IRISS at CEPS/INSTEAD

An Integrated Research Infrastructure in the Socio-Economic Sciences

WHAT LIES BEHIND INCOME MOBILITY?

RERANKING AND DISTRIBUTIONAL CHANGE IN BELGIUM, WESTERN GERMANY AND THE USA

by

Philippe Van Kerm

IRISS WORKING PAPER SERIES

No. 2003-03

Training and Mobility of Researchers

Access to Research Infrastructures

IRISS-C/I

An Integrated Research Infrastructure in the Socio-Economic Sciences at CEPS/Instead, Luxembourg

Project supported by the European Commission and the Ministry of Culture, Higher Education and Research (Luxembourg)

RESEARCH GRANTS

for individual or collaborative research projects
(grants awarded for periods of 2-12 weeks)

What is IRISS-C/I?

IRISS-C/I is a project funded by the European Commission in its 'Access to Major Research Infrastructures' programme. IRISS-C/I funds short visits at CEPS/Instead for researchers willing to undertake collaborative and/or internationally comparative research in economics and other social sciences.

Who may apply?

We encourage applications from all interested individuals (doing non-proprietary research in a European institution) who want to carry out their research in the fields of expertise of CEPS/Instead.

What is offered by IRISS-C/I?

Free access to the IRISS-C/I research infrastructure (office, computer, library…); access to the CEPS/Instead archive of micro-data (including e.g. the ECHP); technical and scientific assistance; free accommodation and a contribution towards travel and subsistence costs.

Research areas

Survey and panel data methodology; income and poverty dynamics; gender, ethnic and social inequality; unemployment; segmentation of labour markets; education and training; social protection and redistributive policies; impact of ageing populations; intergenerational relations; regional development and structural change.

Additional information and application form

IRISS-C/I
B.P. 48   L-4501 Differdange (Luxembourg)
Email: iriss@ceps.lu
Homepage: http://www.ceps.lu/iriss

What Lies Behind Income Mobility? Reranking and Distributional Change in Belgium, Western Germany and the USA*

Philippe Van Kerm
CEPS/INSTEAD, G.-D. Luxembourg

Final version: October 2002

Abstract

The paper presents a decomposition of income mobility indices into two basic sources: Mobility induced by a change of the income distribution shape and mobility induced by a re-ordering of individuals in the income pecking order. The decomposition procedure based on counterfactual distributions results in a decomposition that is applicable to a broad class of mobility measures. Application to income 'movement' indices with data for Belgium, Western Germany and the USA indicates that reranking has been the major force behind income mobility.

Keywords: Income mobility; Distributional change; Exchange and Structural mobility

JEL Classification: D31; D39; D63

*This paper is forthcoming in ***Economica***. It forms part of the research programme of the TMR network Living Standards, Inequality and Taxation (Contract No. ERBFMRXCT 980248) of the European Communities whose financial support is gratefully acknowledged. It has also been supported under the Transnational Access to major Research Infrastructures programme (Contract No. HPRI-CT-2001-00128) hosted by IRISS at CEPS/INSTEAD, Differdange (Luxembourg). I thank the Centrum voor Sociaal Beleid for providing the SEP data, and Eve Froidbise and Rudi Van Dam for their help in preparing the data. The paper benefited from helpful comments by three anonymous referees, Louis Gevers, Markus Jäntti, Stephen Jenkins, François Maniquet, Javier Ruiz-Castillo, Tim Smeeding, Alain Trannoy, and seminar participants at the University of Essex, the University of Namur, the University of Leuven, and at the third LivinTaX meeting held in Universidad Carlos III de Madrid. Contact: `philippe.vankerm@ceps.lu`.

Introduction

Income mobility studies are typically concerned with the evolution over time of the economic well-being –the income– of given recipient units in a society. The central argument of this paper is that individual income changes can be interpreted as resulting from the combined effects of two factors: The change in the *marginal* income distribution (i.e. the set of incomes available in the society at a given time period) reflecting the evolution of the economic environment in which individuals function, and the change in their position in the income pecking order which reflects the evolution of their economic status relative to other recipient units in the society. Thence the question: What lies behind income mobility? Reranking or distributional change? This idea is reminiscent of the distinction between 'exchange' and 'structural' mobility in the sociological literature on occupational mobility which has been applied in welfare economics terms in the early eighties (Markandya 1982*a*, Markandya 1982*b*, Markandya 1984).[1] This paper revisits such an approach and proposes a method to help disentangle and quantify the 'exchange' and 'structural' components of a broad class of income mobility measures. Additionally, further decomposition of the effect of the changing income distribution shape is suggested so as to separate out 'growth' effects from 'dispersion' effects.

A similar decomposition has been developed in Ruiz-Castillo (2001) in the particular case of the mobility index advocated by Chakravarty et al. (1985). The present paper differs from (and complements) Ruiz-Castillo's (2001) in two main directions. Firstly, the principle of the decomposition and the estimation procedure are presented and discussed independently on any mobility index, thereby offering a general framework within which to apply the decomposition.[2] Secondly, greater focus is put on the estimation procedure with a discussion of the sequencing problem in constructing the counterfactual distributions on which the decomposition procedure is based.

Using panel data on incomes for Belgium, Western Germany and the USA between 1985 and 1997, I present an application of the methodology for a somehow neglected concept of mobility, one of *income movement* as advocated in Fields & Ok (1996) and Fields & Ok (1999*b*). The results show that individual income changes are much larger in the USA than in the two European countries. Such a finding is coherent with the differences of economic institutions between these countries, al-

[1] See also Dardanoni (1993), Maasoumi (1998) or Formby et al. (2001).

[2] Note however that, unlike many mobility indices, the Chakravarty-Dutta-Weymark index allows a social welfare-based assessment of mobility. Ruiz-Castillo (2001) provides a detailed discussion of the normative interpretation of the estimated factors.

though it contrasts with previous income mobility comparisons (see e.g. Burkhauser & Poupore 1997). The 'exchange' component turns out to be the main explanatory factor for the observed income variations in all three countries. Changes in the marginal distribution contrbuted approximately to a quarter to one third of the adopted income mobility measures between 1985 and 1997.

The remainder of the paper is organised as follows. The next section introduces notation and details the methodology. Section 2 discusses the scope for application of the decomposition to specific mobility indices. The empirical application is presented in Section 3. A brief conclusion ends the paper.

