Income Mobility

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Abstract

JEL Classification:

Keywords: Intra-generational mobility, inter-generational mobility, income mobility, earnings mobility

1. Introduction

Most of the information that we have about the 'income distribution' is cross-sectional in nature: there are statistics about for example income levels, poverty rates, and the extent of inequality for a given year or for a series of years. The data sources used to provide estimates for the different year refer to different samples of individuals. In this chapter, we discuss a different and complementary perspective on income distribution to the cross-sectional one. We take an explicitly longitudinal perspective, one that is based on tracking over time the fortunes of the same set of individuals. We are interested, broadly speaking, in how individuals' incomes change over time in a society. 'Income mobility' is a shorthand label for this topic. In this chapter, we address questions such as: what exactly do we mean by mobility and why should we be interested in it? How should mobility be measured? What is the evidence about income mobility within and between rich industrialised nations?

The period of time over which income mobility is assessed is a fundamental issue and different choices have led to two relatively distinct literatures. On the one hand, there is the subject of how an individual's income changes from one year to the next during their lifetime; on the other hand, there is the subject of income change between generations of parents and children. We use this distinction between intra-generational and inter-generational income mobility as an organisational device in this chapter, reflecting the division in existing literature, but we shall also attempt to draw out the features of the measurement of 'income mobility' that are common to both topics while also highlighting dimensions of them for which different approaches to analysis are appropriate.

Conceptual issues are addressed first because clarification of them is an essential preliminary to any discussion of measurement principles, data sources, and assessment of empirical evidence. In Section 2, we review the reasons why and how income mobility is said to be of interest. There are several distinct reasons and this is because, as we also discuss, there are multiple concepts of mobility, each of which arguably has normative validity. This situation contrasts with assessments of an income distributions at a point in time, in which case there is greater consensus about what is meant by income inequality, say, and how it might be accounted for in social welfare evaluations.

We review the measurement of income mobility in Section 3, starting with the generic case in which there are data on income at two points in time, whether this be two consecutive years (as in the intra-generational mobility literature) or two consecutive generations (as in the inter-generational mobility literature). This is the most commonly-examined situation. Thus we are interested in not only summarising a single bivariate joint distribution of income but also comparing such distributions across time or countries in order to say whether mobility is greater or smaller. We explain various descriptive methods for situations in which income data are either continuous or grouped into categories. First we discuss graphical devices and how they may be used to undertake mobility comparisons without resort to choice of a particular mobility index (so-called dominance checks). Second we consider scalar indices of mobility ranging from regression coefficients and correlations through to other more specialist developments. We also consider generalisations allowing for a non-linear relationship between incomes in the two periods. We then address the situation in which there are more than two consecutive observations on income – the multivariate joint distribution case. This has been considered more rarely than the bivariate distribution case, largely because of the greater data demands and because of the greater complexity, but is arguably more interesting and informative.

By considering measurement from a generic point of view, we aim to show how there might be greater cross-fertilisation between the intra- and inter-generational mobility literatures in approaches to measurement. At the same time, we highlight how the different measurement approaches relate to different concepts of mobility identified in Section 2. Related to this discussion, a feature of our review is that we include discussion of low- and high-income persistence as well as income (im)mobility in general. As shall be demonstrated below, there is interest not only in individuals' mobility throughout the income range, but also the mobility relative to particular income thresholds. In other words, we also discuss measurement methods for the persistence of poverty and of affluence.

Evidence about income mobility is the subject of the next two sections: Section 4 considers intra-generational mobility; Section 5 considers inter-generational mobility. In each case, our strategy is to build a bridge linking concepts and measurement principles to empirical evidence by first discussing data sources and data quality, as well as estimation issues. The implications of transitory variation and measurement error in incomes are a leading example of the latter.

In Section 6, we move from describing how individuals' incomes change from one time period to the next to review models explaining why incomes change as they do. Our review refers to both within- and between-generation models, but our coverage is relatively limited since measurement per se is our main brief. As shall be seen, one of our main themes under this heading is that models of income change are remarkably under-developed, no doubt reflecting the complexity of the processes involved.

The final section summarises what we have learnt and where the gaps are in our knowledge, and makes a number of proposals concerning where the returns to future research efforts are the greatest.

Earlier research on 'income mobility' has typically focused on either within- or between-generation topics. For surveys of intra-generational measurement issues, we build on Jenkins (2011) who, in turn, draws heavily on other surveys such as by e.g. Atkinson et al. (1992) Burkhauser and Couch (2009), Fields and Ok (1999), and Jenkins and Van Kerm (2009), and Maasoumi (1998). For intergenerational mobility, important earlier reviews are provided by Solon (1999), Björklund and Jäntti (2009) Black and Devereux (2011), and Piketty (2000). Many of the reviews just cited in volumes with 'Handbook' in their title. Indeed extensive surveys of cross-sectional approaches to income distribution were provided throughout Volume 1 of the Handbook of Income Distribution (Anthony B Atkinson and François Bourguignon, 2000). It is timely and appropriate to give income mobility similar attention.

The chapter draws heavily on the work of others but also has some distinctive features besides simply being more up-to-date. One aspect is our goal to try and integrate the discussion of intra- and inter-generational mobility in so far as this is possible, while also highlighting what aspects of each topic are intrinsically different and deserving of separate attention. Other aspects include our coverage from conceptual issues through to data, issues of empirical implementation and evidence. Also we consider both mobility in general and persistence at the top and the bottom of the distribution. Finally, although we mainly draw on contributions from various fields of economics (including welfare economics, income distribution and labour economics), we also refer to related contributions from other disciplines notably sociology and social stratification, especially in our discussion of inter-generational issues.

2. Mobility concepts

Writers on income mobility have long emphasised that ‘income mobility’ has multiple dimensions. For example, a leading survey from a decade ago commented that:

> ‘the mobility literature does not provide a unified discourse of analysis. This might be because the very notion of income mobility is not well-defined; different studies concentrate on different aspects of this multi-faceted concept. At any rate, it seems safe to say that a considerable degree of confusion confronts a newcomer to the field’ Fields and Ok (1999, p 557)

The systematic reviews by Fields and Ok and others, have done much to reduce the potential confusion. But they cannot banish mobility's multiple facets, and so newcomers continue to require guided tours of the concepts and literature. This section explains what the multiple dimensions of mobility are. We address the question of whether more mobility is socially desirable in each case, arguing that the answer depends on which mobility concept is the focus. A review of the implications of mobility's various facets for social welfare is used to illustrate trade-offs between different types of mobility. We also point out how different concepts have received different emphasis in studies of mobility within- or between-generations.

2.1. Mobility's multiple dimensions

Consider first the case in which there are observations on income for N individuals for two periods. In the first period, the income distribution is $\mathbf{x}$, in the second period, the distribution is $\mathbf{y}$; there is a bivariate joint density $f(\mathbf{x}, \mathbf{y})$. Overall mobility for the population can be thought of as the transformation linking marginal distribution $\mathbf{x}$ with marginal distribution $\mathbf{y}$. Alternatively, one can say that for each individual i, there is a ordered pair of incomes for the two periods (z_{1i}, z_{2i}). Mobility for the population overall can be thought of as the aggregation of the individual-level income changes. The raw data are the same in both cases of course, since $(z_{1i}, z_{2i}) = (x_i, y_i)$, but helps to explain different mobility concepts to look at the data from the two perspectives. @ Check back later whether this distinction is required. @

In this section, we distinguish four concepts (Jenkins, 2011): positional change (which comes in two flavours), individual income growth, reduction of longer-term inequality, and income risk. The different concepts use different approaches to 'standardise' the marginal distributions $\mathbf{x}$ and $\mathbf{y}$ in order to focus attention on the nature of the link $\mathbf{x} \rightarrow \mathbf{y}$ or, equivalently, $z_{1i} \rightarrow z_{2i}$ for all i.

Positional change refers to mobility that arises separately from any changes in the shapes of the marginal distributions in each period, for example a rise in average income or in income inequality or, more generally, a change in the concentration of individuals at different points along the income range in **y** compared to in **x**. Standardisation for such changes is most easily accomplished by summarising each person's position not in terms of their income per se but in terms of their rank in the population normalised by the population size. (The marginal distribution of normalised ranks is a standard uniform distribution for both **x** and **y**.) Thus positional change mobility refers to the pattern of exchange of individuals between positions, while abstracting from any change in the concentration of people in a particular slot in each year. The latter change is 'structural mobility', whereas the former is 'exchange mobility' (see for example (Markandya, 1984). Changes in income affect positional mobility only in so far as these changes alter each person's position relative to the position of others. Equiproportionate income growth or equal absolute additions to income for everyone raise incomes but there is immobility in the positional sense.

There are some distinctive characteristics of the concept of mobility as positional change. Mobility for any specific individual necessarily depends on other people's positions as well, which is not true for every mobility concept as we shall see. The definition of each person's origin and destination position depends on the positions of everyone else in the society: it is these taken altogether that define a hierarchy of positions. Second, and related, if one person changes position then so too must at least other person. It is not possible for everyone to be upwardly mobile or, indeed, downwardly mobile. Third, the situation corresponding to 'no mobility' is straightforwardly defined: perfect immobility is when every person has the same position in $\mathbf{x}$ and in $\mathbf{y}$. If income mobility is summarized using a transition matrix in which cell entries a_{jk} show the probability that an individual in income class j in period 1 is found in income class k in period 2, then perfect mobility is the case in which $a_{jk} = 1$ for all income classes (all individuals are on the leading diagonal). However, fourth, there are two different ways of thinking about the situation describing the configuration with the maximum mobility, one focusing of lack of dependence and the second focusing on movement.

One view is that perfect mobility occurs when one's destination is completely unrelated to one's income origin ('origin independence'). For example, the chances of being found in the richest tenth in period 2 are exactly the same for people who were in the poorest tenth in period 1 as for the people who were in the richest tenth in period 1. In transition matrix terms, this is the case in which $a_{jk} = a_{mk}$ for all origin classes j or m (each row of the transition matrix has identical entries). Another view is that perfect mobility occurs when destination positions are a complete reversal of origin positions ('rank reversal'), emphasising positional movement per se. For example, the poorest person in period 1 is the richest person in period 2, and the richest person in period 1 is the poorest person in period 2, and so on. All entries in the transition matrix lie on the diagonal going from bottom left (richest origin class and poorest destination class) to top right (poorest origin class and richest destination class).

Mobility as *individual income growth* refers to an aggregate measure of the changes in income experienced by each individual within the society between two points in time, where the individual-level changes might be gains or losses. Income growth is defined for each individual separately and income mobility for society overall is derived by aggregating the mobility experienced by each and every individual. This mobility concept contrasts sharply with the positional change one in several ways. No distinction is made between structural and exchange mobility: it is gross (total) mobility that is described. It is possible for everyone to be upwardly mobile or, indeed, to be downwardly mobile. Positive income growth for everyone may count as mobility even if relative positions are preserved. Thus, standardisation of the marginal distributions is not an essential feature of the concept. It is natural to define mobility for each individual in terms of 'distance' between origin and destination income, and to think of the zero mobility case for the population as being when the measure of distance equals zero for every individual $z_{1i} = z_{2i}$ for all i). Mobility is greater if the distance between origin and destination is greater for any individual, other things being equal. This is similar to the idea of greater movement meaning more mobility according to the 'reversals' version of positional mobility. But, by contrast, there is no natural maximal mobility reference point as distance has no obvious upper bound. (Observe that there is no obvious way to represent individual income growth in terms of a transition matrix, since the mobility concept in this case is intrinsically individual- rather than group-based.) Defining the metric for 'distance' is of course vitally important for the concept, and the main distinctions have been measures of 'directional' and 'non-directional' growth. In the first case, income increases over time are treated differently from income decreases; in the second, an income increase and an income decrease of equal magnitude are attributed the same distance. (For more precise definitions, see Fields and Ok, 1999). Because non-directional measures summarise income 'flux' rather than mobility as it is commonly understood, we focus on directional measures of individual income growth under this heading.

The third mobility concept defines income mobility with reference to its *impact on inequality in longer-term incomes*. The longer-term income for each individual is the longitudinal average of incomes in each period. In our two period case, longer-term income $\bar{z}_i = \frac{1}{2}(z_{1i} + z_{2i})$ for each i. Averaging across time smooths the longitudinal variability in each person's income and, in addition, the inequality across individuals in these longitudinally-averaged incomes will be less than the dispersion across individuals in their incomes for any single period. Mobility can therefore be characterized in terms of the extent to which inequality in longer-term income is less than the inequality in marginal distributions of period-specific income. (See Shorrocks, 1978, 1981) and below for further details.) The zero mobility reference point is when the income of each person in every period is equal to their longer-term income: there is complete rigidity. At the other extreme, there is perfect mobility if there is inequality in per-period incomes but no inequality at all in longer-term incomes. The issue of whether everyone can be upwardly (or downwardly) mobile does not arise according to this mobility concept because it defines mobility using inequality comparisons, and inequality is measured at the aggregate (population) level. There are similarities between this concept of mobility and the rank reversal flavour of the positional change concept since both are concerned with movement, but they use different reference points to assess this (longer-term incomes versus base-period positions respectively).[1]

The fourth concept of mobility, as *income risk*, is closely related to the third. The previous paragraph expressed each person's period-specific income as the

[1]NB for later: Chakravarty, Dutta, and Weymark version of Shorrocks, using ede of longer-term income rather than longer-term income itself. Similarly, Maasoumi and Zandvakili (1986), Zandvakili (1992) and Maasoumi and Zandvakili (1990) using generalised means instead of means as Shorrocks did. Also cf. Fields JEI using initial period for the reference.

sum of a 'permanent' component (the longer-term average) and a 'transitory' component (the period-specific deviations from the average). Suppose now that the longer-term average is given a behavioural interpretation: it is the expected future income per period given information in the first period about future incomes. From this ex ante perspective, the transitory components represent unexpected idiosyncratic shocks to income, and the greater their dispersion across individuals each period, the greater is income risk for this population. The measure of mobility cited in the previous paragraph, the inequality reduction associated with longitudinal averaging of incomes, is now re-interpreted as a measure of income risk and has different normative implications (see below). Income movement over time represents unpredictability. This is essentially what Fields and Ok (1999) refer to as income 'flux' (non-directional income movement). Despite their apparent similarities in construction, the concepts of mobility as inequality-reduction and as income risk diverge in practice once when the process describing income generation is not a simple sum of a fixed individual-level permanent component and an idiosyncratic transitory component. As we discuss in Section @, econometric models have been developed with more complicated descriptions of how the permanent and transitory components evolve over time and these imply, in turn, different calculations of expected income and transitory deviations from it. However the distinction between predictable relatively fixed elements and unpredictable transitory elements of income is maintained and hence so too is a link between mobility as transitory variation and income risk.

2.2. *Is income mobility socially desirable?*

In what ways are these various mobility concepts of public interest over and above providing useful descriptive content? Does having more mobility represent a social improvement or is it undesirable? The answers depend on the mobility concept employed, and that the support for the different concepts has depended on whether one is assessing within- or between-generation mobility.

Greater mobility in the sense of less association between origins and destinations has long been linked with having a more open society: if where you end up does not depend on where you started from, there is greater equality of opportunity. @ find a good historical quotation check@ More recently, a UK government advisor's report on Social Mobility stated that 'Social mobility matters because ... equality of opportunity is an aspiration across the political spectrum. Lack of social mobility implies inequality of opportunity' (Aldridge, 2001). @ Cross-cite HandbookID2 chapter on Equality of Opportunity @

From this perspective, greater mobility is socially desirable since equality of opportunity is a principle that is widely supported, regardless of attitudes to inequality of outcomes. This is relevant because independence of origins and destinations is consistent with inequality of outcomes being relatively equal or unequal. The argument just rehearsed is, however, typically made in the context of intergenerational mobility rather than intra-generational mobility, and origins refer to parental circumstances ('family background'). The appeal to fairness in this context is based on the meritocratic idea that someone's life chances should depend on their own abilities and efforts rather than on whom their parents were. At the same time, it is important to appreciate that the degree of intergenerational association is only an imperfect indicator of the degree of inequality of opportunity.

The degree of origin independence is a direct measure of inequality of opportunity only if two rather special conditions apply (Roemer, 2004). First, the advantages associated with parental background (over which it is assumed that an individual had no choice) are entirely summarised by parental income. Second, the concept of equality of opportunity that is employed views as unacceptable any income differences in the children's generation that are attributable to differences in innate talents (which might be partly genetically inherited). This is what (Swift, 2005) (2006?) describes as a 'radical' interpretation of the equality of opportunity principle, and likely to command much less widespread assent than what he refers to as the 'minimal' and 'conventional' definitions (respectively, access and recruitment processes to life chances are free of prejudice and discrimination; and outcomes achieved depend on 'ability' and 'effort' but not on family background).

Arguably he social desirability of mobility as independence of origins has less force in the intra-generational context. The reason is that incomes are measured at a point within the life course. By that stage, period 1 incomes are likely to reflect differences in peoples' abilities and efforts (in addition to family background and other factors), and period 2 incomes to reflect the persisting effects of these factors. To the extent that abilities and efforts do play this role (or are seen to) and also viewed as 'fair' on the grounds of merit or desert, the reduction of dependence between origins and destination has less appeal as a principle of social justice.

More common in the within-generation context are statements that income mobility is desirable because it is a force for reduction in the inequality of longer-term incomes. The most famous statement in this connection was by Milton Friedman six decades ago in his *Capitalism and Freedom* (though observe that he does refer to equality of opportunity in this context):

> 'A major problem in interpreting evidence on the distribution of income is the need to distinguish two basically different kinds of in-

> equality; temporary, short-run differences in income, and differences in long-run income status. Consider two societies that have the same annual distribution of income. In one there is great mobility and change so that the position of particular families in the income hierarchy varies widely from year to year. In the other there is great rigidity so that each family stays in the same position year after year. The one kind of inequality is a sign of dynamic change, social mobility, equality of opportunity; the other, of a status society' (Friedman, 1962, p. 171).

Similar views are apparent across the political spectrum in the USA. The Chairman of President Obama's Council of Economic Advisors recently stated that

> 'Higher income inequality would be less of a concern if low-income earners became high-income earners at some point in their career, or if children of low-income parents had a good chance of climbing up the income scales when they grow up. In other words, if we had a high degree of income mobility we would be less concerned about the degree of inequality in any given year.' (Krueger, 2012)

Although both authors are clearly referring to the distributions of incomes within generations, one could extend the same inequality-reduction idea to the intergenerational context, by summarising mobility in terms of the extent to which dynastic inequality (referring to incomes averaged over generations of the same family) is less than the inequality in any given generation. But this is rarely done, probably because the normative appeal of the dynastic average income is much less than that of a multi-period average within generations.

