker in the middle. Hence it is not possible to make a single definitive statement as to whether the UK or Spain has the higher mobility in total, as there clearly is no dominance over the entire range, but there is a pattern of dominance for the UK over lower parts of the distribution, up to around 0.5 of mean and dominance by Spain from 0.5 to 1.5 of the mean. In fact Figure 9 shows that Denmark doesn't dominate the UK over the whole range, though it does Spain and Germany. Up to about 0.4 mean the UK has higher mobility, although Denmark has very few people in the range and hence estimates of mobility in this range has rather weak common support.

What this has made clear is that the weighting choice drives the differences across results on the extent of mobility and to a degree differences

across countries. These weights are subjective placing different emphasis on different parts of the distribution, making it hard for the analyst to make up his or her own mind. The pictorial and summary statistics over parts of the range allow a clearer picture of mobility and for an analyst to make their own assessment based on the issue they wish to consider. These make clear how countries have mobility in different parts of the distribution, which lies behind the divergence in results across alternative measures.

Over 6 years earnings mobility for full-time full-year workers is low, reducing measured earnings inequalities by just 5.5% in Germany to 11% in Denmark when comparing cross-sectional to longer-term earnings inequalities. Most (55-70%) of the observed mobility occurs in lowest fifth of the earnings distribution. Denmark has the highest mobility over almost all of the earnings distribution, but especially convergence towards the mean from all parts of the distribution. The UK has high mobility at lower earnings but very little above mean earnings, especially from mean to nearly twice mean. In other words in Britain mobility is short range with a thinning of the distribution at very low wages but the increases in density fall well short of the mean. Germany shows low mobility in general, sharing lowest extent of mobility with Spain at the bottom and top and with the UK in the middle.

6 Conclusions

The Shorrocks approach to mobility has a number of attractions. First compared to transition matrices it captures mobility across the full distribution, not just for those who cross boundaries. As such it produces an easily interpretable measure of aggregate mobility, the proportionate reduction in initial inequality due to earnings mobility. Further it has a strong link to the inequality literature. Yet it also has some draw backs. As a global index it does not describe mobility in different parts of the distribution. Furthermore there are a range of alternative inequality measures on which Shorrocks indices of mobility can be based on. These alternative measures within Western Europe, show very different overall levels of mobility (as proportionate reductions in inequality) and often contradictory information about rankings of mobility across countries or changes across time. This is due to the way alternative measures of inequality give different weights to income values in different parts of the distribution and those that weight extreme values highly can give a very different impression of mobility than those that don't. Furthermore the index is not able to distinguish between those movements that tend to equalize or disequalize the level of permanent inequality. There are a large number of studies which document differences in mobility patterns across Europe, often including Shorrocks based measures but using alternatives to explore mobility in different parts of the distribution. The problems outlined above have hampered the drawing clear conclusions, which

has been noted by many of the authors of this literature, for example Jarvis and Jenkins (1998), Canto'(2000), Hofer and Weber (2002) or Aaberge at al. (2002).

Starting from the intuition of Schluter and Trede (2003) we develop an alternative and continuous form of the Shorrocks index that allows for the analysis over different parts of the earnings distribution to be undertaken and that is able to distinguish between mobility as equalization or disequalization of longer term income.

This paper focuses on four European countries, Denmark, Germany, Spain and the UK. Six year changes averaging two years at the beginning and end of the ECHP panel, suggest that overall mobility produces only a modest reduction in inequality patterns (5.5% to 11%) using our favorite measure. Denmark has the highest mobility mainly almost entirely from higher mobility at the middle of the distribution. The UK and Spain are similar overall but the UK shows greater mobility at low earnings values and Spain in the middle. Germany has the lowest overall mobility. Short run earnings mobility (two years) variations are higher in Spain (3 percent) followed by Denmark and UK and are again the lowest in Germany (0.5 percent).

The overall picture tells that mobility tends to reduce permanent inequality, although to a modest degree when measures are used that do not put high weights on extreme values and attempts to reduce the impact of measurement error or temporary transitory mobility are made. Second there is no clear correlation between mobility and inequality levels. Denmark has the lowest and the UK and Spain the highest inequality but Denmark has the highest mobility and Spain and the UK follow. From the local analysis of our index M_2 we are able to understand that it is the bottom 20 percent of the distribution that makes the largest contribution to the global index [26] and we can also capture that with the exception of Denmark mobility does not lead to clear convergence to the mean but at points around 0.7-0.8 and 1.5 to 2 times the mean, suggesting polarised population groups.