1 Reranking and distribution change: Decomposing income mobility measures

The framework of analysis is a two time periods context: A base period labelled 0, and a final period labelled 1. The population is described by the index set $N \equiv \{1, 2, \ldots, n\}$. For any time period $k \in \{0, 1\}$, let y_i^k denote the income of individual $i \in N$, and $y_i = (y_i^0, y_i^1)$ be her income profile over the two time periods. The (marginal) income distribution at each period is the vector $y^k = \left(y_1^k, \ldots, y_n^k\right)'$ and all the elements at the heart of the analysis are therefore collected in the $n \times 2$ matrix $\mathbf{y} = (y^0, y^1)$. Let $A \equiv R_+^n$ be the domain of y^0 and y^1 and $A^2 \equiv R_+^{2n}$ be the domain of $\mathbf{y}$. Crucially, it is taken for granted that a particular mobility index $M : A^2 \rightarrow R$ has been adopted to measure the level of mobility in the process of moving from y^0 to y^1. Examples of such mobility indices are numerous.[3]

My objective is to decompose $M(\mathbf{y})$ into components quantifying the 'exchange' and 'structural' factors identified in the Introduction. The contribution of the 'structural' component is the share of $M(\mathbf{y})$ that can be explained by the evolution of the shape of the distribution, and the 'exchange' contribution is the proportion of $M(\mathbf{y})$ that is due to the reranking of individuals over the positions available in the economy. This exercise tells us, in an accounting sense, to what extent it is because the economy evolved (driving individual's income along with it) and to what extent is it because people moved up or down within a given structure that income mobility is observed, thereby building a bridge between analyses quantifying the evolution of the marginal income distribution over time and the studies on income mobility.

[3]See Fields & Ok (1999*a*) for a survey. Different indices often capture different notions of 'mobility'. Many indices capture some intuitive descriptive content of the concept whereas a limited number of them attempt to rank income structures in terms of the social welfare implications of mobility.

Consider the following four hypothetical processes with $n = 3$:

$$\begin{array}{rc} & y^0 \longrightarrow y^1 \\ \hline \text{I:} & (1,2,3)' \longrightarrow (1,2,3)' \\ \text{II:} & (1,2,3)' \longrightarrow (2,4,6)' \\ \text{III:} & (1,2,3)' \longrightarrow (0,2,4)' \\ \text{IV:} & (1,2,3)' \longrightarrow (3,1,2)' \end{array}$$

Only process I exhibits no mobility under any reasonable concept of mobility since no-one's income changes. Some individuals experience income variations in the next three cases and there is therefore room for a diagnosis of non-zero income mobility. II and III depict two situations in which there is no 'exchange' mobility. Whether there is at all any mobility in such processes is a matter of judgement and will depend on the specific function M. But if there is any mobility, all of it can be attributed to the 'structural' component. In case IV, individuals experience income variations and move along the income ladder so that mobility would probably be seen as non-zero by any reasonable observer. But, by contrast to II and III, all of the mobility is accounted for by the 'exchange' component since the shape of the (marginal) income distribution is left unchanged.

A natural refinement of this decomposition is to split the 'structural' component into a 'growth' term and a 'dispersion' term. The 'growth' component is the share of $M(\mathbf{y})$ that can be attributed to a growth of the 'size' of the economy. The 'dispersion' term is the share of $M(\mathbf{y})$ that can be attributed to a change in the way total income is distributed among agents. The 'structural' mobility component in process II is entirely due to 'growth' because total income has grown but the income *shares* held by individuals are left unchanged. On the contrary the 'dispersion' term accounts for all the 'structural' mobility in process III since there is no income growth but a change in the available income shares.[4]

To quantify the three components, I suggest a simple marginalist procedure based on the construction of counterfactual income structures. Starting from the initial income vector, one moves progressively towards the actual final income vector by isolating and adding one of the three sources of change at each step. The contribution of each factor is quantified by the marginal change in the estimated mobility level when its effect is added to the counterfactual income structure.

[4] Fields & Ok (1996) suggest a decomposition of their income movement index in a similar fashion. A 'transfer' component is arising from the transfer of income among individuals with total income held constant, and a residual 'growth' component is due to the change in *per capita* income. Although similar in spirit, this decomposition differs from the approach suggested here, and is specific to a single income mobility index.

Define $G(y; y^1)$, $D(y; y^1)$ and $E(y; y^1)$ as three transformation functions that, when applied to an income vector y with income vector y^1 used for calibration, generate counterfactual income vectors that incorporate respectively the growth component, the dispersion component and the exchange component, but all leave the other factors unchanged. For example, the counterfactual vector $\tilde{y} = G(y^0; y^1)$ embodies a growth mobility element (mean income in $\tilde{y}$ and y^1 are equal), but has the same Lorenz curve as y^0 and individual ranks are left unchanged. Define also $S(y; y^1) = G \circ D(y; y^1) = D \circ G(y; y^1)$ as isolating the overall 'structural' component so that $\tilde{\tilde{y}} = S(y; y^1)$ is equal to y^1 up to a permutation of its elements. A natural quantification of the contribution of each factor is then by the marginal impact on the mobility index $M(\mathbf{y})$ of applying each of these three functions sequentially: e.g.,

$$\begin{aligned} M(\mathbf{y}) \quad = \quad & \underbrace{\{M((y^0, G(y^0; y^1)))\}}_{\substack{M^G(\mathbf{y}) \\ \text{('growth')}}} + \underbrace{\{M((y^0, D \circ G(y^0; y^1))) - M((y^0, G(y^0; y^1)))\}}_{\substack{M^D(\mathbf{y}) \\ \text{('dispersion')}}} \\ & + \underbrace{\{M((y^0, y^1)) - M((y^0, D \circ G(y^0; y^1)))\}}_{\substack{M^E(\mathbf{y}) \\ \text{('exchange')}}}. \end{aligned} \quad (1)$$

with $M((y^0, y^0)) = 0$ and $M((y^0, E \circ D \circ G(y^0; y^1))) = M((y^0, y^1))$. By the additive structure of this decomposition, the 'structural' component is $M^S(\mathbf{y}) = M^G(\mathbf{y}) + M^D(\mathbf{y})$.

To make this decomposition operational, it suffices to construct the functions G, D, and E to reflect the effect we attempt to isolate at each step. This procedure has the advantage of making the decomposition applicable to a broad class of mobility indices (see Section 2). I suggest the following straightforward specifications. For the 'growth' component, let

$$G(y; y^1) = \frac{\mu^1}{\mu} \times y. \quad (2)$$

This inflates all incomes in y by a constant (so that the means of $G(y; y^1)$ and y^1 are equal) but keeps income shares constant in y. For the 'dispersion' component, let

$$D(y; y^1) = \frac{\mu}{\mu^1} \times L \times y \quad (3)$$

where L is a $n \times n$ diagonal matrix with generic elements $y^1_{(r(y_i))}/y_i$ ($y^1_{(i)}$ are order statistics and $r(y_i)$ is the rank order of y_i in vector y). This applies the Lorenz curve of y^1 to y neither changing mean income nor the ordering of values in y. By construction, we also have

$$S(y; y^1) = G \circ D(y; y^1) = D \circ G(y; y^1) = L \times y. \quad (4)$$

Finally, assuming for notational convenience that row indices are specified so that y is ordered $(y_1 \leq \ldots \leq y_n)$, let

$$E(y; y^1) = P'_{y^1} \times y \tag{5}$$

where P_{y^1} is a $n \times n$ permutation matrix that ranks y^1 in increasing order.[5] This transformation sorts income values in y in the order of y_1 incomes, i.e. $\tilde{y} = E(y; y^1) \Longrightarrow r(\tilde{y}_i) = r(y_i^1)$.