According to the arguments about longer-term inequality reduction, income mobility is socially desirable for instrumental reasons rather than for its own sake. That is, society is assumed to care about income inequality (less is better, other things being equal), but inequality is assessed using longer-term incomes and year-to-year mobility means that the inequality of this distribution is less than the inequality of incomes in any particular year. The normative content of the mobility principle therefore hinges on views concerning the nature and validity of the benchmark that is provided by the distribution of longer-term incomes. As Shorrocks points out,[2] there is

> 'the presumption that individuals are indifferent between two income streams offering the same real present value. This might be true if capital markets were perfect (or if there was perfect substitutability of income between periods), but it seems likely that individuals are concerned with both the average rate of income receipts and the pattern of receipts over time. We may go further and suggest that individuals tend to prefer a constant income stream, or one which is growing steadily, to one which continually fluctuates' (Shorrocks, 1978, p. 392)

Thus, the argument is not only about the feasibility of smoothing incomes to achieve the longer-term average, but also the undesirability of the uncertainty associated with a fluctuating income stream.

This brings us to the fourth concept of income mobility, as income risk. To illustrate this, Shorrocks defines for each individual a 'constant income flow rate

[2] Shorrocks also draws attention to the assumption that the same measure should be used to summarise both the dispersion of longer-period incomes and the dispersion of per period incomes.

generating receipts which gives the same level of welfare as the income stream he currently faces' (Shorrocks, 1978, p. 392), and he argues that

> '[r]eplacing actual recorded incomes with this alternative income concept in the computation of inequality values introduces a new dimension into the discussion of mobility. No longer is mobility necessarily desirable. Changes in relative incomes still tend over time to equalise the distribution of total income receipts, and to this extent welfare is improved. But greater variability of incomes about the same average level is disliked by individuals who prefer a stable flow. So to the extent that mobility leads to more pronounced fluctuations and more uncertainty, it is not regarded as socially desirable. A more detailed examination of these two facets of mobility will provide a better understanding of the impact of income variability and the implications for social welfare.' (Shorrocks, 1978, p. 392-3)

Thus, even though income mobility has an inequality-reducing impact, mobility is not necessarily socially desirable if mobility represents transitory shocks. In this case, mobility is a synonym for not only income fluctuation but also unpredictability and economic insecurity. Fluctuating incomes are undesirable because most people prefer greater stability in income flows to less, other things being equal, if only because it facilitates easier and better planning for the future. But, more than this, by definition, transitory income variation is an idiosyncratic shock which cannot be predicted at the individual level: greater transitory variation corresponds to greater income risk, and greater risk is undesirable for risk-averse individuals.

What about the social desirability of individual income growth (the second mobility concept)? The answer is not clear cut because it depends on the nature of the income growth and who receives it. An increase in income for any given individual is a social improvement and an income fall is socially undesirable. The main issue, then, is how to aggregate gains and losses in the social calculus. Evaluation of the impact of individual income growth on the welfare of society as a whole requires a weighing up of the gains and losses for different people, and opinions are likely to differ about how to do this. An egalitarian may weight income gains for the initially poor greater than income gains for the initially rich because this will contribute to reducing income differences between them over time. But arguments to the contrary appealing to principles of desert or incentives might also be made. It might be argued, for instance, that differential income growth rates are of less concern if income gains among the rich reflect appropriate returns to entrepreneurial activity or to widely-acclaimed talents. The rise in bankers' bonuses in the manner observed in many Anglophone countries in recent years may not count as an example of the former. But as an example of the latter, we note the views of the UK's former Prime Minister Tony Blair expressed in an interview asking him whether it was acceptable for the gap between rich and poor to get bigger. His response referred instead to individual income growth:

> 'the justice for me is concentrated on lifting incomes of those that don't have a decent income. It's not a burning ambition for me to make sure that David Beckham earns less money... [T]he issue isn't in fact whether the very richest person ends up becoming richer. ... the most important thing is to level up, not level down'.[3]

[3] Interview on BBC Newsnight, 5 June 2001: transcript at http://news.bbc.co.uk/1/hi/events/newsnight/1372220.stm

We end this section with the observation that our discussion of the social desirability or otherwise of income mobility has referred to income movement from throughout the range of base-period income origins to all potential final-period income destinations. There has been no particular focus on persistence at the bottom or at the top. In part, this is because such a focus does not raise additional conceptual issues, except where to draw the cut-offs demarcating the poor and non-poor, or rich and non-rich. Indeed if the bivariate joint distribution is summarised using a transition matrix, then suitable definition of the income groups reveals the movement at the top and the bottom. @ do we believe this claim? @

2.3. Income mobility and social welfare

The discussion so far demonstrates that the impact on social welfare of greater income mobility is not clear cut, and depends on the mobility concept that is emphasised. A natural question for an economist to ask is whether there are explicit welfare foundations for the various mobility concepts that have been discussed so far. For inequality measurement, the use of an explicit model of social welfare is known to yield dividends: see, notably, Atkinson's (1970) demonstration of how inequality comparisons are intimately linked to comparisons of social welfare functions that are additive increasing and concave function of individuals' incomes. For mobility comparisons, the literature on welfare foundations is small, with contributions including Atkinson (1981a), reprinted as Atkinson (1983) **?**, Markandya (1984), and 2002.

The social welfare function (SWF) used in the multi-period context is a straightforward generalization of the one-period case discussed by Atkinson (1970). Overall social welfare, W, is the expected value of the individual utilities. In the two-period case, these individual utilities are $U(x,y)$, and weighted by the joint probability density $f(x,y)$. That is,

$$W = \int_0^{a_x} \int_0^{a_y} U(x,y) f(x,y) dx dy \tag{1}$$

where $U(x,y)$ is differentiable and a_x and a_y are the maximum incomes in periods 1 and 2. It is assumed that increases in income in either period are desirable, other things being equal (so positive income growth raises utility): $U_1 \geq 0$ and $U_2 \geq 0$. Welfare comparisons of differences in mobility for bivariate distributions f and f^* are based the difference

$$\Delta W = \int_0^{a_x} \int_0^{a_y} U(x,y) \Delta f(x,y) dx dy \tag{2}$$

where $\Delta f(x,y) = f - f^*$ is the difference in bivariate densities and the same $U(.)$ is used for the social evaluation of each distribution.

All four papers concentrate on the case in which the marginal distributions **x** and **y** are identical. In other words, the economic context is the same as the one used earlier to characterize positional mobility. In this case, all relevant mobility is encapsulated by the changes in individuals' ranks or by the transition matrix when individual incomes are classified into discrete classes. **?** show that if the SWF is additively separable across time periods (so that $U_{12} = 0$, then income mobility is irrelevant for social welfare: only the marginal distributions matter.[4] If, instead $U(x,y)$ is a concave transformation of the sum of the per-period utilities, then $U_{12} < 0$ and a sufficient condition for a welfare improvement $\Delta W \geq 0$ is that $\Delta F(x,y) \leq 0$ for all x and y. That is, differences in the cumulative bivariate distribution are lower at each point (a first-order stochastic dominance condition).

What sorts of differences between joint distributions are associated with such

[4]See also (Markandya, 1984) and **?**.

conditions being satisfied? **?** discuss the case of a transformation which leaves the marginal distributions unchanged but reduces the correlation between x and y:

$$\left\{\begin{array}{ccc} & x & x+h \\ y & \text{density reduced by } \eta & \text{density increased by } \eta \\ y+k & \text{density increased by } \eta & \text{density reduced by } \eta \end{array}\right\} \text{where } \eta, h, k > 0.$$

When the cross-period dependence is summarized using a transition matrix, this transformation is equivalent to shifting probability mass away from the matrix diagonal.[5]

What is the case for considering the case $U_{12} < 0$ rather than say $U_{12} > 0$ in social assessments? **?** consider the class of least concave functions associated with a particular preference ordering and the special case in which preferences are homothetic. In this situation, the utility function $U.$ is neatly characterized by two parameters: $\varepsilon > 0$ summarizing *aversion to inequality of multi-period utility*, and $\rho > 0$ summarizing the inverse of the elasticity of substitution between income in each period, i.e. the degree of *aversion to inter-temporal fluctuations in income* (Gottschalk and Spolaore, 2002, 295). The case $U_{12} < 0$ corresponds to the situation in which $\varepsilon > \rho$, i.e. multi-period inequality aversion offsets aversion to inter-temporal fluctuations (which are of course reducing multi-period inequality). Observe that when $\rho = 0$, an increase in income mobility must increase social welfare. In effect, we are giving total priority to the third concept of mobility:

[5]NB See (Jenkins, 1994) and also Fields and Ok (1999). Both articles question whether such correlation-reducing transformations are so intuitively associated with more mobility when the transformations are made off the diagonal.

with perfect substitution of income between periods, one is only interested in the reduction of multi-period inequality.

Gottschalk and Spolaore (2002) point out that in this model origin dependence has no role.[6]. In transition matrix terms, if there is any preference at all for income reversals ($\varepsilon > \rho$), not only does an increase in mobility represent a social welfare gain, but the complete reversal scenario is preferred to the origin independence one. This is somewhat ironic given that Atkinson's (1981a, 1980?) discussion of mobility measurement, which is based on the **?** model, refers to inter-generational mobility rather than intra-generational mobility and we have seen earlier that origin dependence is the mobility principle most commonly espoused in that context.

An important contribution of (Gottschalk and Spolaore, 2002) was to show that greater origin independence can be social welfare improving if the SWF is generalized to take account of aversion to future income risk. In the two-period context, they drop Atkinson and Bourguignon's assumption that period-2 income is known with certainty in period 1. Individuals take conditional expectations of period-2 incomes based on observed period-1 incomes and he joint density of outcomes. With homothetic preferences, the utility function is now characterized by a third parameter, γ, summarizing the degree of aversion to second-period risk. As they demonstrate,

> Origin independence reduces both multi-period inequality and intertemporal fluctuations, but increases future risk. Individuals will positively value origin indepedence as long as aversion to multi-period inequality and aversion to fluctuations dominate aversion to future risk (ε and

[6]See also the similar remarks by Fields and Ok (1999, pp. 578-9)

ρ are not smaller than γ, and at least one of them is larger).(Gottschalk and Spolaore, 2002, p. 204)

In summary, evaluating income mobility in terms of social welfare has payoffs. Within a single unifying framework, it can be seen that whether an increase in income mobility is social welfare improving depends on the priority given to different mobility concepts. For instance, reversals are less likely to be valued the greater the aversion to inter-temporal fluctuations and to future income risk, but more likely to be valued the greater the aversion to multi-period inequality. Nonetheless one limitation of the SWF framework discussed so far is that it does not incorporate evaluations of mobility in the form of individual income growth – other than the aspects also picked up by the other concepts. One exception is Bourguignon (2011) who shows that the Atkinson and Bourguignon results can be applied to comparisons of alternative 'growth processes' in the case in which the marginal distributions for the first period are identical. However the dominance conditions that Bourguignon derives are complex, and their applicability is restricted by the constraint on the base-period distribution.

An alternative strategy is to assume preferences over mobility directly. That is, the individual-level utility function is the product of some measure of 'distance' between first and second period incomes for each individual i, $\delta(x_i, y_i)$, where the distance function is common to all individuals, and a social weight. Overall social welfare is the weighted sum over individuals of the δ_i. King (1983) and Chakravarty (1995) (1984?) assume that δ_i is a function of period-1 and period-2 income ranks (the positional mobility case), and that re-ranking is desirable ($\partial W / \partial \delta_i > 0$) and the social weight is increasing in period-2 income. By contrast, for Van Kerm (2006); **?** and Jenkins and Van Kerm (2011), δ_i is a directional measure of individual income growth, and the social weight depends on base-year income ranks.

The major advantage of this alternative approach is that there is no necessary restriction to the equal-margins case (though this can be included), and there is great flexibility in the specification of the distance function δ_i. The disadvantage of the approach is that it runs the risk of being ad hoc rather than a general unifying framework like the **?** one.

All the welfare approaches described so far assume that W is a form of expected utility evaluation, though modified to context: **?** incorporated preferences that were not time-additive and in addition Gottschalk and Spolaore(Gottschalk and Spolaore, 2002) abandoned complete predictability of income. A different approach altogether is to suppose that evaluations are based not on expected utility but prospect theory. **?** explore this idea, utilising a utility function that incorporates reference-income dependence and loss aversion. The latter feature means that, over and above any preference for smooth rather than fluctuating incomes over time, fluctuations lower individuals' welfare directly since losses outweigh gains on equal size. This is a promising area of research, and chimes with more popular expressions of the problem of growing income risk. Hacker and Jacobs (2008) (2010?), for instance, specifically cites loss aversion as one of the factors related to the growth of income risk in the USA.

3. Mobility measurement

This section is about measuring mobility. We focus on the case where there are data for two periods – the most commonly-examined situation – but also comment on extensions to more periods. First we discuss descriptive devices by which we mean graphical and tabular methods for summarizing patterns of mobility. Second we describe how such devices are linked to dominance checks for mobility comparisons. Third we consider scalar indices of mobility. The fourth subsection considers topics such as the decomposability of mobility by population subgroup, and of total mobility into structural and exchange components. @We also comment on extensions to description of low- and high-income persistence.@ Throughout the section we relate the descriptive devices and measures to the different concepts of mobility identified earlier.

3.1. Describing mobility

In the two-period case, the bivariate joint distribution of income contains all the information there is about mobility, so a natural way to begin is by summarizing the joint distribution in tabular or graphical form. How one proceeds depends on the nature of the data to hand, and the mobility concept of interest. We have been assuming that income distributions are continuous but in practice it is often convenient to represent the data in grouped form, or the data may intrinsically discrete as in the case of ‘social classes’. In addition the information content of the descriptive device is related to the way (if any) in which the analyst standardises the marginal distributions of any one bivariate distribution and, when making comparisons of bivariate distributions, makes further adjustments, e.g. to control for differences in average income between the bivariate distributions for two countries. If one is solely interested in pure exchange mobility (changes in relative position), then both issues are dealt with by working with the ‘normalised rank’ implied by an individual’s income rather than the income itself. In this case, all the marginal distributions are standard uniform variates and the same across time periods and countries. But if the focus is on other mobility concepts, other standardisations may be used.

A mobility matrix, M, is constructed by first dividing the income range of each marginal distribution into a number of categories (which need not be the same in each period, but typically is) and cross-tabulating the relative frequencies of observations with each matrix cell: typical element m_{ij} is the relative frequency of observations with period one income in range (group) i and period 2 income in range j. The graphical representation of the discrete joint probability density function is the bivariate histogram. Alternatively, the mobility process may be represented by the transition matrix and the marginal distributions. Using Atkinson's (1980) notation, suppose that there are n income ranges, with the relative number of observations in group k in period one is m_1^k for $k = 1, ...n$, and correspondingly in period 2. The marginal (discrete) distribution in period one is summarized by the vector $m_1 = (m_1^1, m_1^2, ..., m_1^n)$ and correspondingly for period 2. Hence,

$$m_1^k = m_2^k A \tag{3}$$

When the focus is on pure exchange mobility, the ranges typically refer to quantile groups, with e.g each group containing one fifth of the population in the case of quintile groups. The transition matrix is then bistochastic. Mobility is entirely characterized by the transition matrix A. The extremes of perfect immobility and perfect mobility (both flavours) are straightforwardly represented. @ Should we include examples of transition matrices in this section to match the graphical examples below @

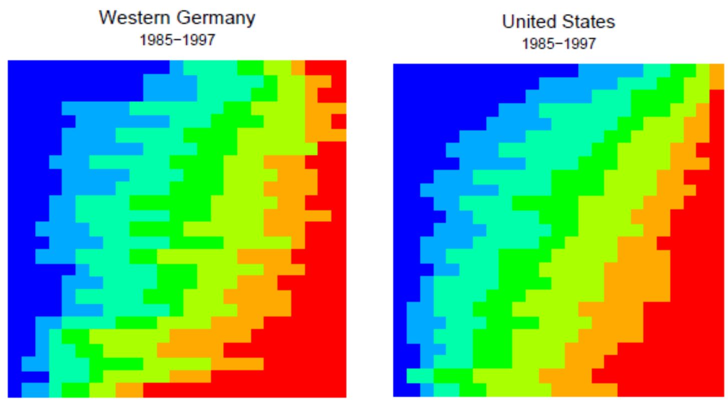
If the interest is in total mobility, the changes in the marginal distributions are also of interest. A particular example might be when the income class boundaries are defined as fractions of the poverty line, and there is interest in poverty rate trends as well as movements into and out of low income. More generally, using real incomes to define income boundaries provides indications about individual income growth for individuals of different origins; if each period's incomes are standardized by period-average income the information refers to income growth relative to the average. (We say 'indications' regarding this mobility concept because its essence refers to income changes at the individual rather than group level.) Similarly, the dispersion across origin groups of individuals from a common income origin may be indicative of income risk, but the connection is not altogether obvious. Neither the mobility matrix or the transition matrix are directly informative about mobility as longer-term inequality reduction.

The visual impact provided by graphical summaries can complement and sometimes be more effective than tabular presentations. Even transition matrices and comparisons of them can be 'visualised'. We refer, for instance, to the use of transition probability colour plots introduced by Van Kerm (2011). @ Van Kerm, P. (2011) 'Picturing mobility: Transition probability color plots', Presentation to 2011 London Stata Users Group meeting, London. *http://www.stata.com/meeting/uk11/abstracts/UK*
@ Suppose individuals are classified into vingtile groups in each of period-1 and period-2. For the visualisation, individuals are classified according to their income group in period-2, and lined up in rows with the poorest twentieth in one row at the top, the next twentieth in the row beneath, and so on down to the final row containing the richest twentieth. Each person is also tagged with their period-1 group membership using a colour coding system. Suppose the poorest twentieth in period-1 is represented by blue and the richest twentieth by red, and the intermediate groups are represented by the colours of the rainbow in between. If there were no changes in relative position over time, every one would remain in their period-1 income group: there would be a one-to-one correspondence between rows and colours. Rows would consist of full blocks of colour. If there no associ-

ation between income origin and income destination, every colour would form an equal-sized block in each and every row. If there were complete rank reversal, the original colour scheme would be reversed, with the richest period-1 group (red) in the top row and the poorest period-1 group (blue) in the bottom row. Examples of such representations, due to Van Kerm (2011), are shown in Figure 1 below for individuals' household income mobility between 1987 and 1995 in Western Germany (left) and the USA (right). It is immediately apparent that, over this twelve year period, there is substantial income mobility in both countries, and throughout the income distribution, including a small fraction of the richest twentieth falling to the poorest twentieth, and vice versa. But there is clearly no origin independence in either country, let alone complete rank reversal. Interestingly, however, it is clearly apparent that there are more changes in relative position in Western Germany than in the USA. The particular advantage of the transition colour plots is their visual immediacy. One disadvantage is that this relies on colour, and this is not always available. By necessity, the transition plots summarising income mobility in the book by Jenkins (2011: Figure 5.1) were reproduced in black and white, and arguably this reduced their effectiveness.