[26] for instance in Germany using the Gini index the contribution of the top 20 percent of the distribution is around 59 percent

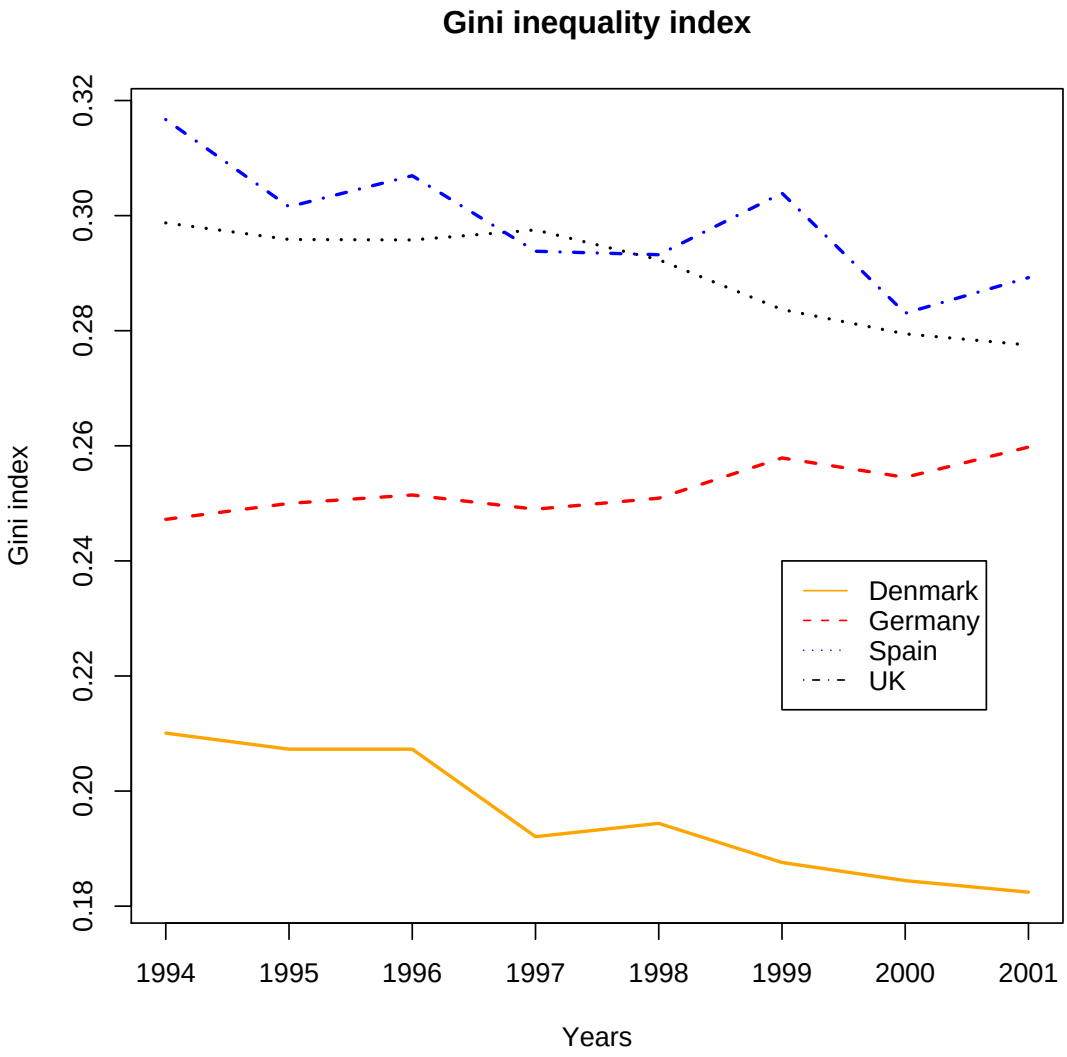