This construct is illustrated in Figure 1 in the case of an economy with two agents. Alternatively, it can be represented using Generalised Lorenz and Concentration curves.[6] The income structure $\mathbf{y}$ is depicted by the Generalised Lorenz curve of the initial income distribution, $GL(y^0)$, and the Generalised Concentration curve of final incomes ordered by initial income position, $GC(y^1)$ (see Formby et al. 2002). Mobility indices measure the 'distance' between the two curves.[7] The suggested decomposition decomposes this distance as exemplified in Figure 2. $GL(y^0)$ is an initial Generalised Lorenz curve, $GC(y^1)$ is the Generalised Concentration curve of final incomes and $GL(G(y^0; y^1))$ and $GL(D \circ G(y^0; y^1)$ are counterfactual distributions. The sequential change in the distance from $GL(y^0)$ to $GC(y^1)$ identifies the role of the three factors in turn.

One major shortcoming of such a sequential decomposition procedure is the dependence of the estimated contributions upon the sequence adopted to introduce the factors. Equation 1 and the two figures illustrate a Growth-Dispersion-Exchange sequence that first measures the effect of changes in the marginal distribution (assuming no reranking), then assesses the impact of reranking net of distributional changes. Other sequences of introduction of the factors (i.e. different sequences of composition of the G, D and E functions) could be applied, and different values for the factor contributions are likely to be obtained. In particular, one could first assess the effect of reranking assuming no 'structural' change, and then let the structural component be measured as an added effect. Similarly, whether the 'growth' component should be entered before or after the 'dispersion' component may be unclear.[8]

To deal with situations where no single sequence appears as a legitimate option, a procedure inspired from cooperative game theory which has recently been adapted

[5] P_{y^1} can be defined implicitly by $\tilde{y} = P_{y^1} \times y^1 \Longrightarrow (\tilde{y}_1 \leq \ldots \leq \tilde{y}_n)$.

[6] I am grateful to an anonymous referee for suggesting this alternative representation.

[7] Note that the area between the curves conveys a visual impression of mobility that may not correspond to what some mobility indices measure (in particular, the visual impact of income gains of the initially poorest is more important than similar gains for the richest). The size of this area should not be mis-interpreted as being in agreement with all measures of mobility.

[8] Ruiz-Castillo (2001) adopts a sequence with 'dispersion' entered first followed by 'exchange' and 'growth'.

Figure 1: Sequential decomposition of a distributional change in an economy with two agents

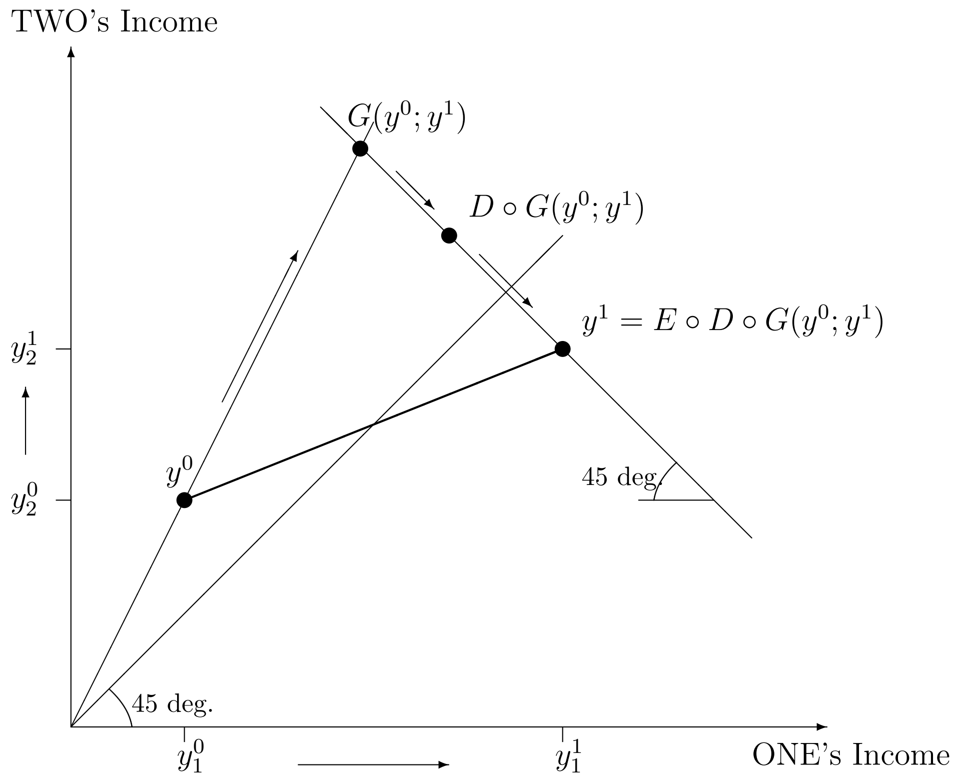
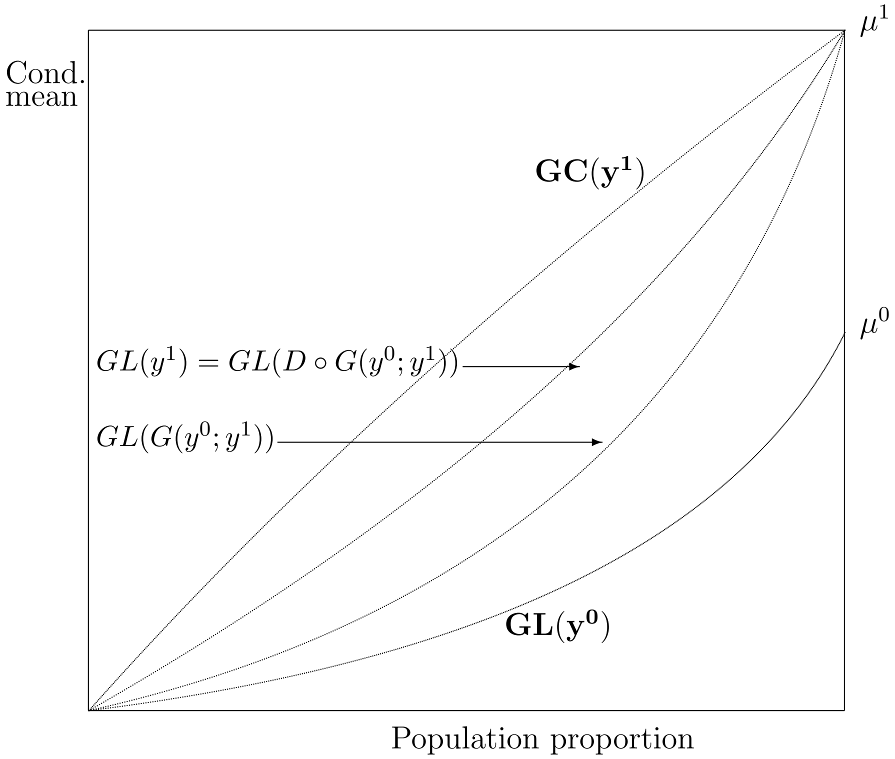