What about alternative devices? Perhaps the most straightforward way to summarize a bivariate joint distribution is using a scatterplot of period-two incomes against period-one incomes. Figure 2 provides a within-generation example using British income data for 1991 and 1992. @ Observe that intergenerational mobility studies tend to use graphical summaries much less than within-generation studies – unclear why. Is this a useful opportunity foregone? NB It does mean that the examples below are all drawn from the within-generation context. @ @ Question: instead of using examples from the work of others, should we instead create all

Figure 1 Transition colour plot examples. Source: Van Kerm (2011).



graphs and illustrative estimates using a single data source of our own? @

The advantages of the scatter plot are that it is very easy to produce and provides an immediate impression about the degree of immobility of incomes (the clustering around the 45° line), as well as the nature of the marginal distributions. For a focus on changes in relative position alone, the corresponding scatter plot would be of individuals' normalised ranks in each of the two periods (though we are no aware of examples of this @check@). @ NB connection to beta-coefficient and non-parametric summaries in later sub-section @ The main disadvantage is that potentially important detail is lost since the bivariate density is not estimated: there is no difference to the eye between 10 observations with a particular combination of period 1 and period 2 incomes and 100 observations with the same pair of incomes. The obvious way to proceed is derive and plot the joint density. The simplest estimates to produce are those of the bivariate discrete density (essentially plotting the bivariate histogram – see above). However, there are well-known disadvantages of such discretization: as in the univariate distribution case, the estimates are sensitive to choice of income class boundaries (@reference@),

Figure 2 Scatterplot example. Source: Jenkins (2011: Figure 1.1).

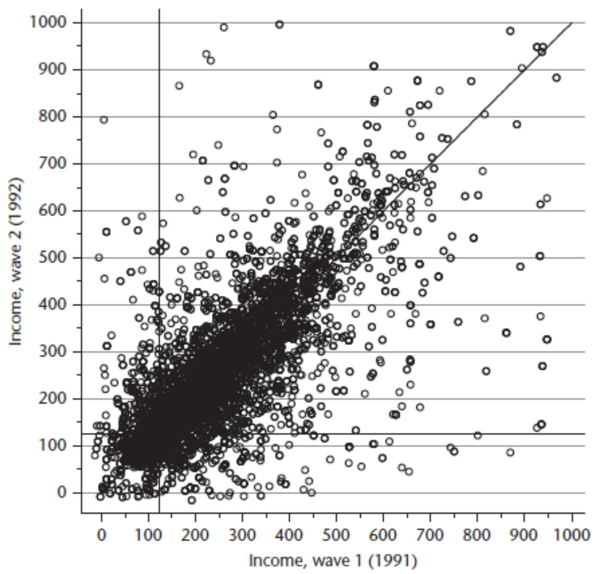


Figure 1.2. Scatter plot of 1991 and 1992 incomes

Notes: Sample of individuals (adults and children) present at BHPS waves 1 (1991) and 2 (1992) with incomes less than £1,000 per week. Each circle represents the incomes for the two years for each individual. The definition of income is given in the text (the adjustment for differences in household size and composition uses the Modified OECD equivalence scale). Incomes are expressed in pounds per week (January 2008 prices). The dark horizontal and vertical lines correspond to an income equal to 60% of contemporary median income (£123 per week for wave 1; £126 per week for wave 2).

and of course information within the ranges is lost with the grouping. Kernel density estimation methods avoid the problem because of the way in which they smooth data within a moving window rather than within fixed categories. Figure 3 shows a 'typical' joint bivariate density for West German family incomes for two consecutive years over the period 1983–89. Note that incomes in each year are normalized by the contemporaneous median, but otherwise the marginal distributions are not constrained to be same. This is not the exchange mobility case. Compared to the scatterplot, the concentration of individuals on and around the 45° representing perfect immobility is readily apparent. However the fine detail remains difficult to ascertain, partly because the three-dimensional representation has to use a specific projection. What is perceived may differ if the estimates were viewed from a different angle (including e.g. from the opposite direction). Related, differences in marginal distributions are difficult to examine; so too is individual income growth. A further issue, shared with the scatterplot and bivariate histogram, is that it is difficult to compare a pair of bivariate distributions, e.g. for two different countries, even if the plots to be compared are placed adjacent to other. Overlaying one plot on another is far too messy but, without some form of overlay, detailed comparisons are constrained.

Both issues are resolved to some extent by summarizing the density estimates using contour plots in which contour lines connect income pairs with the same density. An example is provided using US and West German income data for 1984 and 1993 in Figure 4. Income refers to the log of equivalised family income expressed as a deviation from the national comporaneous mean. Contour lines are drawn at densities that separate the quintile groups for each country (the 20^{th}, 40^{th}, 60^{th}, and 80^{th} percentiles). The solid lines are for the USA, the dotted lines

Figure 3 Bivariate density plot example. Source: Schluter (1998: Figure 1.)

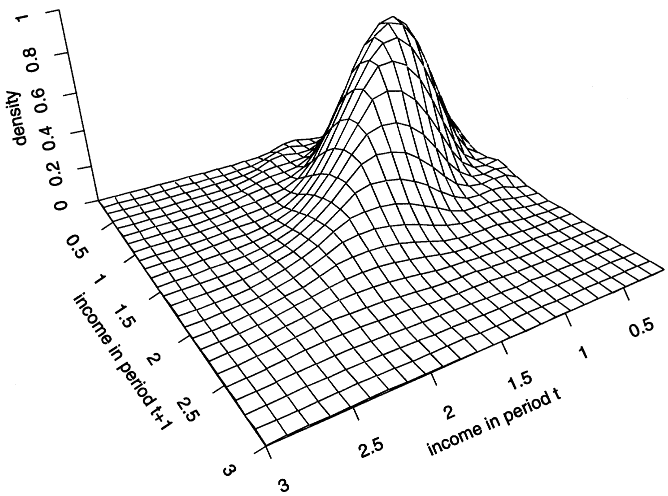


Fig. 1. A typical kernel density estimate for incomes in two consecutive periods.

are for West Germany. As Gottschalk and Spalaore (2002) comment, the plot reveals multiple features of the joint distribution. Each contour line for Germany lies inside its US counterpart indicating greater cross-sectional inequality in the USA. Clustering around the 45° immobility line is apparent for both countries but is greater for the USA. Also, the contour lines are generally flatter for Germany, meaning that expected period-2 income (conditional on period 1 income) varies less with period 1 in West Germany than it does in the USA. Gottschalk and Spalaore (2002) comment that this suggests a lower cross-period correlation in the USA, and they also point to a greater variation around the conditional means in the USA. Contour plots are also used in the US-West German comparisons by Schluter and Van der gaer (2011, Figure 2).

Just as contour plots for continuous income distributions correspond to mobility matrices, there are also devices for continuous incomes corresponding to

Figure 4 Contour plot example. Source: Gottschalk and Spalaore (2002, Figure 1).

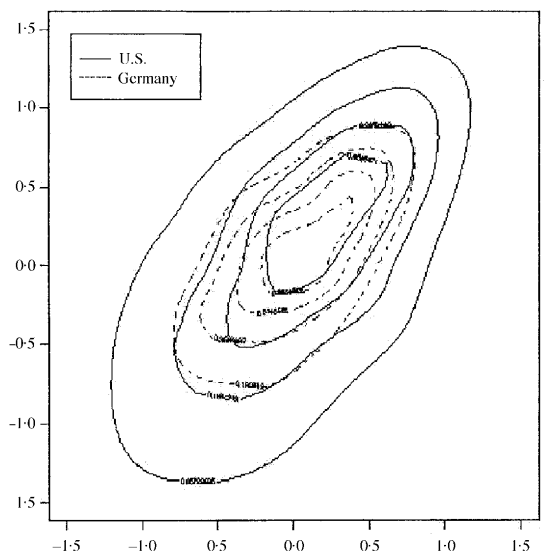
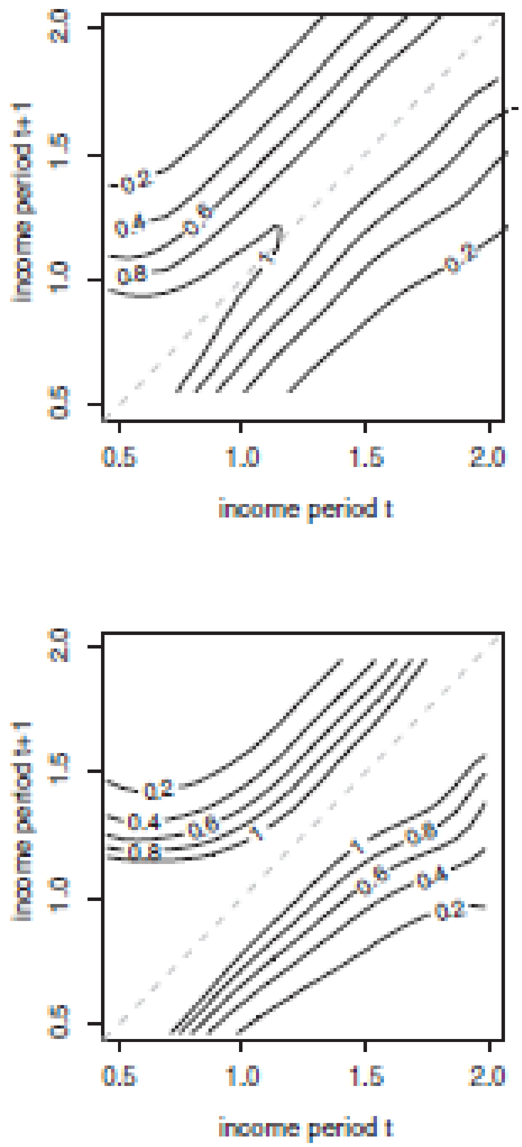


FIGURE 1
Kernal smoothed joint density of 1984 in income to needs ratio for Germany and the U.S.
(Deviations from 1984 and 1993 means)

the transition matrix. One requires estimates of the conditional density $f(y|x)$ which is straightforwardly estimated in principle using the fact that $f(y|x) = f(y,x)/f(x)$. Estimates of the numerator and denominator are derived across a grid of values of x and y using kernel density estimation. See Quah (1996 Journal of Economic Growth) who refers to this concept as a 'stochastic kernel'. Applications to income mobility include Schluter (1998 Econ Letters) and Schluter and Van der gaer (2011, Figure 2, RIW). Compared to unconditional joint density plots, the conditional density plots allow a more direct comparison of expected income growth across the base year income range. Examples are provided in Figure 5 based on data for the USA (top chart) and Western Germany (bottom chart) for 1987 and 1988. Income is equivalized net household income expressed relative to the 1987 median. Schluter and Van der gaer (2011: 11) point to not only the greater spread of contours in the USA indicating differences in marginal distributions, but also that the 'particular ... feature of the conditional densities is the greater upward mobility of low-income Germans' compared to low-income Americans. Note the more distinct upturn of the contours in the top left of the Western German chart compared to the shape of the corresponding US contours.

Observe that conditional densities are not the same as conditional probabilities, which is what constitute the transition matrix. Estimation of the conditional (cumulative) probability density $F(y|x)$ requires integration over the marginal distribution of y. As Trede (1998) explains, estimates of $F(y|x)$ can be inverted to give the probabilities for second-period income conditional on particular values of first-period income ('p-quantiles'). Trede's device for 'making mobility visible' is a plot of these p-quantiles against first-period income values. Figure 4 shows one of these non-parametric transition probability plots using data for West Ger-

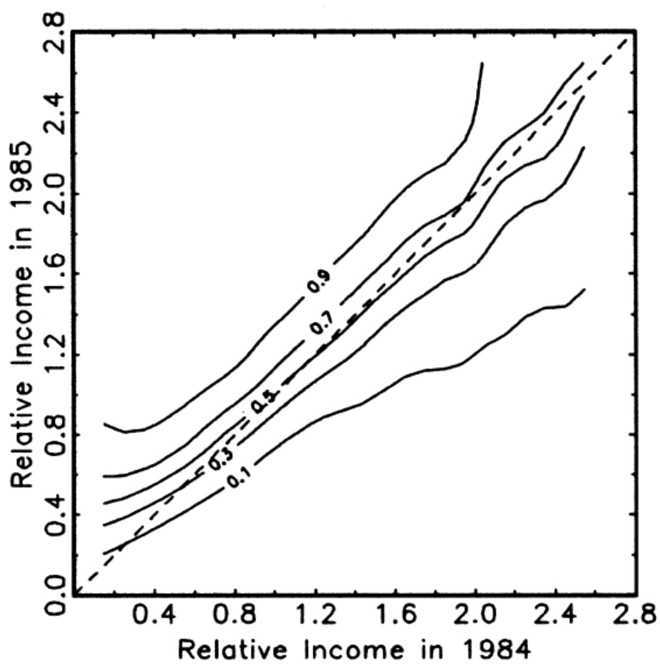
Figure 5 Conditional density plot example. Source: Schluter and Van der gaer 2011, Figure 2). Year t refers to 1987; year $t+1$ refers to 1988. The top chart refers to the USA; the bottom chart to Western Germany.



man equivalized family incomes in 1984 and 1985. Incomes are normalised by the 1984 median, so ‘growth mobility is not excluded from the analysis’ (Trede 1998: 80). In the extreme case of origin independence, each transition probability contour would be horizontal. If, instead, there were complete immobility so that second period incomes were completely determined by first period incomes, the contours would lie on top of each other. (In particular, if there were no change in median income, the contours would lie on the 45° line.) The greater the gaps between the contour lines, the greater is inequality in the second period. The slope of the contours is generally less than 45°, indicating some regression to the median. Figure 6 shows that, among individuals with median income in 1984, around 10 per cent have an income less than 0.7 and about 10 per cent have an income of at least 1.7 of the 1984 median in 1985. Methods closely related to Trede’s are used by Buchinsky and Hunt (1999 REStat Wage mobility in the United States) to derive non-parametric estimates of transition probability estimates, which the authors report in tabular rather than chart form.

Patterns of mobility in the form of individual income growth are not shown directly in the devices discussed so far. The simplest way to focus on this aspect to define income growth at the individual level between the two periods using some measure of directional income growth (Fields and Ok 1999), thereby converting the bivariate joint distribution to a univariate distribution of income changes. Then all the devices commonly used for summarizing univariate income distributions are available with one important proviso. Income changes may be negative or zero and not restricted to positive values (and the mean change may also be zero or negative). However, the ratio of second-period income to first-period income is positive (assuming incomes are positive), and it is often convenient to use this

Figure 6 Non-parametric transition probability plot example. Source: Trede (1998, Figure 1).



metric. Schluter and Van der gaer (2011: Figure 2) present kernel density estimates of the distribution of income ratios. If distributions of income changes are evaluated using a social welfare function that is an increasing function of individual income changes, the non-intersection of the cumulative distribution functions provides a first-order stochastic dominance result. This idea is exploited by Fields et al. (2002) using multiple definitions of income change. @ Fields, G.G., Leary, J.B., and Ok, E.A. (2002). 'Stochastic dominance in mobility analysis', 75, 333–339.) @ Comparisons based on plots of CDFs of income change distributions are also presented by Chen (2009: Figure 4) and Demuynck and Van der gaer (2012: Figure 1).

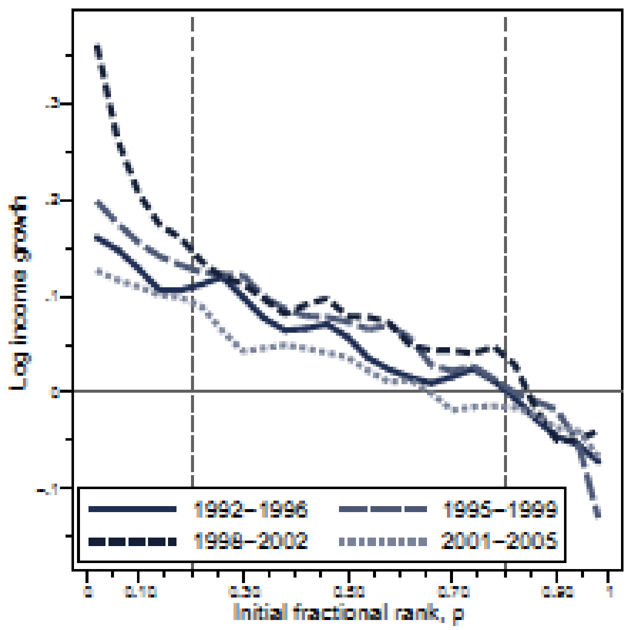
Observe that a CDF plot of this type is based on an ordering of individuals from smallest (most negative) income change to the largest income change. One is often interested in the extent to which individual income growth is 'pro-poor', that is whether income growth is greater for those at the bottom of the first-period income distribution relative to those at the top. In particular, pro-poor growth between two periods is a factor reducing the the inequality of second period incomes relative to first period incomes.[7] See also the discussion of social welfare functions in Section 2. Fields et al. (2003) @ Fields, G.S., Cichello, P.L., Freije, S., Menédez, M., and Newhouse, D. (2003) 'For richer or for poorer? Evidence from Indonesia, South Africa, Spain, and Venezuela', Journal of Economic Inequality 1: 67–99, 2003.@ plot (average) change in log per capita income between two time points against income in the base year, for four countries. Comparisons

[7]But pro-poor growth does not guarantee inequality reduction, because it also leads to reranking which may have an offsetting effect. See Jenkins and Van Kerm (2006 @OEP@ for a fuller explanation and empirical examples.

across countries are constrained by the fact that income range on the horizontal axis (base-year income) varies tremendously. Comparability is enhanced if, instead, one plots individuals' average income change against their normalised rank in the base-year distribution (with individuals ordered from poorest to richest). The horizontal axes in this case are bounded by 0 and 1. Such plots were developed by Van Kerm (2006, 2009) (2006 @Comparisons of mobility profiles, IRISS WP 58, CEPS, Luxembourg. 2009: Income mobility profiles, Economics Letters, 102, 92–95.@ and independently by Grimm (2007) @ Grimm, M. (2007). 'Removing the anonymity axiom in assessing pro-poor growth', Journal of Economic Inequality, 5, 179–197.@ Extensive empirical examples are provided by Jenkins and Van Kerm (2011 WP) for four five-year periods in Britain during the 1990s and 2000s, from which Figure 7 is taken. (Individual income growth refers to the change in the log of individuals' household income between two years.) It is clear that income growth is distinctly pro-poor in each of the subperiods, especially 1998–2002.