Figure 5: Earnings inequality patterns from 1994 to 2001

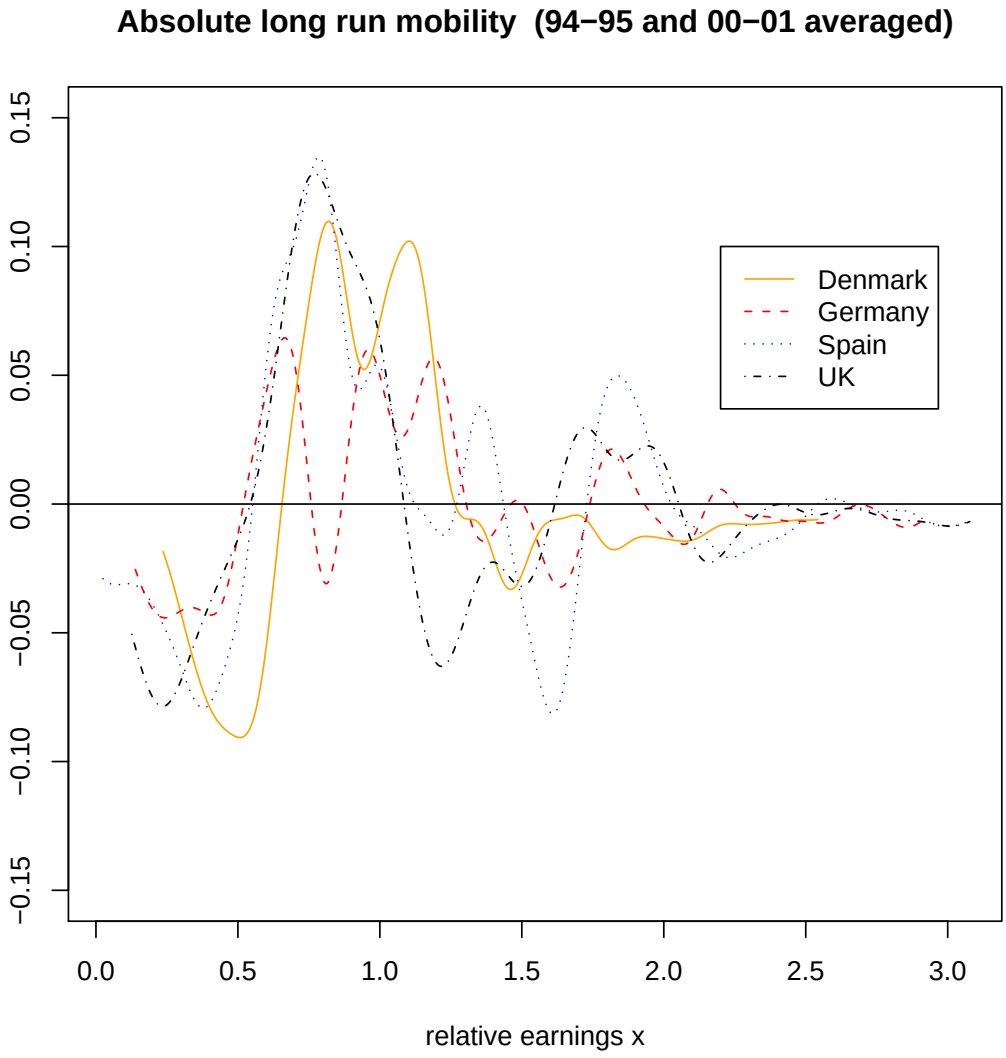


Figure 6: Distributional change term over six years averaging first and last two years $F_1(x) - G(x)$