Figure 2: Sequential decomposition of a distributional change using Generalised Lorenz and Concentration curves



to similar decomposition problems, can be envisaged. Shorrocks (1999) gives a detailed presentation of this approach based on the evaluation of the Shapley value of the decomposition. The approach is also detailed in Chantreuil & Trannoy (1999) and Rongve (1999) with particular reference to the decomposition of inequality measures. As summarised in Shorrocks & Kolenikov (2000), "(t)he technique involves considering the impact of eliminating each factor in succession, and then averaging these effects over all the possible elimination sequences." The procedure results in a decomposition that is *exact* (since it is based on the *marginalist* idea) and *symmetric* (i.e. the estimated contributions do not depend on the order of introduction of the factors). If $M^{j,s}(\mathbf{y})$ denotes the marginal effect of factor j (with $j \in \{G, D, E\}$) in the sequence s, the contribution of factor j is estimated by the Shapley value procedure as:

$$M^j(\mathbf{y}) = \frac{1}{3!} \sum_{s \in S^{(3)}} M^{j,s}(\mathbf{y}). \tag{6}$$

where $S^{(3)}$ is the set of all possible introduction sequences of three factors.

However, a simple averaging over all sequences assumes that all the sequences are equally relevant. In the present context, it can be argued that we face a hierarchical two-stage decomposition with primary focus on the 'exchange'-'structural' distinction, and the 'growth' and 'dispersion' components coming only as secondary factors. Introduction sequences that split the 'growth' and 'dispersion' components (i.e. 'growth'-'exchange'-'dispersion' and 'dispersion'-'exchange'-'growth') could then be discarded. In hierarchical decompositions, Shorrocks (1999) suggests applying a variant of the standard Shapley algorithm, the Owen decomposition rule. Applied to our problem, this algorithm consists in applying the standard Shapley decomposition rule to the two primary factors to estimate their respective contributions:

$$M^i(\mathbf{y}) = \frac{1}{2!} \sum_{s_1 \in S_1^{(2)}} M^{i,s_1}(\mathbf{y}) \tag{7}$$

where $i \in \{S, E\}$ denotes one of the two primary factors ('exchange' or 'structural') and $s_1 \in S_1^{(2)}$ is one of the two possible introduction sequences of these two primary factors. In a second step, the contributions of the 'growth' and 'dispersion' components are computed by applying the Shapley decomposition rule to these secondary factors for each introduction sequence of the primary factors:

$$M^j(\mathbf{y}) = \frac{1}{2!} \sum_{s_1 \in S_1^{(2)}} \frac{1}{2!} \sum_{s_2 \in S_2^{(2)}} M^{j,s_1,s_2}(\mathbf{y}) \tag{8}$$

where $j \in \{G, D\}$ denotes one of the two secondary factors, $s_2 \in S_2^{(2)}$ is one of the two possible introduction sequences of these two secondary factors, and $M^{j,s_1,s_2}(\mathbf{y})$

is the marginal effect of the secondary factor j in the particular sequence s_2 of introduction of the secondary factors and s_1 of introduction of the primary factors.

2 Choosing a mobility measure

In principle, any measure of mobility can be decomposed using the methodology outlined in Section 1.[9] However, indices differ in the notion of mobility that they capture (see the discussions in Fields & Ok (1999*a*), Fields (2000) or Van de Gaer et al. (2001)). For example, some measures are, by construction, insensitive to 'structural' mobility as in Schiller (1977). The 'exchange'-'structural' decomposition is clearly irrelevant in this case as it degenerates to a decomposition with the 'exchange' factor contributing to all mobility. Two properties of mobility indices can be used to detect the applicability of the decomposition to specific mobility measures: If satisfied, then the decomposition degenerates to a case with one (or more) components driven to zero.

The first property is *intertemporal scale invariance* (Fields & Ok 1999*a*):

Property 1 *A mobility index M satisfies intertemporal scale invariance if $M((\gamma y^0, \lambda y^1)) = M((y^0, y^1))$ for any $\gamma, \lambda \in R_{++}$ and any $y^0, y^1 \in A$.*

Note that this property is not to be confused with a weaker *relativity* property stating that 'only income shares matter': $M((\gamma y^0, \lambda y^0)) = M((y^0, y^0))$ for any $\gamma, \lambda \in R_{++}$ and any $y^0 \in A$ (Chakravarty et al. 1985).

The second property requires the definition of a *rank-preserving transformation matrix with respect to vector x*.

Definition 1 *A matrix $H_{(x)}$ is a rank-preserving transformation matrix with respect to vector x if $H_{(x)}$ is a square diagonal matrix such that*

$$P_{(x)} = P_{(H_{(x)}x)}$$

where $P_{(x)}$ is a permutation matrix ordering the vector x in increasing order, i.e. $\widetilde{x} = P_{(x)}x \Rightarrow \widetilde{x}_i \leq \ldots \leq \widetilde{x}_n$.

A rank-preserving transformation matrix with respect to vector x is a matrix transforming the vector x into a vector y while preserving the *order* of the vector elements. With this definition, the second property, *ordinality in units*, is:

[9] I assume that all considered mobility indices satisfy a *normalisation* property: $M((y^0, y^0)) = 0$ for any $y^0 \in A$.

Property 2 *A mobility index M satisfies ordinality in units if* $M((H_{(y^0)}y^0, J_{(y^1)}y^1)) = M((y^0, y^1))$ *for any rank-preserving transformation matrices* $H_{(y^0)}$ *and* $J_{(y^1)}$ *and any* $y^0, y^1 \in A$.