In sum, we have reviewed a portfolio of tabular and graphical devices for summarising income mobility between two periods. By standardizing marginal distributions in different ways, different aspects of the mobility process can be focused on and, for individual income growth, there is a separate devices. Interestingly, within-generation income mobility analysis has tended to use graphical summaries and comparisons rather more than between-generation mobility analysis. This has mainly relied on transition matrix tabulations for detailed summaries of the mobility process. In part, this emphasis is because the mobility concept most associated with inter-generational mobility is pure positional change totally separate from any changes in the marginal distributions. Nonetheless, there do

Figure 7 Individual income growth and mobility profiles. Source: Jenkins and Van Kerm (2011).



appear to be opportunities forgone to use other methods to describe the distribution. @refer forward to (over-)reliance on one-number elasticity summaries in intergenerational context later.@ Our final observation here is that there appear to be no straightforward descriptive summaries that directly highlight the concepts of mobility as longer-term inequality reduction or as income risk. In the former case, and as we show in the next section, representations have been used but they rely on choosing one particular inequality index. In the latter case, one wants something analogous to the mobility profile, but instead of summarising expected (average) income growth conditional on base year income or income position, one would summarise conditional income dispersion.

3.2. Mobility dominance

Dominance checks are a widely-used part of the analyst's toolbox for comparing univariate distributions of income. To what extent can and should this be the case for mobility comparisons. We referred parenthetically to several results in the opening sections. We now discuss them more systematically. We identify three main approaches. @ Question: should this subsection be folded into the earlier one on welfare functions? @

The most well-known dominance result for mobility is that of Atkinson and Bourguignon (1982), discussed further by Atkinson (1980, 1981) @1981 JPost-Keynsian Econ@, and cited earlier. The social welfare function is the expected value of individuals' utility functions defined over period-1 and period-2 income, where individual utility is an concave transformation of the per-period utilities of income, and also increasing in each income. In the situation in which the distributions to be compared have identical margins, Atkinson and Bourguignon show that unanimous rankings according to this social welfare function can be checked by comparing the difference in the cumulative bivariate probability distribution functions for the two distributions in question (a first order stochastic dominance result). If the two joint distributions are represented using transition matrices the dominance check corresponds to a straightforward cumulation of differences in cumulative sums across cells of the matrix starting from the lowest origin and destination group in each generation. Atkinson (1980, 1981) demonstrates the approach in action using intergenerational income data for Britain. The dominance result is a notable addition to the tool box for bivariate distributions but, perhaps surprisingly, has not been widely used, and we have not seen reasons for this enunciated. We can think of several reasons. The first is that, although relevant to evaluations of pure positional change mobility, the social welfare function is sensitive to mobility as reversals rather than mobility as origin dependence (see the earlier discussion). Second, the first order dominance checks have not provided clear cut rankings in practice (cf. Atkinson 1980, 1981). A natural reaction in this case is to seek unanimous rankings according more restricted classes of social welfare functions using second- and higher-order dominance checks that correspond. Atkinson and Bourguignon (1982) provide the theoretical results. The problem, however, is that the required restrictions on the SWF are hard to interpret. They involve the signs of third- and fourth-order partial derivatives of the individual utility function with respect to income. Although Atkinson and Bourguignon point out that in the case of homothetic preferences, 'the signs of higher derivatives depend on the relation between the degree of "inequality-aversion" ... and the degree of substitution' between periods (1982: 18), i.e. parameters ε and ρ discussed earlier, they do not elaborate. It is difficult to understand what the sign conditions mean in everyday language. Third, analysts may be interested in alternative concepts of mobility besides positional change.

Individual income growth is the most prominent example of this situation. As discussed earlier, researchers have used social evaluation functions that are increasing functions of a measure of 'distance' between first and second period incomes for each individual i, $\delta(x_i, y_i)$, and defined social welfare as the socially-weighted sum over individuals of the δ_i. Interestingly, in their article on 'stochastic dominance in mobility analysis', Fields, Leary, and Ok (2002) @ Econ Letters @, for instance, propose checks based on comparisons of pairs of cumulative distribution functions of δ_i (where δ_i is defined in six different ways in their empirical application). Intriguingly, there is no explicit reference to the social welfare function in their article, but it is effectively the average of the δ_i (each individual's income growth is equally weighted). By contrast, Van Kerm (2006, 2009) explicitly derives dominance results for two classes of social welfare function defined over the δ_i. The first is when the social weights are simply assumed to be positive. Van Kerm shows that unanimous rankings by this evaluation function are equivalent to non-intersections of mobility profiles (the graphical device discussed earlier), a first-order dominance result. If one also assumes that the social weights are non-increasing functions of base-year income ranks (poorer individuals receive higher weights), unanimous social welfare rankings are equivalent to non-intersections of cumulative mobility profiles. Jenkins and Van Kerm show that this second-order dominance result is satisfied for a number of their comparisons of income growth in Britain across subperiods in the 1990s and 2000s.

Dardanoni (1993) @JET@ derives stochastic dominance results for rankings of mobility processes that are summarised by transition matrices. He considers pairs of monotone matrices with the same steady-state income distribution.[8] The social welfare function is defined on a vector containing each individual's lifetime expected utility (the discounted sum of per-period utility values, where each income class has a common utility value associated with it; there is no within-class inequality in utility). Overall social welfare is not the average of the individual lifetime expected utilities, since linearity combined with anonymity would imply that mobility is irrelevant for social welfare assessments (as discussed earlier). Instead, Dardanoni's social welfare function is 'a weighted sum of the expected welfares of the individuals, with greater weights to the individuals who start with a lower position in the society' (1993: 371). Thus there is a direct parallel with the social weight system employed in the welfare function used by Van Kerm (2006, 2009). Dardanoni shows that unanimous social welfare rankings by this evaluation function can be checked by comparisons of the cumulative sums of the 'lifetime exchange' matrices corresponding to the two transition matrices. (A lifetime exchange matrix summarises the joint probability that an individual starting in some income class i is in lifetime income class j.) These matrices depend on the discount factor underlying them: although in general mobility processes which improve the position of initially poorer individuals are more highly valued, the timing of utility receipt also matters. Dardanoni (1993) provides additional results for checking the robustness of dominance results to the choice of discount factor. The fact that actual societies may not be in steady state and transition

[8]Monotone transition matrices are those in which each row stochastically dominates the row above it. Essentially, being in a higher income class in the initial period means improved prospects in the second period. Most empirically-observed transition matrices are monotone or approximately so (Dardanoni 1993). If a regular transition matrix characterises a first-order Markov chain, there is a constant long run steady-state marginal distribution corresponding to that matrix.

matrices may imply different steady-state distributions limits the applicability of the dominance results. Dardanoni (1993) acknowledges this, but also points out that this could be remedied by focusing on bistochastic quantile transition matrices (as Atkinson 1980, 1981) did, in which case attention is restricted to changes in relative position. The orderings derived differ from those of Atkinson (1980), however, because the social welfare function is different. For instance, Dardanoni (1993) points out that maximal mobility according to his ordering corresponds to the situation of origin independence, not rank reversal. Finally, we observe that Dardanoni's dominance results appear to have been rarely used. As with the results of Atkinson and Bourguignon (1992), we suspect that is because applied researchers find them relatively complicated to interpret and implement.

In sum, we have shown that there are dominance results for mobility comparisons, but the 'toolbox' is much less settled than it is for comparisons of univariate income distributions. In part, the reason comes back (again) to the fact that there is a multiplicity of mobility concepts, and (related) a lack of consensus about how to specify the social welfare function function in the bivariate case. @ NB Another partial ordering result but for very specific class of income movement indices: Mitra, T., and Ok, E.A. 'The measurement of income mobility: A partial ordering approach', Econometic Theory, 12 (1): 77–102. Think whether/how relates to majorisation results about dominance for increasing convex functions. @

3.3. Mobility indices

@ Incomplete – notes to indicate direction will take @

* scalar indices widely used given issues with descriptive devices. Advantages: provide answers! About magnitude of mobility and mobility differences. Also decompositions (see later subsection). Potential disadvantage in interpreta-

tion since give different emphases to different mobilty concepts. Related to this, is the issue of "standardardisation" of marginal distributions and, related, whether indices are absolute, or weakly or strongly relative. (On this distinction, see e.g. Checchi and Dardanoni, Jenkins and Van Kerm, and Fields and Ok survey.) Examples at extremes. If want to focus on pure exchange mobility, then standardise so that identical margins (e.g. normalised ranks/fractiles) and scaling all incomes equiproportionately or equiabsolutely doesn't change the index. In contrast, for indices of individual income growth we may wish to have either or both equiproportionate or equiabsolute income changes to lead to changes in the overall index.

* main focus on measures calculated from unit-record data, rather than as summaries of transition matrices (for which see e.g. Shorrocks 1978 Econometrica and ...) This largely reflects our interest in income mobility rather than mobility in other variables such as social class which are intrinsically discrete. But also because unit-record data are widely-available now. And because a number of the transition based measures treat transition matrix as first-order Markov process ...

1. Ad hoc or 'intuitive' (Atkinson, Bourguignon and Morrisson 1992) indices (mostly re mobility as positional change). Easy to calculate and also widely-used descriptive statistical measures of association

(a) 'beta' coefficients and correlations: slope coefficient of regression of period-2 (log) income on period-1 (log) income, Pearson correlation of (log) income, Spearman rank correlation. Refer back to way in which these summarise the descriptive information (previous subsection) in one number. Measures of immobility rather than mobility. But easily converted. beta measure dominates in intergen field. Issue not much discussed is whether the variable of substantive interest is income or log income. Matters for interpretation, and for cross-national comparability . Most regressions use ‘log income’ rather than income for regressor and outcome : but could argue that this is simply a mechanism for getting a direct estimate of an intergenerational elasticity of income, i.e. unit-free measure of the degree of regression to (geometric) mean. And hence don’t need to standardize the marginal distributions by differences in marginal SDs of log income (i.e. use instead the correlation between log incomes rather than beta)? Alternatively, is the argument that the variable of interest really is log income since it is a plausible measure of the ‘utility of income’ (or, alternatively, use of log income for outcome relates better to path analytic regressions though go beyond measuring mobility to ‘explain’ it). In which case, standardization by marginal SDs of log income makes more sense? Comment on range of values and correspondence with max and min mobility

Vector generalisations of scalar measures (notably e.g. introducing non-linearities in the bivariate associations via origin-dependent regression coefficients, quantile regressions, etc.: see e.g. Björklund et al. 2007, Grawe 2004, Eide and Showalter 1999). Relationship to ‘proportion of variation explained’ measures as in the ‘sibling correlations’ literature.

(b) diagonality as immobility; and movement with change in income group as summarising mobility. Proportions of people remaining in the same income group (inverse of proportions of people not in same group) ... or adjacent one. Discretization of unit record data to income groups. Note also special case of low (or high) income persistence, entry or exit proportions as important special cases of this Comment on range of values and correspondence with max and min mobility Immobility ratio benchmarks (depending on number of fractile groups). Insensitivity to movements in regions outside the ‘diagonal’ zone Hence Bartholemew type measures of average 'jump' (based on change in quantile group membership) or, more generally with unit record data, based on average change in normalised rank. (NB Checchi and Dardanoni on slightly different versions depending on how treat ties in data.)

(b) Measures of individual income growth, especially the various axiomatized proposals by Fields and Ok (1996, 1999), and their different standardisations. (mainly within-generation) Reminder that focus on directional measures here. Cite Mitra and Ok as variant on Fields and Ok. More on different concepts of 'distance': D'Agnostino and Dardanoni (SCW Euclidean distance). Indices using social weights sensitive to base-year position: Jenkins and Van Kerm (2011)

(c) Mobility as reduction of inequality of longer-term income. (mainly within-generation) Note that only measure so far that straightforwardly generalises to more than 2 periods:

(i) Shorrocks (1978, 1981) as the basic reference. Measure of (im)mobility; 0/1 range if use inequality indices satisfying standard properties (ii) extension by Maasoumi and Zandvakili that uses a different definition of each person's longer-term income; essentially a generalised mean rather than simple mean, with choice of parameter summarising in CES terms the extent to which income assumed substitutable across periods (iii) variation by Fields (JEI 2010 or 2011) that makes the case for comparing inequality reduction with a different denominator – not with the longitudinal average of the per-period inequalities; rather instead inequality in first period income. (Refer back to discussions earlier about the normative status of initial income.) (iv) All the above depend on choice of particular inequality index. But sensitivity of (im)mobility measure to inequality aversion/GE parameter does not correspond with top/middle/bottom sensitivity of the inequality measure.

This importantly clarified by Schluter and Trede (Int Econ Rev 2003) on local versus global summaries. Sensitivity of mobility measure is part dependent on data, but they show some empirical regularities (U-shape) in the relationship between GE inequality parameter and mobility measure sensitivity at different parts of the income distributions being compared. Overall/global inequality reduction is difference in inequality of longer-term income and averaged inequalities in each period's distribution; expansions show that global measure is (approx – good approx) of weighted average of local comparisons, which means a comparison at each point along income range of a value for the longer-term averaged income, and average of the per-period distribution. Comparisons are at same income values, not at same percentiles (it's not a comparison of Lorenz curve for longer-period income distribution with some sort of averaged Lorenz curve for each per-period distribution). (v) check Chakravarty, Dutta and Weymark which uses inequality reduction idea, but utilises EDEincome for longer-term etc (and relate to above). [Used for European comparisons by Ayala and Saestre] (vi) analogous extension to poverty persistence via 'chronic poverty' (e.g. Jalan and Ravallion 1998, and extension by Duclos et al, JDE 2011)

(e) Income mobility as income risk. (mainly within-generation) * focus here on main non-parametric measures a la Gottschalk and Moffitt (1994 Brookings Papers Ec Activity) 'BPEA' method. (Refer forward to parametric model-based estimates of transitory variance.) Risk equated with 'transitory variance' in both cases. Calculate longitudinally average of (log) income for each person. Permanent variance is variance of this. Transitory variations per person are deviations from each person's long-term average income. Transitory variance is essentially the per-person variance of these, averaged over persons. Note close resemblance to Shorrocks type measure (pointed out also by Burkhauser and Couch in OHEI ch 21), with important difference being that implementation in BPEA method in terms of log income rather than income itself as in Shorrocks R measure and, related, use of var(logs) in effect as the inequality measure (non-convex). No 1:1 relationship because of this, but might expect R and BPEA to move similarly over time/ across countries (refer forward to empirical results section). Recent extension to "volatility" measures rather than transitory variance (see review in SPJ 2011; beginning with Shin and Solon et al.) Note Moffitt and Gottschalk (2012 JHR appendix) remark on relationship between volatility and BPEA measures in 2 period case. Also, how "volatility" measures are in effect looking at second moment of individual level income change distribution – by contrast with Fields-Ok measures focusing on first moment.

(f) Assorted other indices or issues ... or how to include them in above?? Cowell and Flaichaire (WP 2012) axiomatic approach too, but note my interpretation issue with one of their axioms (I've forgotten the label); also, related, Cowell (1985 REStud and monotonicity in distance idea; relate to remarks by SPJ 1994 HE measurement piece) ... ? ...

Gottschalk and Spalaore Atkinson-type indices with parameters related to 3 mobility concepts.

King (Econometrica 1984) and Chakravarty (1985 Econ Letters)

Decomposability ... by population subgroup, or total mobility in structural and exchange. Or should this be integrated into above (probably) Decomposability of total mobility: Markandhya (1984). Van Kerm. See also Fields-Ok, and Ruiz-Castillo (JEI 2004). Also Jenkins and Van Kerm (OEP 2006) decompose change in inequality of marginal distributions into components representing progressivity of individual income-growth and re-ranking (which may offset each other)

Especially, ...

(g) Summarising income mobility when there are more than 2 periods (and not using inequality-reduction idea)

* income trajectories and Jenkins (2011) 'spaghetti' statistical models summarising trajectories in terms of distributions of intercepts and slopes

* Mention of the nascent literature on measuring poverty persistence (going beyond counting # times poor within a fixed-time window), e.g. Bossert et al. (2008), all of which, remarkably, ignores left- and right-censoring of poverty spell data – which is ubiquitous, and has been emphasised since at least Bane and Ellwood (1986) who led much of the subsequent 'poverty dynamics' literature into spell-based approaches. Implications ...

@ What else?? @

4. Intra-generational mobility: evidence

@ This section is currently largely a statement of intent (unfortunately). Ideas about coverage and proposed 'direction of travel' are set out in order to elicit comments and suggestions for future writing.@

This section reviews three topics: data requirements for measurement of intra-generational mobility and the nature of the data currently available, issues of empirical implementation, and an overview of mobility estimates. The last of these topics is relatively wide-ranging, reflecting different focuses on different mobility concepts.

@ should the following 2 subsections be combined into one to avoid repetition? @

@ data sources and data issues already reviewed in Jenkins (OUP, chapters 2 and 3, 50 pages of gory detail), so most likely we'll be looking to produce something for here that is a radically-shortened version of that. @

4.1. Data

Requirements: what would one like to have? For what research question? Studies of trends over time (needing many years of data – lots of short-period comparisons) versus studies comparing cross-nationally (short-period comparisons across multiple countries) or both (cross-national and trends comparisons). Measures exploiting more than two periods of data

For each period of interest, measures of earnings or income for a large representative longitudinal sample of individuals that are of good quality (low measurement error, low item non-response, etc. ...)

* the definition of (individual) earnings and (household) income, and the unit of income receipt. Related: earnings mobility and 'missing data' for non-earners

(especially women, and unemployed people more generally), and the effects this has on who gets examined in empirical studies. Example of comparability issue in terms of family income: US PSID 'family income' measures used by Moffitt and Gottschalk do not routinely include income deriving from non-refundable tax credits (EITC) or near-cash benefit income in form of Food Stamps (now called SNAP). Cf. imputations for such elements in CNEF, however. (BHPS and SOEP have these in their post-government income). More generally, observe that tax payments by individuals and households are imputed rather than observed – imputation algorithms based on tax-benefit system rules. = source of potential error?

* the income reference period: current versus annual measures of earnings and income. Shorter periods and greater mobility. (But note the relatively few studies of this – see Böheim and Jenkins (JOS 2006 re BHPS annual and current measures). A couple of later studies: Cantó, O., Gradin, C., and Del Río, C. (2006): Poverty Statics and Dynamics: Does the Accounting Period Matter?, International Journal of Social Welfare, 15, 209-218. Detlefsen, L. (2012): Earnings Inequality: Does the Accounting Period Matter?, Journal of Applied Social Science Studies (forthcoming).

* what samples for different questions? earnings (men; women; what counts as 'of working age') Income: should children be included or just focus on adults (or male heads of household, or ...). Exclude pensioners? Reliability of earnings data for self-employed people (virtually all analysis of earnings mobility is for employee earnings.)