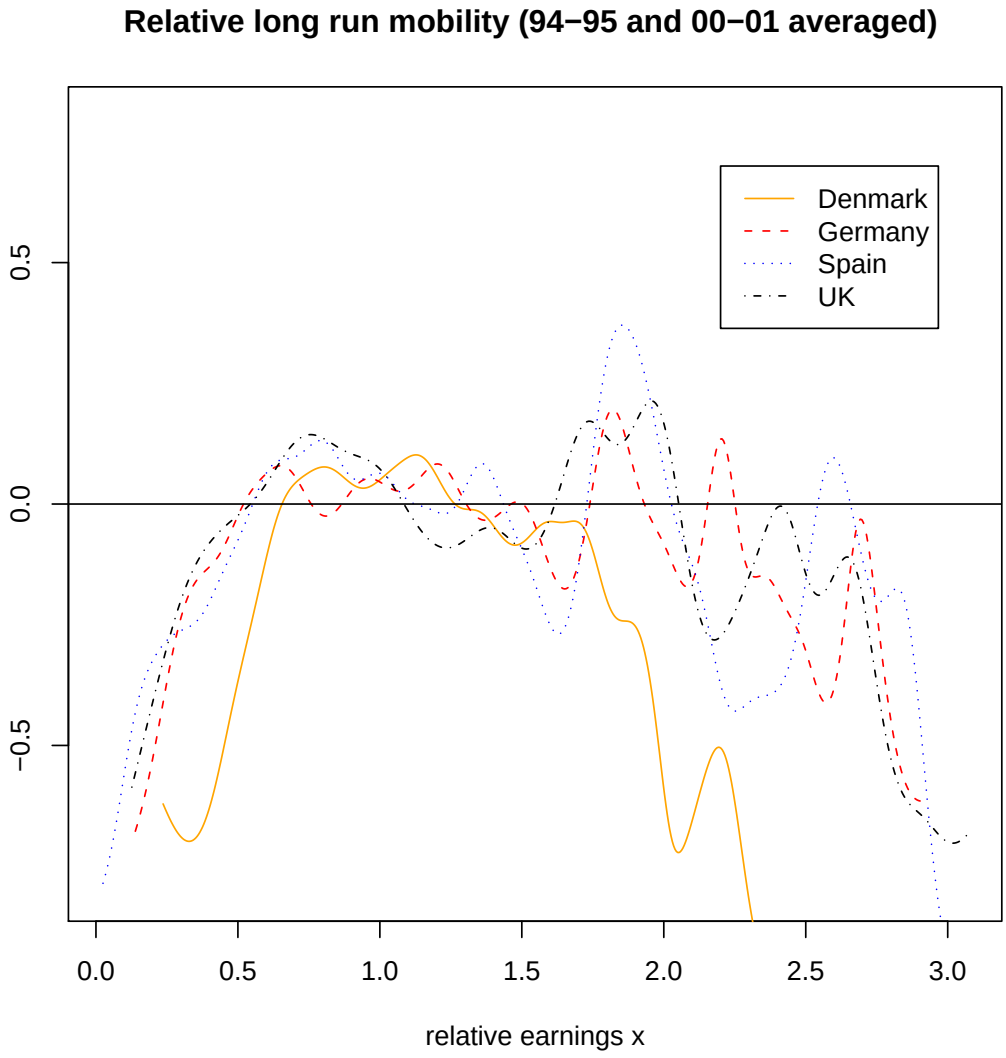
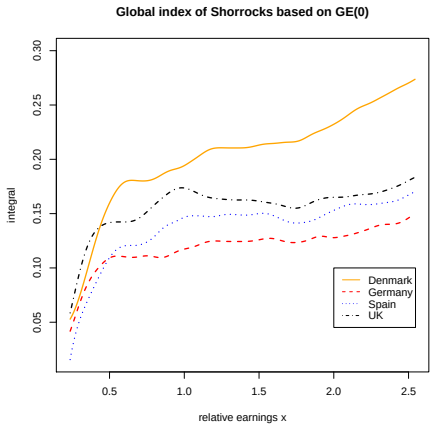
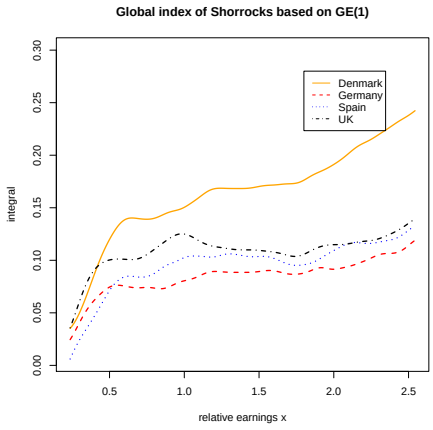


Figure 7: Relative distributional change term over six years averaging first and last two years $[F_1(x) - G(x)]/F_1(x)$


Global index of Shorrocks based on GE(0)
integral
0.05
0.10
0.15
0.20
0.25
0.30
0.5
1.0
1.5
2.0
2.5
relative earnings x
Denmark
Germany
Spain
UK


Global index of Shorrocks based on GE(1)
integral
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.5
1.0
1.5
2.0
2.5
relative earnings x
Denmark
Germany
Spain
UK