It is straighforward to see that *ordinality in units* implies *intertemporal scale invariance*. Again, this property is not to be confused with a weaker *rank sensitivity* property stating that 'only ranks matter': $M((H_{(y^0)}y^0, J_{(y^0)}y^0)) = M((y^0, y^0))$ for any rank-preserving transformation matrices $H_{(y^0)}$ and $J_{(y^0)}$ and any $y^0 \in A$.

The link between these properties and the decomposition is expressed in the following propositions:

Proposition 1 *If M satisfies ordinality in units then* $M^G(\mathbf{y}) = M^D(\mathbf{y}) = M^S(\mathbf{y}) = 0$ *for any* $\mathbf{y} \in A^2$.

Proposition 2 *If M satisfies intertemporal scale invariance then* $M^G(\mathbf{y}) = 0$ *for any* $\mathbf{y} \in A^2$.

Proposition 1 indicates that the decomposition is inapplicable to measures that are 'ordinal in units': All components except the 'exchange' factor degenerate to zero. Proposition 2 indicates that 'intertemporally scale invariant' mobility indices are decomposable into 'exchange' and 'structural' components but the 'growth' component is zero by construction. These results directly follow from the marginal formulation of the decomposition and the approach suggested to construct the intermediate counterfactual distributions.

Table 1 checks the properties satisfied by the most commonly used mobility indices. It turns out that the decomposition into 'exchange' and 'structural' factors is relevant for most of the tabulated indices since only the average jump and measures based on the rank-correlation coefficient satisfy *ordinality in units*. It may seem surprising that the index proposed by King (1983) is meaningfully decomposable. The surprise is explained by the potential confusion between *ordinality in units* and *rank sensitivity*. The distribution of income shares does explain part of the index via a leverage effect on the rerankings observed. Rank changes are weighted by the distance between income shares exchanged, thence the potential 'structural' effect. A similar remark holds for the positive 'growth' effect in *relative* indices such as proposed by Shorrocks (1978), Chakravarty et al. (1985) or Fields (2002).

3 Income mobility in Belgium, Western Germany and the USA, 1985-1997

Let me now illustrate the decomposition with an application to panel data for Belgium, Western Germany and the USA. Two waves of panel data are used in the application. The data cover about a decade starting in the mid-eighties with income information collected in 1985 and 1997.

The income definition is annual post-tax post-transfer disposable household income. It includes labour and non-labour income and transfers of all household members, minus total household taxes and social security contributions. All incomes are expressed at constant 1997 prices. The focus is on individual income changes, not on household income changes since households form and dissolve as time goes by. In order to move from household income to individual income, it is assumed that total resources are equally shared among the members of a household: Each person is assumed to receive the 'single adult equivalent income' of the household to which she belongs. The equivalence scale adopted to equivalise incomes for households of different sizes is $y_{it}^e = y_{it}/n_{it}^{0.66}$ where y_{it}^e is the equivalent income of individual i at time t, and y_{it} and n_{it} are respectively the total income and the size of the household to which individual i belongs at time t.[10]

The data for Western Germany and the USA are drawn from the latest release of the 'Cross-National Equivalent Files (CNEF) 1980-2000' (as of October 2002) provided by the Department of Policy Analysis and Management at Cornell University. This dataset contains standardised and comparable data derived from the German Socio-Economic Panel (GSOEP) and the Panel Study on Income Dynamics (PSID) (see Burkhauser et al. 2001). Results for Belgium are based on the Belgian Socio-Economic Panel (SEP) data collected by the Centrum voor Sociaal Beleid (Universiteit Antwerpen). The Belgian data have not been harmonised with the other two datasets, and the income variable used in the Belgian data do not include asset flows and private transfers as the CNEF data do. Also, taxes are simulated in the CNEF data whereas net amounts are directly collected in the SEP survey. See Cantillon et al. (1999) for more information on the SEP data. To minimise the possibility of showing results driven by outlying observations, the top and bottom percent of the income observations have been removed from all samples at each wave. Sample weights correcting for unequal sampling probabilities are used throughout to improve the representativeness of the samples.

[10]The advantage of this one-parameter equivalence scale over a two-parameter scale that distinguish children and adults, in the context of mobility analysis, is that no discrete income jumps are implied when individuals cross the age delineating childhood from adulthood.

The concept of mobility I concentrate on is one of *income movement* (Fields & Ok 1999*b*) that captures the magnitude of income changes experienced by economic agents. A concept of distance between the incomes received by an individual at both time periods is adopted and assessment of the level of overall income mobility in the society is taken to be an average over the population of these individual distances (Cowell & Schluter 1998). This is meant to give direct information about the income flux that takes place in the society, and to identify how (un-)stable have been the incomes of individuals in a given time period. Fields & Ok (1996) advocate a measure of mobility which uses a distance concept based on the absolute income difference, and Fields & Ok (1999*b*) suggest a concept of distance based on the absolute difference in log-incomes:

$$M(\mathbf{y}) = \frac{1}{n} \sum_{i=1}^{n} \left| \log\left(y_i^1\right) - \log\left(y_i^0\right) \right|. \tag{9}$$

Decompositions of the latter are reported here (decompositions of the former are available from the author on request). This mobility concept differs from most approaches to income mobility measurement in one important respect: Income mobility is seen as the juxtaposition of isolated individual experiences and not as an intrinsically social phenomenon where it is individual experiences *relative* to the experiences of others that matter. In this regard, the point of view adopted is closely related to the approach suggested by Cowell (1985). Estimates of standard error for the reported statistics have been obtained by application of the grouped jackknife technique (see e.g. Särndal et al. (1992, pp.437–442) or Shao & Tu (1995, pp.195–196)).

All three samples experienced a substantial growth of average (real) incomes during the 1985-1997 period, accompanied by an increase in the relative income dispersion: Mean income increased by 22 percent in the USA, 20 percent in Belgium and 16 percent in Western Germany, and the Gini coefficient increased by 10 percent in the USA, 6 percent in Belgium and 5 percent in Western Germany (see Table 2).[11] The USA experienced the biggest distributional change with both the largest increases in mean and dispersion, whereas Western Germany experienced the smallest distributional change. At both time periods, income inequality was the lowest in the Belgian sample and the highest in the US sample, and the gap between inequality indices for the USA and the two European countries widened

[11]These estimates of average income and dispersion are based on the samples used to compute the mobility indices, i.e. samples composed of survey respondents reporting their income at both the initial and final waves. These estimates thus reflect changes in the marginal income distribution for a subset of the population excluding individuals of extreme ages (those born and dead between the initial and final time periods).

between 1985 and 1997.