Data sources for repeated measures on earnings and income: panel surveys and linked administrative record data ...

Panel surveys and cross-national analysis: the importance of comparability in design and variables. Input harmonisation (ECHP) versus output harmonisation (CNEF long panels for few countries; EU-SILC longitudinal component with short panels – max 4 years – for many countries)

Name-checks of main data sets used, referring on to the Evidence sections below. The dominant roles to date of ...

Cross-national studies: long-running household panels especially US PSID, SOEP, BHPS (mostly in CNEF form) but also some using ECHP. And a few using EU-SILC (more problematic) Country studies: administration data, especially on earnings (Nordic countries, US and UK ... but note older studies cited in e.g. Atkinson, Bouguignon and Morrisson) but also income tax records (US Kopchuk Saez and Song ..), plus household panels

Most evidence is for countries with long-running household panel surveys (USA, DE, UK) or administrative record data sets (Nordic countries, but some tax record data elsewhere e.g. USA). Highlight the importance of the Cross-National Equivalent File (CNEF) with comparable longitudinal data for cross-national comparisons, but it also means that the focus restricted to the same countries in most analyses. ECHP results. ECHP is outdated, but there are problems with using EU-SILC for mobility analysis.

4.2. issues of empirical implementation

Issues such as: ...

* selective attrition in longitudinal data, and (as for cross-sectional surveys) item non-response and non-coverage of very poorest or very richest

* Distinguishing 'true' or 'genuine' mobility from transitory variation and measurement error: cross-reference to discussion in corresponding intergenerational mobility section.

* Distinguishing genuine mobility from systematic variation with lifecycle (income increasing with age etc.)

* Implications of classical measurement error for other measures including poverty dynamics. Model-based studies, cf. Breen and Moisio 2004 and related literature that use 'marginal models' (transition matrix has error, but – strangely to me – initial distribution is assumed error-free, I think)

* Non-classical measurement error (cf. Gottschalk and Huynh 2010 for the within-generation case in a specific context (men's earnings) and particular longitudinal statistics – correlation)

* Statistical inference issues: simply ignore except to mention and also cross-reference to Handbook Chapter 7 (Russell)? (Is mobility going to be treated there? An additional issue here relative to the case of inequality and poverty comparisons is that of 'correlated data' across time.)

@ What else? @

4.3. Intragenerational mobility: evidence

@ Note to selves re how others have organised this section. (One issue is the multiple mobility concepts is use by comparison with intergenerational literature that is mostly fixated on 'beta' measures!) Organisation by Burkhauser and Couch (2009 OHEI): they cite research questions such as (i) is greater cross-section inequality associated with more or less mobility? (ii) how much longer-period inequality reduction as the reference period is extended? (iii) variation in mobility across the income distribution (mainly reference to transition matrices); and (iv) trends in mobility over time. But B & C mostly focus on mobility as inequality reduction. NB Some review of evidence are already in Jenkins OUP 2011, chapters 5-7.

@ how much to discuss mobility in individual earnings, and how much to discuss household income, or just squish all together? @

Potential headings for organisation of subsection

'BASIC FACTS': virtually all studies find, (i) over a one- to two-year window, lots of short-distance mobility but little long-distance mobility, at least for hh income. (This is for most mobility concepts). Illustrations using e.g. transition matrices from Hungerford for US in 1970s, 1980s, 1990s. Cross-cite similar for e.g. UK (Jarvis and Jenkins, EconJ 1998). And refer back to descriptive device examples from before (many re DE), and 'intuitive' scalar measures such as correlations and immobility ratios. (ii) longer-term inequality reduction as the reference period increased (more periods used for longitudinal averaging). Wide-ranging US study by Bradbury, K. 'Trends in US family income mobility, 1969-2006' BostonFed wp1110 Auten, Gerald and Geoffrey Gee. 2009. "Income Mobility in the United States: New Evidence from Income Tax Data." National Tax Journal 62(2): 301–328 (June). Dragoset and Fields, US

Related: Poverty persistence; high income persistence (e.g. Kopczuk, Saez, and Song 2010 for the USA).

MOBILITY AS LONGER-TERM INCOME INEQUALITY REDUCTION (SHORROCKS R)

* cross-national studies, mostly focusing on (Western) Germany versus UK. Discuss the long-standing 'surprise' result of Burkhauser and Purpore (2007) that in the 1980s (West) Germany was more mobile than the USA whether looking at men's labour earnings or household income (see also their chapter in Jenkins et al Hagenaars memorial volume and IintEconRev paper, largely because of greater persistence at the bottom in the USA (Schluter and Trede 2003). See also

Maassoumi-Trede REStat 2001. See also Jenkins and Van Kerm (OEP 2006); Gottschalk and Spalaore (2002). However in the 1990s there has been convergence in earnings mobility levels between western Germany and the USA (recent work by BayazOzturk, Burkhauser and Couch_NBERw18618, and by Riphan and colleagues). See also Chen (2009). [Note the choices made of how many periods to average over, and choice of inequality indices used]. Chen (RIW, 2009) adds Canada and UK to the mix (and has first sign of US-DE convergence). ? Try and add some evidence about differences by characteristics, e.g. sex, age, birth cohort ??

* national studies in addition to these: Jenkins (2011) for UK (no decline in R) [See also Dickens and McKnight using admin data on earnings]. Maassoumi studies with Zandvakili using US PSID – useful regarding whether choice of aggregation function for averaging across period incomes makes a difference. Check whether there are similar estimates for other countries ... Some estimates for Europe in Gangl (2005) ....

@@ Example text 'borrowed' from Jenkins (OUP 2011, pp. 137–8 @@ Cross-national comparisons provide a benchmark against which to assess the British situation. Chen (2009), using CNEF data for Britain, Germany, Canada and the USA over the period 1991–2002, provides the most directly comparable estimates for equivalized household income. According to MLD-based estimates of the immobility index R, Britain is distinctly more mobile than Germany which, in turn, is distinctly more mobile than Canada. For instance, taking 1993 as the initial year, R(5) is 0.80 for Canada, around 0.75 for Germany, but about 0.70 for Britain. (The USA's position is similar to Germany's, but is difficult to assess because of the change to biannual interviewing in 1997 by the PSID. For an earlier study finding lower mobility in the USA than Germany during the 1980s according to R measures applied to earnings and household income, see Burkhauser and Poupore 1997.) When Chen (2009) extends the reference period to 10 years, Britain remains distinctly more mobile than Germany: the R(10) estimates are 0.61 and 0.71 respectively. Using inequality indices other than the MLD to calculate R does not change the country rankings. Leigh (2009) calculates estimates of R(2) and R(3) using CNEF data for Britain, Germany and the USA, plus data for Australia (HILDA data were not included in the CNEF at the time). He finds that '[a]round 1990, the US was more immobile than either Britain or Germany ... During the 1990s, Germany became somewhat less mobile, and the US somewhat more mobile' (2009: 16) and that Australia was more mobile than all three other countries in the early 2000s.

Gangl (2005) compared income mobility between the USA and eleven European countries including the UK using European Community Household Panel data covering 1994–1999. His income definition is similar to mine but his sample is restricted to individuals aged 22–55 years. Gangl emphasises similarities across countries rather than differences: for example using a Theil-based index, 'about 75% to 80% of observed income inequality has been permanent over the 6-year observation period in most countries' (2005: 149–51). Nonetheless Germany, Ireland, and the USA are relatively immobile countries and the Netherlands and Denmark the most mobile ones. Interestingly, 'low-inequality countries ... also tend to be the countries exhibiting the lowest degree of persistence in income inequality over time' (Gangl 2005: 151). Germany is an exception to this description: it is relatively low inequality country but also with relatively high immobility. ECHP-based analysis by Gregg and Vittori (2009) comparing the mobility in labour earnings of individuals aged 20–64 across five countries provides rankings consistent with this. Inequality reduction is greatest in Denmark followed by Italy, and Germany is the least mobile, with the UK and Spain in between.

@@ end example text @@

MOBILITY AS INDIVIDUAL INCOME GROWTH

* Examples

Fields-Ok (1999 Economica), USA using PSID data. They write ... "Hungerford (1993) and Gittleman and Joyce (1995, 1996) maintain that the mobility rates were 'rather stable' in this period, Buchinsky and Hunt (1996) reported a 'sharp decrease' in wage and earnings mobility over time from 1979 to 1991. The works of Moffitt and Gottschalk (1995) and Gittleman et al. (1997), on the other hand, report a 'slight fall' in earnings mobility in the same period. (See Gottschalk 1997 for a survey.)" (Fields and Ok 1999: 465). ... @GOTTSCHALK, P. (1997). Inequality, income growth and mobility: the basic facts. Journal of Economic Perspectives, 11, 21–40. Gittleman M, Joyce M. (1999) Have family income mobility patterns changed? Demography 36(3):299-314. @ ... "We use precisely the same extract from the Michigan Panel Study of Income Dynamics that Hungerford used; we thank him for making this data set available to us. Our main finding is that the extent of movement of absolute incomes, as measured by m*n, increased in the United States from 0.498 during the 1969–76 period to 0.528 in the 1979–86 period—an increase of 6%, which is statistically significant at conventional levels. Perhaps even more interestingly, as measured by any directional movement measure of Proposition 2, we find that the aggregate change in welfare during 1969–76 was significantly positive, while the aggregate change in welfare during 1979–86 was significantly negative. ... These findings complement those of the earlier papers cited above. While the aggregate quintile order changes and the movement of relative incomes were (slightly) larger in the 1970s than in the 1980s, there was more income flux overall (and within quintiles) in the 1980s than in the 1970s. Moreover, as also suggested by many other authors, we contend that the income movement observed in the 1969–76 period was welfaristically more desirable than that observed in the 1979–86 period. We have also calculated the income movement for different demographic groups in the population; ...” (Fields and Ok 1999: 465)

Demunyck and Van der gaer (DE,US) and Jenkins and Van Kerm (2011) re GB. Chen (2009) has some cross-national calculations of Fields-Ok flux measure = average of abs(change in log income) and decomposition of directional average growth M_R (plus some subgroup decompositions of Shorrocks R). See also Ayala and Sastre (cited below) for selection of EU countries.

MOBILITY AS INCOME RISK

* estimates of the transitory variance and its trends over time

US: parametric (model-based) and non-parametric results (BPEA method notably) – notably Moffitt and Gottschalk’s multiple studies Britain (Jenkins 2011 reviews literature to date for men’s earnings) SPJ non-parametric estimates = no trend. Germany: e.g. Bartels and Bönke Canada: Beach and ? in recent RIW Pan-European: Gangl (2005) using ECHP

* [related] estimates of ‘volatility’ in earnings. See SPJ review of US and elsewhere, plus GB calculations (more extensive calculations for earnings in Cappellari and Jenkins 2013 in progress). [Note Gottschalk-Moffitt JHR 2011 appendix note re relationship between volatility and BPEA method estimates in the 2-period case)

ASSORTED OTHER STUDIES (how to pull these under one umbrella?):

Role of the Fisc: comparisons of mobility for pre-fisc and post-fisc income.

Decomposition into structural and exchange mobility: see references in measurement section e.g. Van Kerm (Economica 2004) for BE, DE, US using Fields-Ok movement measure

* pan European comparisons

ECHP comparisons by Ayala-Sastre for GB, DE, FR, IT, ES. Fields-Ok index with decomp by population subgroups; Chakravarty-Dutta-Weymark indices with Structural/Exchange/Growth decomp a la Ruiz-Castillo; EU-SILC comparisons by Van Kerm and Pi Alperin. Many countries but short time-period. Also illustrations of some of the pitfalls with data (comparability in this context).

?? How much to put in about poverty dynamics?

SUMMARY AND CONCLUSIONS RE EVIDENCE

@@ Extract from Jenkins (2011, chapter 5, summary and conclusions @@

First, there is a substantial degree of longitudinal flux in incomes between one year and the next, resulting in changes in relative position and a reduction in the inequality of longer-term incomes. It is also clear, however, that most income changes are relatively small and substantial inequalities in longer-term incomes remain after many years.

Second, the degree of longitudinal flux has remained remarkably constant during the period 1991–2006. It is only when one views mobility in terms of income growth and its progressivity that there appears to be some change over time. In particular, there appears to be a small increase in the extent to which longitudinal income growth benefits the poor rather than the rich after 1997. This can be explained by the lower unemployment rates and the redistributive reforms introduced by the Labour government.

Third, from a cross-national perspective, despite the increasing availability of comparable longitudinal data, it is difficult to draw clear cut conclusions about income mobility in Britain relative to other countries. One of the issues is that research to date has tended to employ only one mobility concept and to analyze different selections of countries. The most secure conclusion is that Britain is more mobile than Germany. In terms of average income growth and inequality reduction, Britain appears to be a mid-ranking country relative to the EU nations with data included in the ECHP. Mobility in Britain appears to be much the same or slightly greater than in the USA in terms of positional change but Chapter 6 shows that the reverse is the case for mobility defined in terms of transitory variation and volatility. Let us turn to examine this mobility concept in more detail.

@ so note that choice of mobility concept matters ... @

See also discussion in Jenkins (OUP 2011, end of Chapter 6) discussing potential reasons for differences in mobility patterns (of different types) observed between US, DE in comparison with GB. @

5. Inter-generational mobility: evidence

5.1. Data

In empirical applications, different income concepts have been used. Although data availability has often governed the actual choice, the underlying purpose of the study should ideally guide the income concept that is employed.

Many studies have employed a measure of pre-tax labor earnings, either annual or hourly earnings. This is a meaningful measure in that it captures the earnings power in the labor market. In some data sets, however, information about self-employeds' earnings is missing or measured less accurately, thus limiting the value of the analysis. Total factor income has also been used frequently. This is an even broader measure of income-generating power since it generally also includes capital income and some transfers depend on work and earnings history.

Both labor earnings and total income can be extended to both spouses, thus providing a measure of family earnings or family income. One advantage of such a pooling of income is that the impact of both parents is taken into account; otherwise it has proven difficult to account for mothers' incomes, which often are absent. In interpreting such a measure, one must consider that the intergenerational associations are affected by the degree of assortative mating in the marriage market: since spouses share similar family background, their combined income will be more strongly associated with each of their parents' than in the case when mating appears randomly; see Chadwick and Solon (2002)).

A few studies have used disposable income, which is defined at the household level, subtracts taxes and adds transfers, and it is usually based on the ratio of total income to the needs in the household. Disposable income is an appealing measure, since it is more closely related to the household members' consumption standard that economists believe determines their economic welfare. Thus, intergenerational analysis of disposable incomes comes closer to measuring the intergenerational transmission of welfare. However, one must consider that the "needs" of the household, as defined by the chosen equivalence scale, depends on the family structure. Therefore, estimates of intergenerational mobility using disposable income might reflect inheritance of family structure as well as inheritance of earnings or income capacity.

There is also a large literature in both economics and sociology on intergenerational transmission of educational attainment. Our focus is on income mobility and not on educational mobility per se. However education is a central mediating variable since parents can more easily influence their offspring's education than their income. One of our goals is thus to find out the role of education for intergenerational income mobility.

Whatever income measure is used, it is crucial that it is a measure of long-run income over a reasonably long period of time. The reason is that income during a short period of time, or hourly earnings at a specific point in time, is affected by various temporary factors. Obviously, such factors can make the association between, say, sons' income in 2007 and, say, fathers' income in 1975 quite week or even non-existent. Thus, the focus in this literature is on family associations in long-run income.

This is not to say that variation in income around a long-run level is irrelevant from an equality-of-opportunity point of view. A fluctuating income path often implies uncertainty about the future and thus a welfare loss. Such income volatility might very well be inherited from one generation to the next. Indeed, a common theme in the sociological class-mobility literature is that members of the working class are more exposed to income vulnerability than members of the service classes; see Goldthorpe and McKnight (2006)) for a recent treatment.

The next question is: what is a reasonable measure of long-run income to use in intergenerational income mobility studies? There is no simple answer to that question. Rather, the answer depends on how one wants to measure mobility, a question to which we return below.

The data set must, of course, identify kinship. Either data on parents and offspring or on siblings are needed for the analyses that we discuss in the paper.

With the survey design of, e.g., the PSID it took some 25 years of follow-up until the children in the initially sampled households in 1968 were observed at adult age. In the Nordic countries and Canada, it has been possible to use population registers and censuses to link family members. A major advantage of register data for intergenerational analysis is that larger samples improve the precision in the estimates of single parameters.

While this chapter is primarily about mobility in income, we should note that economic mobility can also be studied in other dimensions. The study of the transmission of socio-economic advantage from generation to generation is one of the core issues in sociology. Empirical research has taken place for almost a hundred years and the theoretical discussion is also rich. Not surprisingly, the available data, the statistical techniques as well as the possibility to handle large data sets with statistical techniques have improved markedly in the last couple of decades. Hence, the prospects for comparative research based on reasonably comparable data have improved. Nonetheless, comparability is a major concern in the literature that we have come across.

One can distinguish between two strands of intergenerational research in modern sociology.[9] One of them focuses upon the relationship between status or prestige attainment of two generations, in general fathers and sons. Occupation is used as the basis to define status and alternative scales that attach status levels to occupations have been suggested in this literature. For example, the famous Duncan status index (Duncan, 1961) used the average education and income of each occupational category. Treiman (1977) has constructed prestige scales from survey data on the average prestige that people attach to various occupations.

[9] Ganzeboom et al. (1991) offer a most informative survey of this literature.

The other strand of research defines socioeconomic status by social class but emphasizes that social classes are intrinsically discrete and unordered. Hence, the analytical task is to measure mobility among these classes.

The pros and cons of these two approaches to intergenerational mobility have been subject to a more than lively discussion within the sociological research community. Both approaches are prevalent and have strong positions in modern sociology.[10] The sociological literature on social mobility is far too vast to be reviewed here. We only want to note that it is a highly mature field that has generated enormous insight into intergenerational mobility. One milestone is the monumental book by Erikson and Goldthorpe (1992b), discussed e.g. in Erikson and Goldthorpe (1992a), Hout and Hauser (1992). See also Hout and Hauser (1992) and Sorensen (1992).

Economists have much to learn from sociologists in the analysis of intergenerational links. Indeed, long-run changes in socio-economic mobility, defined through occupation, have successfully been studied in the United States and the United Kingdom by Long and Ferrie (2005, 2007, 2013) by tracking father-son pairs in historical census records based on names and geographic location. A number of papers have recently appeared that make use of socio-economic variation in surnames to study long-run socio-economic mobility (Güell et al., 2007; Collado et al., 2012; Clark et al., 2012). However, we will confine ourselves hereafter to the economic literature on intergenerational mobility, defined primarily by being about the link between the long-run income, or some measure of the permanent income of parents and children.

[10] For discussions see e.g. Ganzeboom et al. (pp. 3–7 1992), Erikson and Goldthorpe (1992a), Hout and Hauser (1992) and Sorensen (1992).