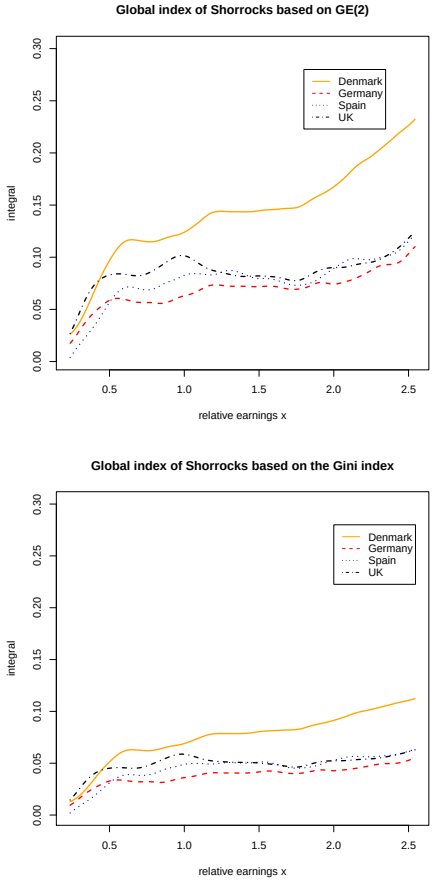


Figure 8: Global index of six years mobility based on different inequality indices when years are averaged (1994-1995 and 2000-2001)