The greater distributional change in the US economy translates in larger relative income 'movements' as measured by Fields & Ok's (1999*b*) index. Western Germany comes second, despite smaller distributional change than in Belgium. In the 1985-1997 time interval, individual incomes changed by approximately 52 percent on average in the USA, against approximately 39 percent in Western Germany and 34 percent in Belgium (see the estimated Fields & Ok (1999*b*) indices in the first row of Table 3). The ranking is confirmed by Fields & Ok (1996) indices. Such an observation conforms to expectations: The US economic institutions are largely free-wheeling and, by contrast, the European countries foster high levels of social protection and their governments exert a much greater influence on the labour market than in the USA so as to try to smooth out economic fluctuations. These factors suggest that income variability should be greater in the USA for the US institutions tend to make incomes more dependent upon individual circumstances and do not provide as much insurance against adverse events than in the European countries.

Arguably, this conformity to the common perception of mobility levels could be seen as an argument in favour of the use of income movement indices *à la* Fields & Ok when studying income mobility. The aforementioned results are in line with the findings of Formby et al. (2001) but contrast with previous cross-national comparisons of income mobility showing that income mobility in the USA was lower than in Western Germany (Burkhauser & Poupore 1997, Schluter & Trede 1999, Maasoumi & Trede 2001). This latter evidence is usually based on indices *à la* Shorrocks (1978) judging mobility by comparing inequality of smoothed (inter-temporally averaged) incomes to yearly income inequality. Different concepts of mobility may indeed lead to completely different rankings of economies as illustrated in the short list of alternative mobility estimates reported in Table 3. In all cases, mobility is higher in Western Germany than in Belgium but the USA can stand at any of the three positions depending on the index considered. In particular, Shorrocks's (1978) and Fields's (2002) indices attribute a low level of mobility to the US economy, indicating that income mobility does not lead to much lower income inequality when incomes are aggregated over multiple years compared to single period inequality.

Decompositions of the Fields & Ok (1999*b*) relative income movement index into the 'exchange', 'growth' and 'dispersion' components are presented in Table 4. Both the non-hierarchical and hierarchical decompositions based on Shapley-Owen methods are reported, as well as a non-additive decomposition in which the role of each factor is assessed by its effect when all the other factors are cancelled

Table 1: Properties of a series of mobility indices.

	Ordinality in units	*Rank Sensitivity*	*Intertemporal scale invariance*	*Relativity*
Average jump (Scott & Litchfield 1994)	yes	yes	yes	yes
Rank-correlation (Schiller 1977)	yes	yes	yes	yes
King (1983)	no	yes	yes	yes
Hart (1976)	no	no	yes	yes
Shorrocks (1978)	no	no	no	yes
Chakravarty et al. (1985)	no	no	no	yes
Fields (2002)	no	no	no	yes
Cowell (1985)	no	no	no	no
Fields and Ok (1996)	no	no	no	no
Fields and Ok (1999*b*)	no	no	no	no

Table 2: Cross-section statistics, 1985-1997.

	Belgium	**Western Germany**	**USA**
Sample size	4440	6646	7691
Initial mean income	37408	2058	1390
	(501)	(26)	(24)
Final mean income	45029	2387	1699
	(557)	(33)	(27)
Income growth rate	20.4%	16.0%	22.2%
	(1.3)	(1.2)	(1.4)
Initial Coefficient of Variation	0.355	0.414	0.531
	(0.007)	(0.005)	(0.009)
Final Coefficient of Variation	0.380	0.436	0.598
	(0.008)	(0.007)	(0.010)
Coefficient of Variation increase (%)	7.0%	5.4%	12.7%
	(2.49)	(1.83)	(1.87)
Initial Gini coefficient	0.196	0.227	0.293
	(0.004)	(0.003)	(0.005)
Final Gini coefficient	0.208	0.239	0.322
	(0.004)	(0.004)	(0.005)
Gini coefficient increase (%)	6.2%	5.1%	9.8%
	(2.34)	(1.78)	(1.65)

Notes: Standard error estimates reported in parentheses. Income values reported are annual incomes expressed on a monthly basis. Observations with both 1985 and 1997 incomes known.

Table 3: Mobility indices, 1985-1997.

	Belgium	**Western Germany**	**USA**
Fields and Ok (1999) index	0.335	0.392	0.523
	(0.008)	(0.009)	(0.008)
Fields and Ok (1996) (as a fraction of avg. income)	0.370	0.399	0.534
	(0.010)	(0.009)	(0.010)
King index ($\eta = 0$, $\gamma = 1$)	0.263	0.300	0.375
	(0.012)	(0.011)	(0.027)
Hart index	0.584	0.630	0.544
	(0.021)	(0.024)	(0.016)
Chakravarty et al. index	0.030	0.040	0.038
	(0.004)	(0.003)	(0.004)
Fields (2002) index	0.122	0.138	0.091
	(0.014)	(0.011)	(0.009)
Shorrocks index	0.150	0.161	0.137
	(0.006)	(0.007)	(0.004)

Notes: Standard error estimates reported in parentheses. See Fields & Ok (1999*a*) for the definition of most of these indices. Also see Fields (2002) and Shorrocks (1978). The Chakravarty et al., Fields and Shorrocks indices reported are based on the Gini coefficient of inequality and use only cumulated 1985 and 1997 incomes.

out. This latter decomposition gives the level of mobility that would be observed if only reranking, or only equiproportionate income growth, or only relative income changes had been observed. This corresponds to the factor components obtained when the factors are introduced first in the sequential procedure described *infra*. The difference between the hierarchical and the non-hierarchical decompositions turns out to be very small, with only the hierarchical structure giving slightly greater importance to the 'exchange' component. The contribution of the three components is higher in the non-additive decomposition (the three components add up to 135 to 147 percent of the actual mobility level), but the comparative contribution of each of them is similar to the exact decompositions.

Table 4: Three Exchange-Growth-Dispersion decompositions of $M(\mathbf{y})$.