5.2. Measuring between-generation associations

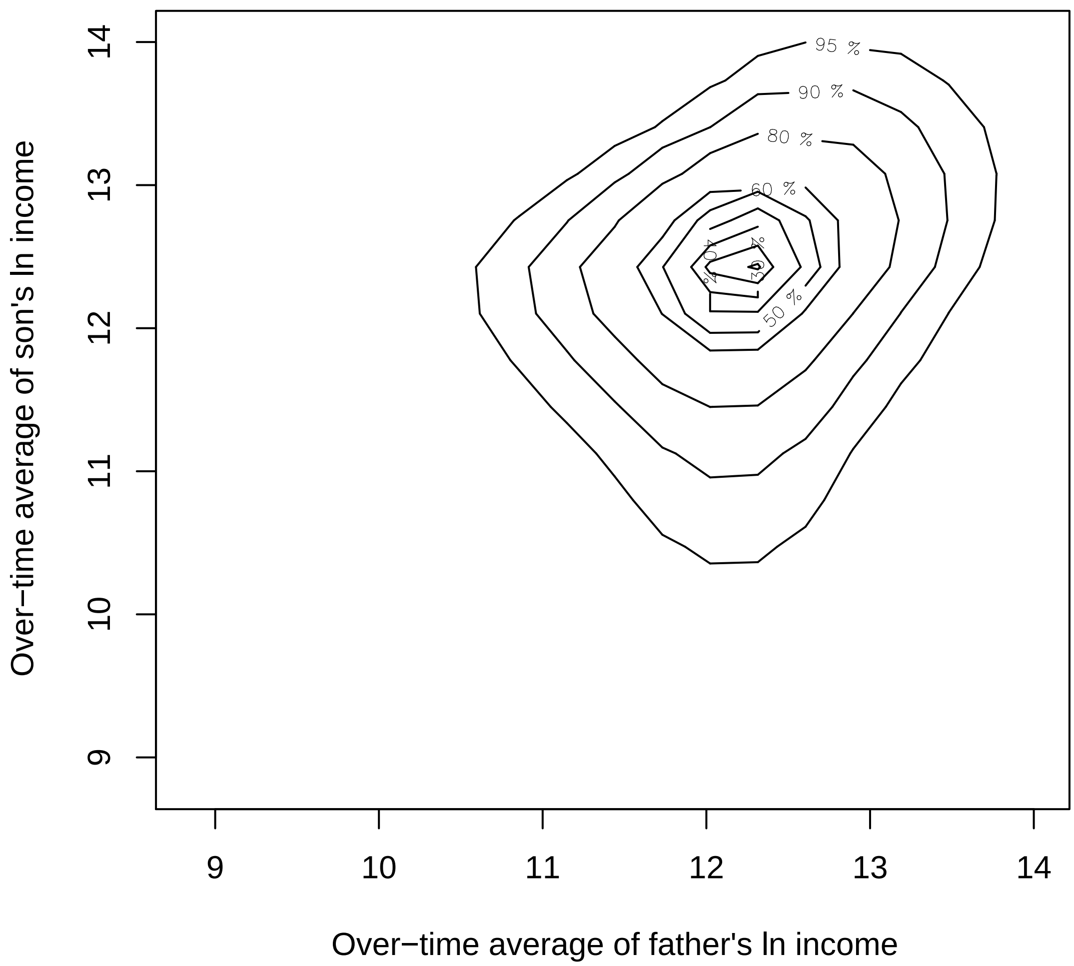
We start by looking at the association of sons' long-run income with that of their fathers. Denote the long-run, or over-time average of the natural logarithm (ln) of income of the father and son in family i as y_{fi} and y_{si}, with generational variances σ_f^2 and σ_s^2, respectively. Intergenerational associations can be found by studying the joint distribution of father's and son's income. A starting point is the bivariate distribution of the over-time average income, or its natural logarithm, for fathers and sons.

The true functional form is of course unknown. In its place, we plot in Figure 8 the estimated bivariate density of fathers' and son's (natural logarithm of) long-run income.[11] The plot is drawn so that the axes include the innermost 99.9 percent of the marginal distributions – i.e., we exclude from the picture pairs where either the son's or the father's income is in the lowest or highest 0.5 percent. The contours show the shape of the bivariate density for regions that enclose cumulative decile groups of the bivariate distribution. For instance, the outermost contour leaves 10 percent of the observations on the outside, whereas the next contour leaves 20 percent, and so on.

One of the things to note in this bivariate distribution is that the shape of the distribution in the south-west part suggests that there are very few father-son pairs where both have low income, as indicated by the negative slope of the 10 percentile group contour in that region. We shall return to this point below. We should also not that we have not (at least not yet) conditioned either father's or

[11]The bivariate density, as well as the non-parametric regressions we show below, were estimated using the software package **R** (Ihaka and Gentleman, 1996) using the `locfit` package for non-parametric estimation (see Loader, 1999).

Figure 8 The bivariate distribution of son's and father's over-time average ln income



Note:
Source: Authors' computations from Swedish register data.

son's income on age.

So given a bivariate distribution of parent-offspring income, such as our father-son distribution in Figure 8, what succinct ways can be used to summarise the extent of mobility in that distribution? The way in which to summarize mobility depends, among other things, on how much information one has access to.

One candidate, which turns out to have quite low data requirements, is to estimate the regression of son's income on that of father's. When applied to data that are expressed in natural logarithms, the regression coefficient on father's income is the intergenerational elasticity, i.e., it measures the percentage change in son's income wrt. to a marginal change in the income of the father.

The intergenerational elasticity would be found by applying ordinary least squares (OLS) to

$$y_{si} = \alpha + \beta y_{fi} + \varepsilon_i. \tag{4}$$

Usually, researchers either measure incomes as deviations from the age profile or add a polynomial in age to the estimating equation to control for differences in the age-income profile. As is well known, if long-run income is unavailable and annual incomes $(y_{fit}, y_{sit'})$ are used instead, the OLS estimate will suffer from attenuation bias (or attenuation inconsistency) if the transitory errors that cause annual incomes to deviate from long-run income are "classical".[12]. I.e., the transitory errors v_f are assumed to be independent of the true value of long-run income and to have a constant variance $\sigma^2_{v_f}$. In the case, the OLS estimator has the probability

[12]See, inter alia, Solon (1989), Jenkins (1987), Grawe (2006). Note also, however, that more complex models for the longitudinal process of annual earnings, such as Haider and Solon (2006) and Böhlmark and Lindquist (2006), show that the above extremely simple measurement model is observationally false. Several other problems may invalidate the measurement model outlined above. See Jenkins (1987) and Grawe (2006).

limit (ignoring the constant, α):

$$p\lim\widehat{\beta}_{OLS,t} = \frac{\beta\sigma_f^2}{\sigma_f^2+\sigma_{v_f}^2} < \beta. \tag{5}$$

While the true long-run income of fathers is unknown, taking a multi-year average in its place leads, still under the assumption of classical and homoscedastic transitory errors v, to a downwards-inconsistent estimate of β:[13]

$$p\lim\widehat{\beta}_{OLS,TA} = \frac{\beta\sigma_f^2}{\sigma_f^2+\sigma_{v_f}^2/T} < \beta; \quad p\lim\widehat{\beta}_{OLS,TA} > p\lim\widehat{\beta}_{OLS,t}. \tag{6}$$

Note that getting a less biased estimate of β requires a multi-year average of father's, not son's income. The estimated correlation coefficient is, of course, affected by transitory errors in son's income, with

$$p\lim\hat{\rho} = \frac{Cov[y_f,y_s]}{(\sigma_s^2+\sigma_{v_s}^2)(\sigma_f^2+\sigma_{v_f}^2/T)} < \rho. \tag{7}$$

Thus, more accurate estimates of the intergenerational correlation coefficient require multi-year averages of both son's and father's income. The fact that a multi-year measure of son's income is needed to reduce the attenuation bias in the correlation coefficient is one reason the US studies in the early 1990s (Solon, 1992; Zimmerman, 1992; Altonji and Dunn, 1991) tended to emphasize the elasticities, as at the time the main US studies, the PSID and the NLS, had quite young sons.

In our Swedish data, we have multi-year measures of both father's and son's income – 8 years for both father's and son's income, so we can plausibly examine both the regression and correlation coefficients. First, we note that the slope

[13] We assume, in line with what is mostly found in the literature, that the the true β is non-negative. We also assume the data are balanced.

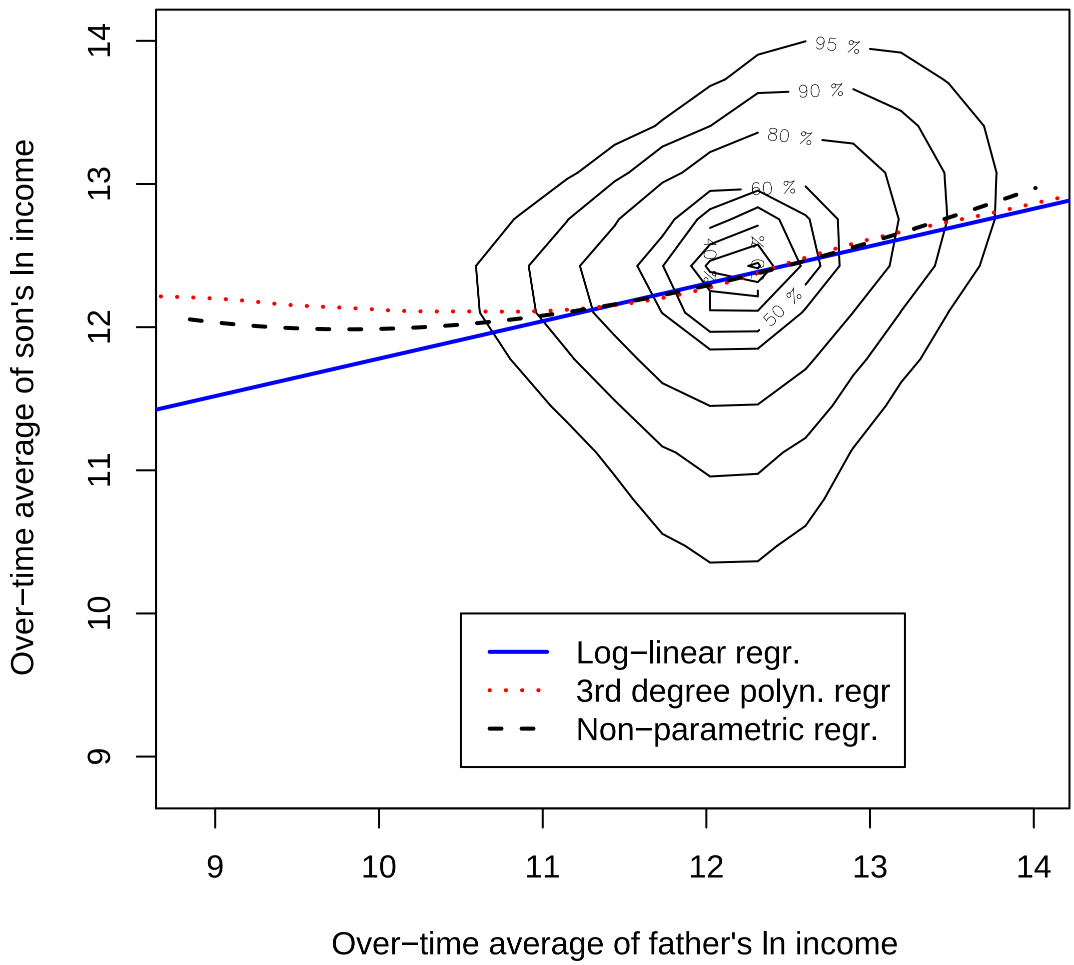
coefficient in a log-linear regression of son's over-time average ln income on father's over-time average ln income, the intergenerational elasticity β is estimated to be 0.262. This is very close to earlier estimates for Swedish father'son pairs. The correlation is estimated to be 0.192,which suggests that the marginal distributions of father's and son's incomes may be quite different. Indeed, inspection of the marginal distributions (not shown here) suggests that son's have both a higher mean and a greater variance than fathers.

Next, one might ask if the log-linear is a reasonable function form for the father-son relationship. One approach to this, that has been used e.g. for Canadian data by Corak and Heisz (1999) is to use non-parametric regression. Another approach, used recently by Bratsberg et al. (2007), is to include a higher-order polynomial in parental income in the estimating equation – i.e., to include e.g. quadratic and cubic terms in the estimating equation 4.

We plot in Figure 9, again, the bivariate density of fathers' and son's (natural logarithm of) long-run income. We add to this figure three estimates of the conditional mean or expectation of son's over-time average ln income, given father's, namely (1) the regression line from a bivariate regression of son's on father's income, drawn as a solid straight line, (2) the conditional expectation from a log-linear regression that includes a second- and third-order term in father's ln income as a dashed line, and (3) a non-parametric estimate of the conditional mean function as a dotted line.

A comparison of the linear regression line with the polynomial and non-parametric regressions suggests that log-linearity gives a reasonable fit, except at low levels of father's income. This is consistent with the finding in Bratsberg et al. (2007), which suggests that in the Nordic countries, the relationship between father's and

Figure 9 The expected mean of son's over-time average ln income given father's over-time average ln income



Note:
Source: Authors' computations from Swedish register data.

son's income is convex. We further note that the non-parametric regression suggest is less steep at both low and high father's income that the regression that includes second and third order terms in father's income.

Recall that the "time-averaging" approach to providing less-biased measures of parental income, discussed above, relies on a classical measurement error model in parental (and offspring) income. With multiple years of incomes in both generations, we can examine the plausibility of this assumption. We do so by examining the extent to which the within-individual over-time variance (measured by the variation from year to year of an individual's annual income around his over-time average) varies across the range of over-time average incomes we observe.

Figure 10 plots the expected value of the variance of an individual's ln income around his over-time average, estimated using local likelihood regression (using a gamma family to so the variances are positive, see Loader (1999)). Both variance functions suggest that the transitory errors have quite different variances across the level of over-time average ln income (or "permanent income"). In particular, those with low incomes are subject to substantially larger shocks than those with incomes in close to the mode of the distribution, who also have smaller transitory shocks than those at the higher end. Note also, that the son's are subject to transitory shocks that have a uniformly higher variance than those their father's faced (even if the difference near the mode of the distribution is very small. The difference is especially large at the very low end of the distribution.

Another approach to trying to summarise the information contained in the full bivariate distribution is to estimate quantile regressions of son's (or more broadly, offspring's) income on that of the father (see Eide and Showalter, 1999). While this may yield interesting insights, it is not immediately clear what question is

Figure 10 The variation of annual ln income across over-time mean of ln income – fathers and sons

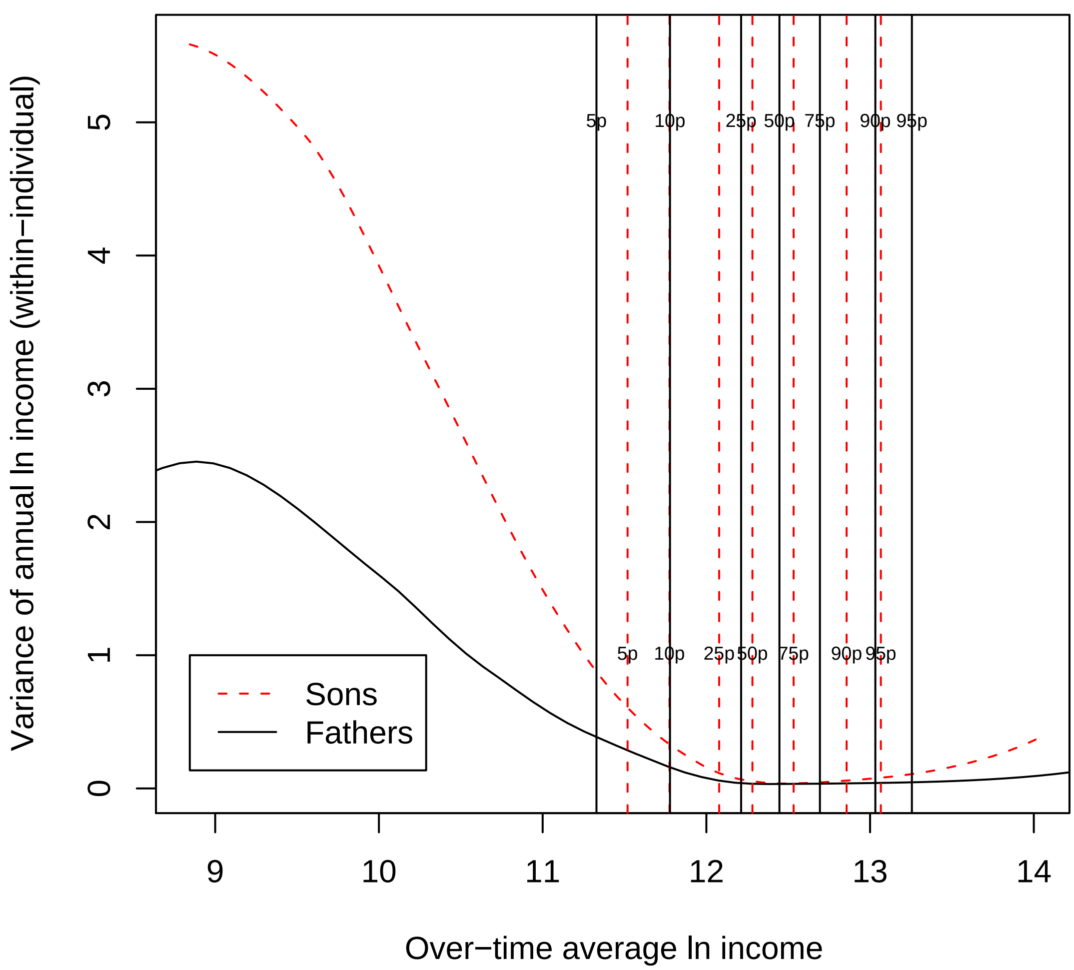
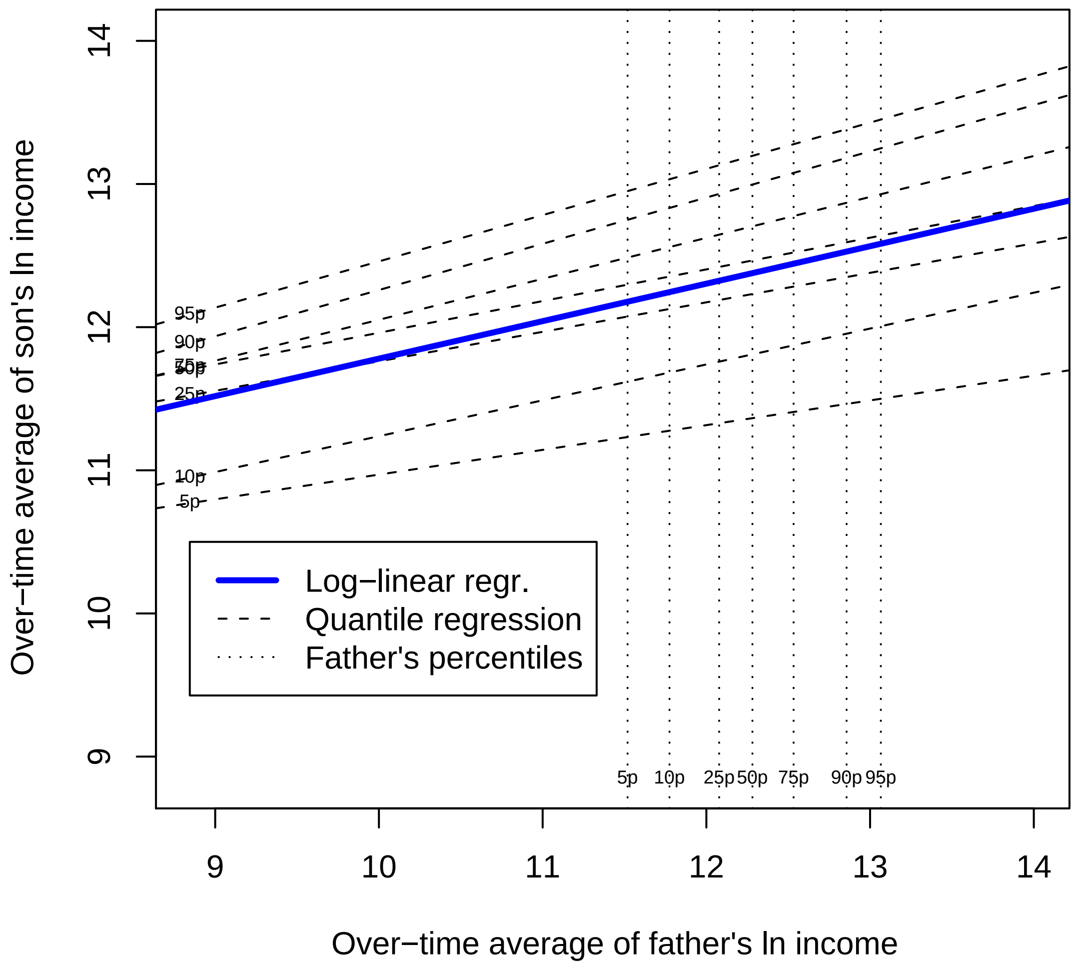