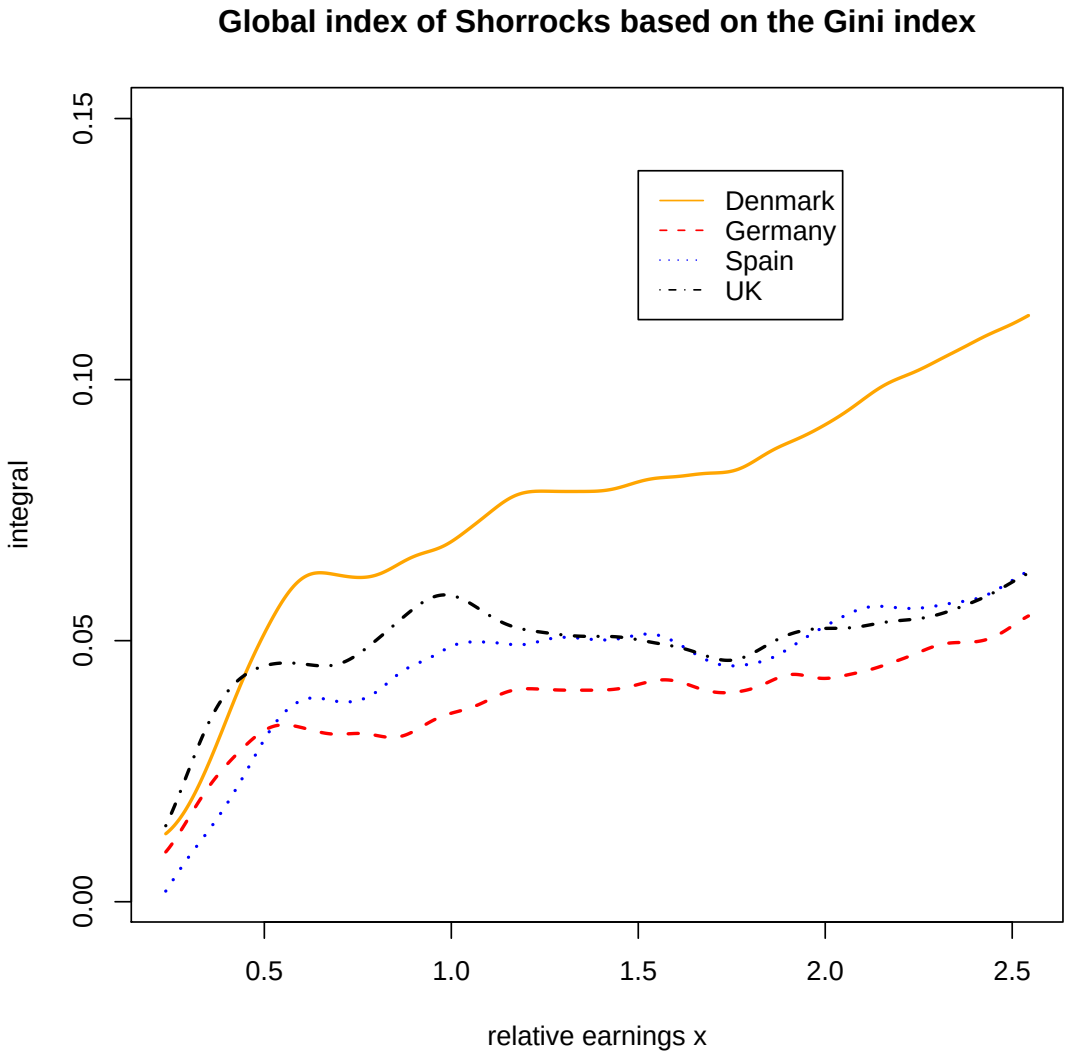


Figure 9: Global index of six years mobility based on the Gini index when years are averaged to control for measurement error

Table 2: Inequality based on different measures in 1996

1996	**GE(0)**	**GE(1)**	**GE(2)**	**GINI**
Denmark	0.0824	0.0717	0.0728	0.2037
	(0.041)	(0.0027)	(0.0027)	(0.0050)
Germany	0.1142	0.1057	0.1117	0.2514
	(0.0026)	(0.0021)	(0.0025)	(0.0029)
Spain	0.1494	0.1508	0.1540	0.2958
	(0.0037)	(0.0038)	(0.0038)	(0.0018)
UK	0.2134	0.1588	0.1582	0.3069
	(0.0067)	(0.0037)	(0.0039)	(0.0043)

Table 3: Long-run mobility where two years of data averaged 1994-1995 averaged and same for 2000-2001 to reduce measurement error

Long run mobility	**Denmark**	**Germany**	**Spain**	**UK**
GE(0)	0.2737	0.1497	0.1701	0.1834
	(0.0444)	(0.0197)	(0.0184)	(0.0185)
GE(1)	0.2423	0.1190	0.1329	0.1393
	(0.0319)	(0.0121)	(0.014)	(0.0179)
GINI	0.1123	0.0547	0.0633	0.0629
	(0.0147)	(0.0064)	(0.0079)	(0.0086)
GE(2)	0.2323	0.1101	0.1217	0.1244
	(0.0303)	(0.0111)	(0.0177)	(0.0188)

27

[27]Standard errors in parenthesis.

Table 4: Long run Decomposition of the Shorrocks Mobility Index approximation by quintiles for Alternative Inequality (1994-1995 and 2000-2001) averaged

Bottom 20%	**GE(0)**	**GE(1)**	**Gini**	**GE(2)**
Denmark	0.1802	0.1397	0.0626	0.1160
Germany	0.1102	0.0738	0.0321	0.0567
Spain	0.1210	0.0840	0.0384	0.0698
UK	0.1456	0.1016	0.0455	0.0822
Middle 20-80%	**GE(0)**	**GE(1)**	**Gini**	**GE(2)**
Denmark	0.0591	0.0598	0.0325	0.0614
Germany	0.0195	0.0197	0.0117	0.0199
Spain	0.0365	0.0311	0.0173	0.0267
UK	0.0199	0.0137	0.0071	0.0084
Top 20%	**GE(0)**	**GE(1)**	**Gini**	**GE(2)**
Denmark	0.0344	0.0428	0.01715	0.0549
Germany	0.0200	0.0255	0.0110	0.0334
Spain	0.0126	0.0178	0.0076	0.0252
UK	0.0180	0.0240	0.0103	0.0337

Table 5: Percentage contribution by quintile groups to the global long-run index

Bottom 20%	**GE(0)**	**GE(1)**	**Gini**	**GE(2)**
Denmark	66	57	56	50
Germany	74	62	59	52
Spain	71	63	61	57
UK	79	73	72	66
Middle 20-80%	**GE(0)**	**GE(1)**	**Gini**	**GE(2)**
Denmark	22	25	29	26
Germany	12.3	17	21	18
Spain	22	23	27	22
UK	11	10	11	7
Top 20%	**GE(0)**	**GE(1)**	**Gini**	**GE(2)**
Denmark	12	18	15	24
Germany	13	21	20	30
Spain	7	14	12	21
UK	10	17	17	27

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