	Belgium		**Western Germany**		**USA**	
1. Non-hierarchical decomposition (Shapley)						
Exchange factor	0.219	[65%]	0.296	[75%]	0.389	[74%]
	(0.006)	(1.87)	(0.010)	(1.60)	(0.008)	(1.27)
Growth factor	0.107	[32%]	0.081	[21%]	0.107	[20%]
	(0.007)	(1.66)	(0.006)	(1.67)	(0.007)	(1.25)
Dispersion factor	0.009	[3%]	0.015	[4%]	0.027	[5%]
	(0.003)	(0.93)	(0.003)	(0.87)	(0.004)	(0.83)
2. Hierarchical decomposition (Owen)						
Exchange factor	0.223	[67%]	0.300	[76%]	0.396	[76%]
	(0.006)	(1.72)	(0.010)	(1.56)	(0.008)	(1.14)
Growth factor	0.105	[31%]	0.079	[20%]	0.103	[20%]
	(0.007)	(1.68)	(0.006)	(1.66)	(0.007)	(1.28)
Dispersion factor	0.007	[2%]	0.013	[3%]	0.024	[5%]
	(0.002)	(0.73)	(0.003)	(0.84)	(0.003)	(0.67)
3. Marginal impact when factors introduced first						
Exchange factor	0.289	[86%]	0.358	[91%]	0.469	[90%]
	(0.007)	(1.44)	(0.009)	(0.96)	(0.008)	(1.06)
Growth factor	0.185	[55%]	0.148	[38%]	0.201	[38%]
	(0.011)	(2.55)	(0.011)	(2.73)	(0.011)	(2.00)
Dispersion factor	0.020	[6%]	0.025	[6%]	0.042	[8%]
	(0.007)	(2.12)	(0.004)	(1.04)	(0.009)	(1.76)

Notes: Figures in square brackets give relative contributions (contributions expressed as a fraction of total $M(\mathbf{y}) \times 100$). Standard error estimates reported in parentheses. The 3rd decomposition is not additive and give the mobility that would be observed if only the isolated factor had been into play (i.e. its effect when introduced first in the sequential decomposition).

What lies behind income mobility? The striking feature of the decompositions is that income movements in the three countries considered between 1985 and 1997 are essentially due to 'exchange' mobility, leaving 'structural' factors account for a smaller fraction of aggregate income movements. According to the hierarchical decomposition, 'exchange' mobility accounts for 67 to 76 percent of income changes. The non-addtitive decomposition indicates that 86 to 91 percent of the mobility would still be observed if there were no change in the marginal distribution. A great deal of income changes experienced at the individual level are therefore overlooked when studying the change of the income distribution shape without taking intra-distributional changes into account. Interestingly, although the level of mobility varies widely between countries, the share of the 'exchange' factor is similar in all countries (especially in Western Germany and the USA).

After the 'exchange' component, it is the 'growth' component that plays the most important role with contributions of 20 to 31 percent in the hierarchical decomposition, leaving only a contribution of 2 to 5 percent to the 'dispersion' factor. 38 to 55 percent of the observed mobility would be preserved by a *ceteris paribus* equiproportionate growth of all incomes, but only 6 to 8 percent of the mobility would be preserved by the observed increase in income inequality leaving all other elements constant. The increase in income inequality over the period, although distressing in its own right, only had a limited impact on individual incomes.

The 'exchange' component in the decomposition of the Fields and Ok indices *per se* can be considered as a 'positional' (or 'pure') income mobility measure since it is not sensitive to changes in the economic environment. Quantifying the aggregate income changes implied by the sole re-ordering of individuals in the income pecking order, it is a measure of positional mobility where the rerankings are weighted by the income difference between the positions exchanged. Rerankings in highly dispersed distributions will *ceteris paribus* be given greater weight than rerankings in a concentrated distribution. Such a feature is shared by the King index. If we use the 'exchange' component of the decompositions to compare levels of 'pure' mobility between the three countries, i.e. controlling for their different distributional changes, it is still clear that mobility levels are higher in the USA than in Belgium and Western Germany. The sole 'exchange' component for the USA is indeed greater than the overall index for Belgium (with both 'exchange' and 'structural' mobility components added up).

The indices advocated by Fields and Ok are additively decomposable by population subgroups, and it is possible to apply the decomposition across subgroups.[12]

[12]It is worth pointing out that with the decomposition by factor source advocated in this paper, *taken separately* the 'exchange' and 'structural' factors are *not* subgroup decomposable: The sum of each subgroup's factor component is not equal to the overall effect of this factor in the

This exercise has been made with a partition of the population in four age groups (below 26, 26 to 45, 46 to 60 and above 60). For brevity, complete results are not reported but are available from the author. Mobility turned up to be higher in the USA than in Western Germany and Belgium in all age groups, and mobility levels were decreasing with age. The decrease is steeper in the two European countries so that for the 60+ age group, mobility levels in the USA were 60 percent and 65 percent higher than in Western Germany and Belgium respectively (against 33 percent and 56 percent for the whole population). Within all subgroups, the 'exchange' component was the major force behind income mobility. The 'growth' factor was however important too for the two age groups below the age of 46, with estimated contributions ranging from 29 percent to 42 percent. 'Structural' components were negligible for the age groups above 45 with the exception of the 60+ in the USA for whom 'growth' and 'dispersion' factors accounted for respectively 14 and 12 percent of overall mobility. Consequently, if one looks only at the 'exchange' component to assess pure mobility, mobility is no more decreasing with age. In all countries, it is in the 46-59 age group that pure mobility was the highest and in the 26-45 age group that it was the lowest.

4 Conclusion

This paper is a contribution to the study of income mobility. The contribution is twofold. Firstly, a decomposition is suggested to look at what lies behind income mobility to help disentangle the impact of rerankings, broadly interpreted as reflecting the competition among agents over time, from (anonymous) distributional changes reflecting the change in the economic environment within which agents behave. The central argument is that any mobility index can be decomposed into two main factors: The mobility induced by a change in the shape of the marginal distribution of incomes and the mobility induced by a reranking of individuals in the income pecking order. This corresponds to the distinction between 'exchange' and 'structural' mobility introduced in the early eighties in the literature on income mobility. The paper revisits such an approach by showing how a straightforward counterfactual approach, possibly combined with a Shapley-Owen algorithm, can be used to estimate the factor contributions in a general framework applicable to a broad class of mobility indices. Furthermore a decomposition of the 'structural'

population. There is a hard to interpret residual reflecting the degree to which the positions held by the various subgroups in the distribution vary from one time period to the next. The residual term disappears only if the set of ranks occupied by members of each group in the overall distribution is not altered during the process of moving from one distribution to the next.

factor into two elements is introduced: The mobility induced by a growth (or contraction) of the economy and the mobility induced by a change in the dispersion of incomes.

Secondly, new empirical evidence showing both the relevance and feasibility of the advocated approach is reported. Income mobility within OECD countries has received increasing attention over the last decade following the development of panel data bases. The diversity of approaches makes it difficult to compare different studies but some features are now well documented. A particularly surprising result is the low degree of income mobility in the USA. This surprising result disappears in our analysis where one focuses on the 'income movement' aspect of income mobility as measured by Fields & Ok (1999*b*) indices. The reported estimates pertaining to the 1985-1997 time period rank the USA above Western Germany and Belgium by decreasing order of income mobility –a result coherent with differences in economic institutions–. It is shown that although 'structural' factors may have a significant impact on income movements, it is 'exchange' mobility that accounts for most (about two thirds to three quarters) of the observed mobility in all three countries. It is the re-ordering of individuals in the income pecking order that is the major source of income variability. A stable marginal income distribution must therefore not be mis-interpreted as reflecting an economy in stasis.