Figure 11 Conditional quantile regression, log-linear and kernel regression lines of son’s over-time average income conditional on father’s



Note:
Source: Authors’ computations from Swedish register data.

being answered when quantile regressions are reported. At a technical level, the answer is clear. A quantile regression of, say, the 10th percentile of son's ln income on father's ln income allows the researcher to express the 10th percentile of son's ln income as a function of father's income.

The coefficient on father's ln long-run income then measures the elasticity of the particular how quantile of son's long-run income with respect to father's income. Differences across the quantiles tell us how sensitive different parts of the son's distribution conditional on father's income to small changes in father's income. It is not immediately clear, however, why these marginal changes, measured by slopes of the conditional quantiles, are of interest.

We illustrate the use of quantile regression using a few figures. Figure 11 shows selected percentile's of son's income as linear functions of father's income. We have plotted as vertical dashed lines the corresponding pecentiles of father's income. The figure also shows the linear and non-parametric regression from Figure 8. We would argue that a figure like this does convey some potentially interesting information.

The slopes of the conditional percentiles wrt. to father's income, for instance, tell us how the distribution of son's income changes as father's income changes. Differences in the slopes for different percentiles may reveal differences in how much the son's income changes when father's income changes across the distribution. Our estimated slopes in Figure 11 suggest that the relative increase in son's long-run income tends to increase across the distribution, except that the slope for the 10th percentile is actually steeper, at 0.251 than the corresponding number for the 25th percentile, 0.206.

Another way to interpret Figure 11 is in terms of the full conditional distrbution of son's income. A picture that is familiar to all student's of regression analysis is the estimated regression line in a regression with one explanatory variable, with the distribution of the error term around that line drawn in a a few different levels of the explanatory variable. In the classical case, all those distributions are the same, or at least have the same variance, i.e., the error term is homoscedastic.

If the distribution of y_s, conditional on y_f, is homoscedastic, all estimated quantiles would have the same slope coefficient (save for random error). The differences that can be observed in the picture suggest that, while the distribution does not appear to be wildly different, the estimates do suggest that the conditional variance of son's may be increasing with father's income in that the slopes are higher for higher percentiles of the son's distribution.

A comparison of the quantile regression results with the log-linear regression reveal some further aspects of the conditional distribution of son's income, given that of the father. For example, compare the log-linear regression line, which gives the conditional expectation, and the line for the 50th percentile, which gives the expected median. For most of the range of father's incomes, the conditional mean is lower than that of the father. This suggests that, conditional on father's income, son's income is in fact skewed to the left, rather than (as is usually true for income distributions) skewed to the right.

We can use the predicted percentiles for different values of father's income to generate summary distributional statistics for the conditional distribution. For instance, we show in Figure 12 the (discrete) cumulative distribution functions for son's, conditional on a set of father's income percentiles. Unsurpsiringly, given Figure 11, these c.d.f.:s depict a case where we have a sequence of distributions that each first-order stochastically dominate each other (leaving aside the thorny

Table 1 Predicted inequality of son income by father's income percentile

Father p	**Percentile ratios**			**Share of 90/10**	
	p90/p10	p90/p50	p50/p10	p90/p50	p50/p10
5	1.131	0.453	0.678	40.1	59.9
10	1.150	0.479	0.670	41.7	58.3
25	1.172	0.510	0.662	43.5	56.5
50	1.186	0.531	0.656	44.7	55.3
75	1.204	0.556	0.648	46.2	53.8
90	1.228	0.589	0.639	48.0	52.0
95	1.243	0.610	0.633	49.1	50.9

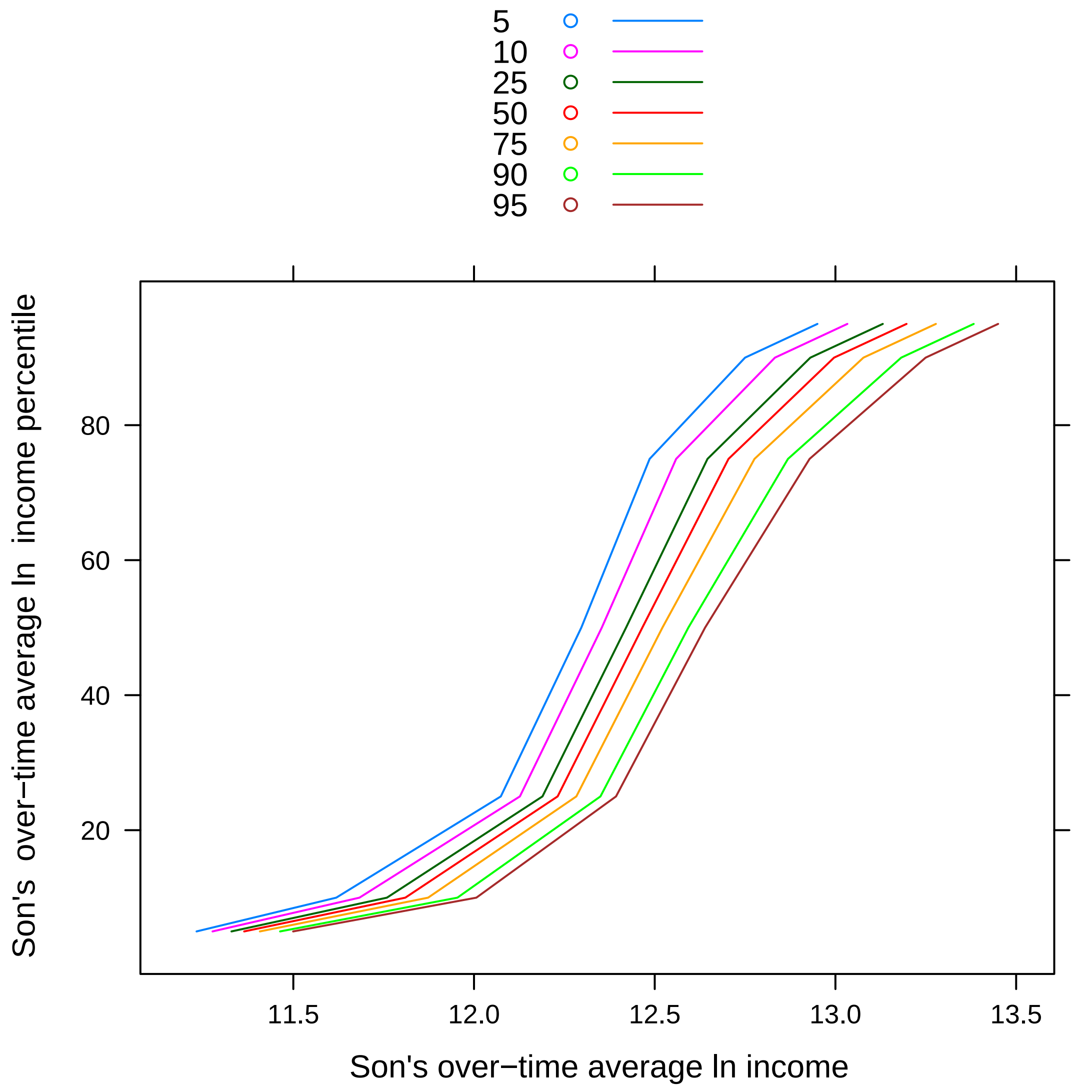
Note:

issue of statistical inference, however). If we were to invert the c.d.f..s, we would have a sequence of Pen's parade's, instead.

Any conditional summary statistics can be generated this way. For instance, we show in Table 1 the percentile ratios (in fact, ln differences) of the 90th to the 10th percentile of son's income at various points in the father's distrbution, along with its breakdown into the 90/50 and 50/10 ratios. We also show the proportion of the 90/10 is above and below median in the last two columns. This same information can be visually gleaned from Figure 11 by measuring the vertical distance between the 90th and 10th conditional percentiles at variious points along the horizontal axis. Or indeed, by taking the difference along the horizontal axis in Figure 12 of the various c.d.f.:s.

The numbers in Table 1 suggest that the dispersion of sons's income tends to increase with father's income. Furthermore, as father's income increases, the relative difference between the 90th and 50th as well as the difference between the 50th and the 10th percentile increase. The higher father's income, the greater

Figure 12 Conditional distribution of son's income given father's income percentile



Note:
Source: Authors' computations from Swedish register data.

Table 2 Quintile group mobility matrix – fathers' and sons' over-time average ln income

Father's q g	**Son's quintile group**				
	1	2	3	4	5
1	0.288	0.243	0.203	0.164	0.102
2	0.210	0.247	0.235	0.194	0.115
3	0.182	0.218	0.232	0.217	0.150
4	0.166	0.176	0.203	0.236	0.219
5	0.154	0.116	0.127	0.189	0.414

Note:

Table 3 Median band mobility matrix – fathers' and sons' over-time average ln income

Father's m b	**Son's median band**					**Fath d**
	-0.9 m	0.9 -0.975 m	0.975 -1.025 m	1.025 -1.1 m	1.1 m-	
Trans. matrix						
-0.9 m	0.086	0.258	0.542	0.111	0.004	0.016
0.9 -0.975 m	0.059	0.240	0.596	0.102	0.003	0.184
0.975 -1.025 m	0.037	0.162	0.637	0.159	0.006	0.588
1.025 -1.1 m	0.040	0.123	0.437	0.368	0.031	0.196
1.1 m-	0.048	0.106	0.261	0.482	0.104	0.016
Son d						
	0.042	0.169	0.583	0.194	0.012	

Note:

the proportion of the overall gap that is above, rather than below the median.

One popular way to examine mobility is to focus less on summary measures, such as the elasticity, correlation or even the slopes of quantile regressions, but to look at transition matrices across the discretized bivariate distribution. The most common approach is to define the classes that underlie the transition matrix in terms of quantile groups of the marginal distribution. To illustrate this approach, we use quintile groups of both son's and father's over-time average ln income. The resulting transition matrix is shown in Table 2.

The transition matrix shows reasonably familiar properties. The elements on the main diagonal, which give the estimated probability that a son's relative position is the same as his father's, are in all cases higher than the probabilities of moving out of the father's income quintile group. Also, the probability that a son remains in the lowest or highest group, given his father was in that same group, is higher then the probability he remains in one of the three middle main diagonal cells.

Note also that the sum of the upper diagonal elements (which is proportional to the proportion of persons who move up in the distribution) is 1.842 while that of the lower diagonal is 1.742. This despite the fact that in these data, the probability of an extreme downward movement – i.e., the son of richest fifth father moves to the poorest fifth – is higher, at 0.154, than the probability of an extreme upward movement – i.e., the son of a poorest fifth father moves into the richest fifth – at 0.102. However, the probability of moving up one or two quintile groups tends to be higher than the probability of moving down.

There are, of course, many different ways to define the income classes. One way is to define classes based on different bands constructed around the median income in each marginal distribution. We have here chosen the to define the classes in terms 90, 97.5, 112.5 and 110.0 percent of the median in the two marginal distributions. The resulting transition matrix is shown in Table 3. Our choice of bands has generated a transition matrix that is very different from that based on income quintile groups. Now, the main diagonal does not have the uniformly highest elements on each row. The marginal distributions for both father and sons incomes across the median bands, also shown in Table 3, suggest that the very high transition probabilities that tend to occur in the columns for son's between

90 and 112.5 percent of the median are across father's income classes of quite different sizes. The bottom class as only 1.7 percent of all fathers while the two next ones have 18.8 and 77.9 percent, respectively. The probability mass in the two highest classes in either marginal distribution is very small indeed. These problems may be driven by our not having chosen the median bands wisely. However, choosing them such that each class has a reasonable sample size involves looking closely at the data and it is not clear if this approach is useful for comparing two different bivariate distributions. [14]

5.3. Comparative evidence on intergenerational associations

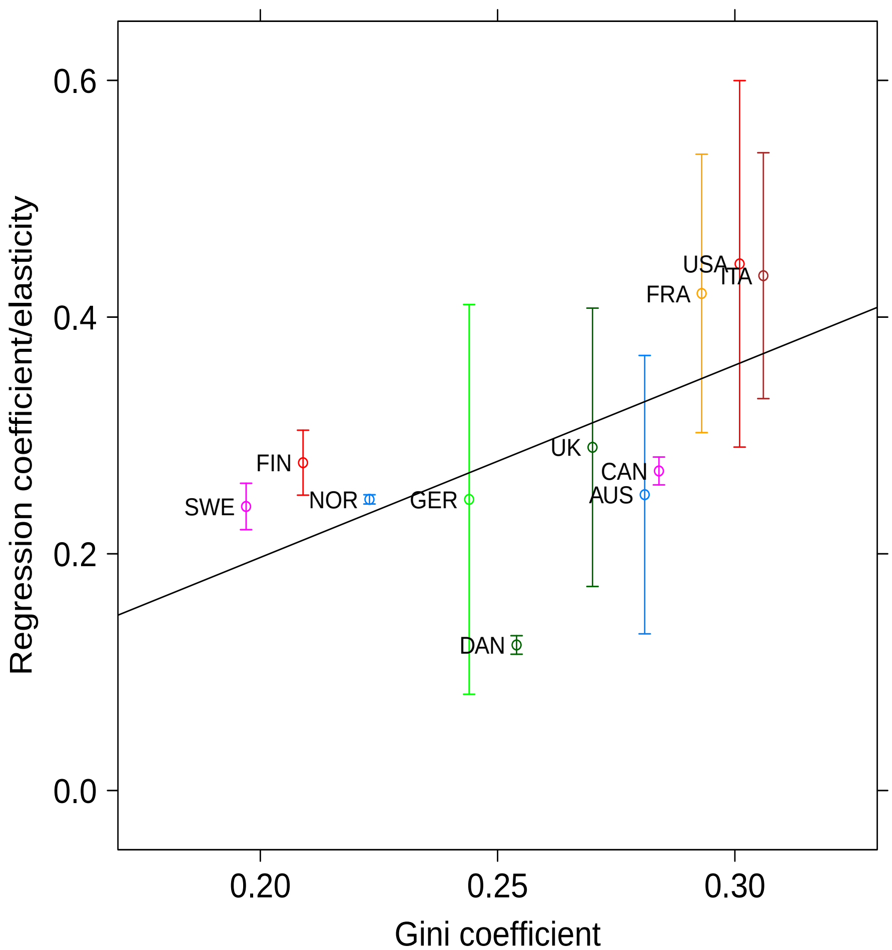
Section 5.2 presented a set of measures by means of which we can describe intergenerational associations in a society. We now continue by reporting results from research that has used these measures. We start with results from comparable studies of various countries. The cross-national pattern we get from such an overview can also help us evaluate the theoretical framework presented above and otherwise give clues about mechanisms behind the family associations in income.

We start reporting results from estimates of intergenerational associations. We are aware of such estimates for eleven developed countries. Some authors have strived for explicit cross-national comparisons by choosing similar sample definitions and time periods. Most cross-national comparisons stick to the standard constant-elasticity model presented above, partly because comparisons become more complicated with more elaborate measures of associations, partly because data in some countries only permit estimation of the linear model.