References

Burkhauser, R. V., Butrica, B. A., Daly, M. C. & Lillard, D. R. (2001), The Cross-National Equivalent File: A product of cross-national research, *in* I. Becker, N. Ott & G. Rolf, eds, 'Soziale Sicherung in einer dynamsichen Gesellschaft. Festschrift fr Richard Hauser zum 65. Geburtstag', Frankfurt/New York: Campus, pp. 354–376.

Burkhauser, R. V. & Poupore, J. (1997), 'A cross-national comparison of permanent inequality in the United States and Germany', *Review of Economics and Statistics* **79**(1), 10–17.

Cantillon, B., De Lathouwer, B., Marx, I., Van Dam, R. & Van Den Bosch, K. (1999), Sociale indicatoren 1976-1997, CSB Bericht D/1999/6104/05, Centrum voor Sociaal Beleid, Universiteit Antwerpen, UFSIA, Belgium.

Chakravarty, S. R., Dutta, B. & Weymark, J. A. (1985), 'Ethical indices of income mobility', *Social Choice and Welfare* **2**(1), 1–21.

Chantreuil, F. & Trannoy, A. (1999), Inequality decomposition values: The trade-off between marginality and consistency, Discussion Paper DP 9924, THEMA, Université de Cergy-Pontoise, France.

Cowell, F. A. (1985), 'Measures of distributional change: An axiomatic approach', *Review of Economic Studies* **52**, 135–151.

Cowell, F. A. & Schluter, C. (1998), Measuring income mobility with dirty data, CASEpaper 16, Centre for Analysis of Social Exclusion, London School of Economics, London, UK.

Dardanoni, V. (1993), 'Measuring social mobility', *Journal of Economic Theory* **61**, 372–394.

Fields, G. S. (2000), Income mobility: Concepts and measures, *in* N. Birdsall & C. Graham, eds, 'New Markets, New Opportunities? Economic and Social Mobility in a Changing World', The Brookings Institution Press, Washington D.C., USA, chapter 5, pp. 101–132.

Fields, G. S. (2002), Does income mobility equalize longer-term incomes? New measures of an old concept. Unpublished paper. Cornell University.

Fields, G. S. & Ok, E. A. (1996), 'The meaning and measurement of income mobility', *Journal of Economic Theory* **71**(2), 349–377.

Fields, G. S. & Ok, E. A. (1999*a*), The measurement of income mobility: An introduction to the literature, *in* J. Silber, ed., 'Handbook of Income Inequality Measurement', Kluwer, Deventer, chapter 19, pp. 557–596.

Fields, G. S. & Ok, E. A. (1999*b*), 'Measuring movement of incomes', *Economica* **66**(264), 455–471.

Formby, J. P., Smith, W. J. & Zheng, B. (2001), Mobility measurement, transition matrices and statistical inference, Working Paper 2001-04, Department of Economics, University of Colorado at Denver, USA.

Formby, J. P., Smith, W. J. & Zheng, B. (2002), Economic growth, welfare and the measurement of social mobility, *in* Y. Amiel & J. A. Bishop, eds, 'Research on Economic Inequality', Vol. 11, Elsevier, Amsterdam. (Forthcoming.).

Hart, P. E. (1976), 'The comparative statics and dynamics of income distributions', *Journal of the Royal Statistical Society (Series A)* **139**(1), 108–125.

King, M. A. (1983), 'An index of inequality with applications to horizontal equity and social mobility', *Econometrica* **51**(1), 99–115.

Maasoumi, E. (1998), On mobility, *in* A. Ullah & D. E. A. Giles, eds, 'Handbook of Applied Economic Statistics', Marcel Dekker, Inc., New York, chapter 5, pp. 119–175.

Maasoumi, E. & Trede, M. (2001), 'Comparing income mobility in Germany and the United States using generalized entropy mobility measures', *Review of Economics and Statistics* **83**(3), 551–559.

Markandya, A. (1982*a*), 'Intergenerational exchange mobility and economic welfare', *European Economic Review* **17**, 307–324.

Markandya, A. (1982*b*), 'The measurement of earnings mobility among occupational groups', *Scottish Journal of Political Economy* **29**(1), 75–88.

Markandya, A. (1984), 'The welfare measurement of changes in economic mobility', *Economica* **51**, 457–471.

Rongve, I. (1999), A Shapley decomposition of inequality indices by income source, Discussion Paper 59, Department of Economics, University of Regina, Canada.

Ruiz-Castillo, J. (2001), The measurement of structural and exchange income mobility. Unpublished paper. Universidad Carlos III de Madrid, Spain.

Särndal, C.-E., Swensson, B. & Wretman, J. (1992), *Model Assisted Survey Sampling*, Springer Series in Statistics, Springer-Verlag, New York, USA.

Schiller, B. R. (1977), 'Relative earnings mobility in the U.S.', *American Economic Review* **67**(5), 926–941.

Schluter, C. & Trede, M. (1999), Local versus global assessment of mobility, Discussion Papers in Statistics and Econometrics 4/99, Seminar of Economic and Social Statistics, University of Cologne, Germany. Forthcoming in *International Economic Review*.

Scott, C. D. & Litchfield, J. A. (1994), Inequality, mobility and the determinants of income among the rural poor in Chile, 1968-1986, Discussion paper 53, Development Economics Research Programme, London School of Economics, London, UK.

Shao, J. & Tu, D. (1995), *The Jackknife and Bootstrap*, Springer Series in Statistics, Springer-Verlag, New York, USA.

Shorrocks, A. F. (1978), 'Income inequality and income mobility', *Journal of Economic Theory* **46**, 376–393.

Shorrocks, A. F. (1999), Decomposition procedures for distributional analysis: A unified framework based on the Shapley value. Unpublished paper, University of Essex, Colchester, UK.

Shorrocks, A. F. & Kolenikov, S. (2000), Poverty trends in Russia during the transition. Unpublished paper, RECEP, Moscow, Russia.

Van de Gaer, D., Schokkaert, E. & Martinez, M. (2001), 'Three meanings of intergenerational mobility', *Economica* **68**(272), 519–537.

IRISS-C/I is currently supported by the European Community under the *Transnational Access to Major Research Infrastructures* action of the *Improving the Human Research Potential and the Socio-Economic Knowledge Base* programme (5th framework programme)

[contract HPRI-CT-2001-00128]

Access to Research Infrastructures

Please refer to this document as

IRISS Working Paper 2003-03, CEPS/INSTEAD, Differdange, G.-D. Luxembourg. Forthcoming in *Economica*.

(CEPS/INSTEAD internal doc. #07-03-0011-E)