In Figure 13, we show our preferred intergenerational elasticity estimates (NB:

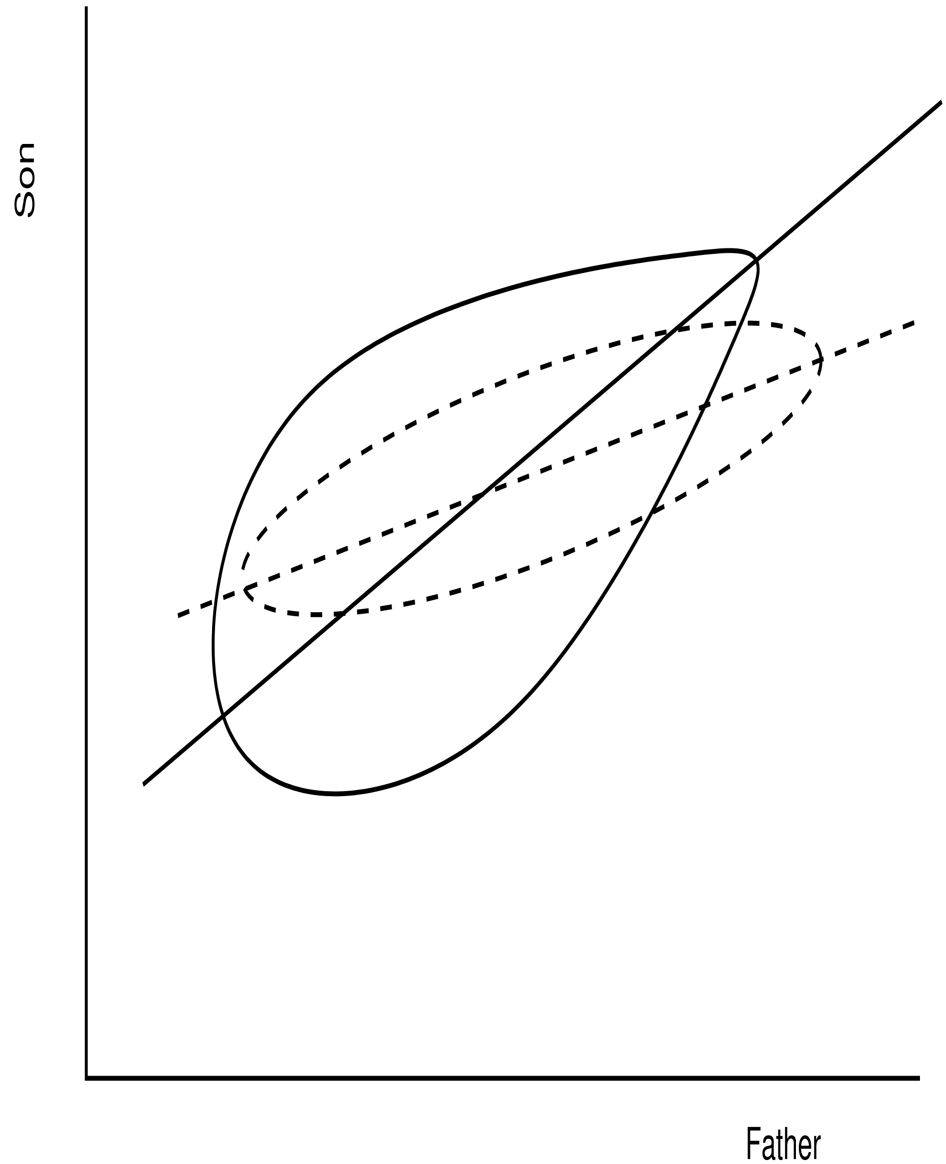
[14] O'Neill et al. (2005) study the effect of transitory errors on the estimation of transition matrices.

Figure 13 Evidence on intergenerational associations



Source: Björklund and Jäntti (2009)

Figure 14 Persistence vs mobility in two stylized distributions A and B



TO BE UPDATED). In order to be able to discuss our theoretical framework, we relate the estimates to a common measure of cross-sectional inequality, namely the Gini coefficient of annual disposable income in the most recent wave of LIS data. By and large the table reveals that high intergenerational elasticities are associated with high levels of cross-sectional inequality.

Many important insights into the comparative patterns of intergenerational inequality have been gained from studying the intergenerational elasticity (i.e., the regression coefficient in a log-log regression) or the correlation coefficient in the log incomes of the offspring and the parent(s). These two both have their benefits. The correlation coefficient is a measure of association between variables whose dispersion has been standardized and can be useful when the marginal distribution has changed substantially across time. The elasticity of offspring income with respect to that of the father is a well understood measure of conditional expectation in log incomes.

The elasticity is, however, a measure of average *persistence* of income rather than of *mobility*. In other words, the regression coefficient on father's log (permanent) earnings tells us how closely related, on average, an offspring's economic status is to that of his or her parent. It is quite possible for two countries to have highly similar average peristence, but for one to have substantially more mobility around that average persistence. The elasticity can thus be the same, but arguably the country with a greater residual variation – that is, variability around the average persistence – is the one with greater mobility. Moreover, two countries with the same regression slope may have quite different, and varying, conditional variances around that slope. For instance, a country with a "bulge" in the variance at low levels of fathers' earnings, that is, a pear-shaped bivariate distribution, will exhibit relatively more mobility at the low end of the distribution than will a country with a constant conditional variance.

One approach is to examine both the regression coefficients and residual variances. We use a more direct method of comparison, however, based on quintile group mobility matrices. In allowing for fairly general patterns of mobility, mobility matrices offer the additional advantage of allowing for asymmetric patterns – more mobility at the top than at the bottom, say. Other approaches, such as non-parametric bivariate density estimates, would in principle be available (see e.g. Bowles and Gintis, 2002). Since these typically require a large number of observations to work well and some of our data sets are fairly small, these are not an option here. We now turn to the estimated mobility matrices. The full mobility matrices, both excluding zero father-offspring pairs and including them, are shown in Tables 4- 5. First, for men, the Nordic countries are relatively similar in all parts of the bivariate father-offspring earnings distribution. In particular, approximately 25 per cent of sons born into the poorest quintile remain in that position themselves, while around 10-15 per cent reach the very top quintile (compared to the 20 per cent who would have ended up in each of these two states if the distribution of offspring earnings was completely random). Bottom-to-top mobility is significantly larger in Denmark than in the other Nordic countries. The persistence of very high incomes is much larger than the persistence of very low incomes in all the Nordic countries – around 35 per cent of sons born into the richest quintile remain in that position.

An interesting set of cross-country differences emerge from the study of the extreme cells, or "corners" of the mobility matrix, shown for both sons and daughters in Figure 15. . Comparing the Nordic matrices with those of the U.S., there is one difference that immediately stands out as significant, substantively as well as statistically, and that is the much lower upwards mobility out of the poorest quintile group in the U.S. More than 40 per cent of U.S. males born into this position remain there. For this away-from-the-bottom mobility measure, the U.K. is much more similar to the Nordic countries than to the U.S.. The probability that the son of a lowest-quintile father makes it into the top quintile group – "rags-to-riches" mobility – is lower in the U.S. than in all other countries, statistically significantly so for Denmark, Norway and the U.K. These two findings – higher low-income persistence and a lower likelihood of rags-to-riches mobility – seem to us quite powerful evidence against the traditional notion of American exceptionalism consisting of a greater rate of upward social mobility than in other countries. In light of this evidence, the U.S. appears to be exceptional in having less rather than more upward mobility.

Another interesting difference between the U.S. and the Nordic countries is that of top-to-bottom downwards mobility. Fewer than 10 per cent of U.S. males born into the richest quintile take the step all the way down to the bottom quintile, while this is typically the case for around 15 per cent of Nordic males. And at this point, the U.K. is very similar to the U.S. . As pointed out already by Atkinson (1981b, p 213), there is less long-distance mobility down from the top than there is upward mobility from the bottom in the U.K.. The probability that the son of a rich father remains in that group is highest in Sweden and lowest in the U.K., but the persistence of high earnings is strikingly similar across countries.

In more central parts of the bivariate income distributions, as shown in Tables 4- 5 in the Appendix, all six countries are remarkably similar, a point we shall return to in our concluding comments. Hence, we conclude that most of the differences reflected in elasticity and correlation measures discussed above reflect the phenomenon that mobility out of the lowest earnings quintile group is much lower in the U.S. than in the other countries, and that mobility from the top to the bottom of the earnings distributions is lower in both the U.S. and the U.K. than in the Nordic countries.

For daughters, the picture is again much more blurred, and most differences between countries are not statistically significant at conventional levels. A point to note, however, is that daughters born into poor families in the U.S. have a much higher probability of climbing up the income distribution than their brothers have. The out-of-poverty mobility for women is almost at the same level as for the other five countries, i.e. around 75 per cent. However, very few of them (around 9 per cent according to the point estimate) reach the very top quintile. This bottom-to-top mobility seems to be higher in all the other countries (around 15 per cent). Apart from this, there are only minor differences between the mobility matrices for the different countries.

In conclusion, a fairly rich picture emerges from an examination of the transition probabilities combined with the elasticities and correlations. Admittedly, the comparable data that we could construct suffer from the well-known short-coming that having only a single year of parental income data tends to bias the estimated elasticities downward. The bias may well vary across countries and is likely to affect the mobility tables as well. However, a comparison of our regression-based results suggest the same ordering as other within-country studies, where this bias has been reduced. The mobility matrices enrich our picture of the orderings generated by the elasticities and correlations, in particular in allowing us to examine persistence and movements in various parts of the distribution.

Table 4 Intergenerational mobility tables – earnings quintile group transition matrices corrected for age for fathers and sons. Excluding zeros

Denmark (n = 82087)

Father	Son oq1	oq2	oq3	oq4	oq5
fq1	0.243 [0.237,0.249]	0.216 [0.210,0.222]	0.204 [0.198,0.209]	0.187 [0.182,0.192]	0.150 [0.145,0.156]
fq2	0.223 [0.218,0.229]	0.231 [0.225,0.237]	0.211 [0.206,0.217]	0.186 [0.180,0.191]	0.149 [0.143,0.154]
fq3	0.199 [0.193,0.204]	0.226 [0.220,0.231]	0.213 [0.207,0.219]	0.202 [0.196,0.208]	0.161 [0.155,0.166]
fq4	0.178 [0.172,0.184]	0.197 [0.192,0.203]	0.209 [0.203,0.215]	0.216 [0.210,0.221]	0.200 [0.195,0.206]
fq5	0.145 [0.139,0.150]	0.130 [0.124,0.135]	0.164 [0.158,0.170]	0.212 [0.206,0.217]	0.349 [0.343,0.356]

Finland (n = 5488)

Father	Son oq1	oq2	oq3	oq4	oq5
fq1	0.276 [0.252,0.301]	0.237 [0.210,0.261]	0.203 [0.180,0.228]	0.171 [0.151,0.192]	0.113 [0.094,0.133]
fq2	0.193 [0.168,0.216]	0.215 [0.191,0.240]	0.249 [0.224,0.272]	0.192 [0.169,0.216]	0.151 [0.131,0.174]
fq3	0.178 [0.152,0.202]	0.197 [0.169,0.225]	0.219 [0.195,0.244]	0.218 [0.194,0.241]	0.189 [0.165,0.212]
fq4	0.164 [0.141,0.185]	0.195 [0.170,0.221]	0.193 [0.170,0.216]	0.229 [0.203,0.254]	0.219 [0.195,0.242]
fq5	0.150 [0.129,0.171]	0.156 [0.135,0.177]	0.140 [0.118,0.161]	0.205 [0.181,0.228]	0.348 [0.321,0.375]

Norway (n = 25425)

Father	Son oq1	oq2	oq3	oq4	oq5
fq1	0.282 [0.270,0.293]	0.231 [0.221,0.242]	0.208 [0.197,0.219]	0.158 [0.148,0.167]	0.122 [0.113,0.130]
fq2	0.203 [0.192,0.214]	0.234 [0.224,0.244]	0.223 [0.213,0.233]	0.202 [0.192,0.212]	0.138 [0.129,0.147]
fq3	0.182 [0.172,0.193]	0.209 [0.199,0.220]	0.216 [0.205,0.226]	0.213 [0.202,0.223]	0.180 [0.169,0.190]
fq4	0.174 [0.164,0.184]	0.184 [0.175,0.194]	0.200 [0.191,0.212]	0.220 [0.210,0.230]	0.221 [0.211,0.232]
fq5	0.143 [0.134,0.152]	0.138 [0.129,0.147]	0.158 [0.149,0.168]	0.211 [0.201,0.221]	0.350 [0.338,0.361]

Sweden (n = 32192)

Father	Son oq1	oq2	oq3	oq4	oq5
fq1	0.262 [0.252,0.271]	0.243 [0.233,0.253]	0.213 [0.204,0.222]	0.174 [0.166,0.183]	0.108 [0.101,0.115]
fq2	0.206 [0.196,0.215]	0.225 [0.216,0.235]	0.237 [0.228,0.246]	0.200 [0.191,0.210]	0.132 [0.124,0.140]
fq3	0.186 [0.177,0.194]	0.210 [0.200,0.218]	0.223 [0.213,0.232]	0.220 [0.211,0.229]	0.161 [0.153,0.171]
fq4	0.176 [0.168,0.185]	0.178 [0.169,0.188]	0.196 [0.187,0.205]	0.217 [0.207,0.226]	0.233 [0.223,0.242]
fq5	0.159 [0.151,0.168]	0.139 [0.132,0.147]	0.135 [0.127,0.143]	0.193 [0.184,0.202]	0.374 [0.363,0.384]

UK (n = 2423)

Father	Son oq1	oq2	oq3	oq4	oq5
fq1	0.303 [0.267,0.340]	0.219 [0.184,0.257]	0.215 [0.179,0.253]	0.159 [0.128,0.191]	0.103 [0.078,0.132]
fq2	0.255 [0.218,0.290]	0.226 [0.190,0.265]	0.202 [0.165,0.238]	0.165 [0.130,0.201]	0.153 [0.124,0.185]
fq3	0.214 [0.180,0.250]	0.221 [0.185,0.260]	0.186 [0.147,0.225]	0.204 [0.167,0.242]	0.175 [0.143,0.210]
fq4	0.132 [0.102,0.163]	0.190 [0.154,0.227]	0.212 [0.174,0.253]	0.232 [0.197,0.266]	0.232 [0.201,0.266]
fq5	0.101 [0.075,0.130]	0.145 [0.113,0.178]	0.184 [0.152,0.220]	0.238 [0.204,0.272]	0.331 [0.297,0.368]

USNLSY (n = 1483)

Father	Son oq1	oq2	oq3	oq4	oq5
fq1	0.432 [0.364,0.501]	0.254 [0.194,0.318]	0.149 [0.100,0.203]	0.083 [0.043,0.130]	0.081 [0.048,0.120]
fq2	0.194 [0.134,0.254]	0.265 [0.203,0.332]	0.214 [0.158,0.272]	0.169 [0.115,0.225]	0.158 [0.114,0.208]
fq3	0.178 [0.123,0.236]	0.208 [0.149,0.274]	0.250 [0.182,0.319]	0.230 [0.171,0.295]	0.134 [0.078,0.195]
fq4	0.137 [0.087,0.194]	0.203 [0.140,0.277]	0.162 [0.091,0.230]	0.252 [0.188,0.315]	0.246 [0.182,0.311]
fq5	0.094 [0.052,0.139]	0.114 [0.068,0.166]	0.168 [0.111,0.229]	0.261 [0.201,0.326]	0.363 [0.298,0.430]

Note: These results include only those father-offspring pairs that have non-zero earnings. The numbers in brackets below the point estimates show the bias corrected 95 percent bootstrap confidence interval.

Table 5 Intergenerational mobility tables – earnings quintile group transition matrices corrected for age for fathers and daughters. Excluding zeros

Denmark (n = 75915)

Father	oq1	oq2	oq3	oq4	oq5
	Daughter				
fq1	0.223	0.217	0.210	0.185	0.165
	[0.217,0.229]	[0.210,0.223]	[0.204,0.215]	[0.179,0.191]	[0.160,0.170]
fq2	0.221	0.226	0.209	0.188	0.156
	[0.215,0.227]	[0.220,0.232]	[0.203,0.215]	[0.182,0.194]	[0.151,0.162]
fq3	0.214	0.212	0.210	0.198	0.167
	[0.208,0.220]	[0.206,0.218]	[0.203,0.216]	[0.192,0.204]	[0.161,0.172]
fq4	0.184	0.190	0.203	0.216	0.207
	[0.179,0.190]	[0.184,0.196]	[0.197,0.208]	[0.209,0.222]	[0.201,0.213]
fq5	0.156	0.154	0.168	0.215	0.308
	[0.150,0.161]	[0.149,0.159]	[0.162,0.173]	[0.209,0.221]	[0.301,0.314]

Finland (n = 5184)

Father	oq1	oq2	oq3	oq4	oq5
	Daughter				
fq1	0.241	0.198	0.231	0.194	0.135
	[0.216,0.267]	[0.175,0.223]	[0.207,0.257]	[0.170,0.219]	[0.113,0.158]
fq2	0.220	0.226	0.202	0.193	0.158
	[0.196,0.245]	[0.203,0.251]	[0.176,0.230]	[0.169,0.221]	[0.136,0.180]
fq3	0.188	0.190	0.201	0.225	0.197
	[0.165,0.211]	[0.164,0.215]	[0.177,0.227]	[0.198,0.252]	[0.172,0.221]
fq4	0.180	0.205	0.201	0.204	0.209
	[0.156,0.204]	[0.180,0.231]	[0.175,0.228]	[0.179,0.230]	[0.184,0.233]
fq5	0.172	0.168	0.158	0.187	0.315
	[0.146,0.196]	[0.144,0.193]	[0.133,0.183]	[0.163,0.213]	[0.289,0.343]

Norway (n = 23903)

Father	oq1	oq2	oq3	oq4	oq5
	Daughter				
fq1	0.234	0.214	0.209	0.198	0.146
	[0.222,0.245]	[0.203,0.226]	[0.198,0.220]	[0.187,0.208]	[0.136,0.156]
fq2	0.212	0.221	0.223	0.197	0.147
	[0.202,0.223]	[0.210,0.233]	[0.212,0.235]	[0.186,0.208]	[0.137,0.157]
fq3	0.192	0.204	0.215	0.201	0.188
	[0.181,0.203]	[0.193,0.216]	[0.204,0.226]	[0.190,0.212]	[0.178,0.198]
fq4	0.186	0.189	0.200	0.211	0.213
	[0.175,0.196]	[0.179,0.201]	[0.190,0.211]	[0.200,0.223]	[0.203,0.224]
fq5	0.171	0.163	0.162	0.194	0.310
	[0.161,0.181]	[0.153,0.173]	[0.152,0.172]	[0.184,0.205]	[0.299,0.321]

Sweden (n = 30670)

Father	oq1	oq2	oq3	oq4	oq5
	Daughter				
fq1	0.238	0.215	0.214	0.187	0.145
	[0.228,0.248]	[0.207,0.224]	[0.205,0.223]	[0.177,0.196]	[0.137,0.154]
fq2	0.212	0.213	0.221	0.210	0.145
	[0.203,0.221]	[0.204,0.222]	[0.212,0.231]	[0.200,0.219]	[0.136,0.153]
fq3	0.197	0.203	0.211	0.214	0.175
	[0.188,0.207]	[0.193,0.212]	[0.202,0.221]	[0.205,0.224]	[0.166,0.184]
fq4	0.181	0.194	0.204	0.203	0.219
	[0.172,0.191]	[0.184,0.202]	[0.195,0.213]	[0.193,0.212]	[0.209,0.229]
fq5	0.164	0.172	0.151	0.188	0.325
	[0.155,0.173]	[0.163,0.181]	[0.142,0.159]	[0.179,0.198]	[0.314,0.336]

UK (n = 2471)

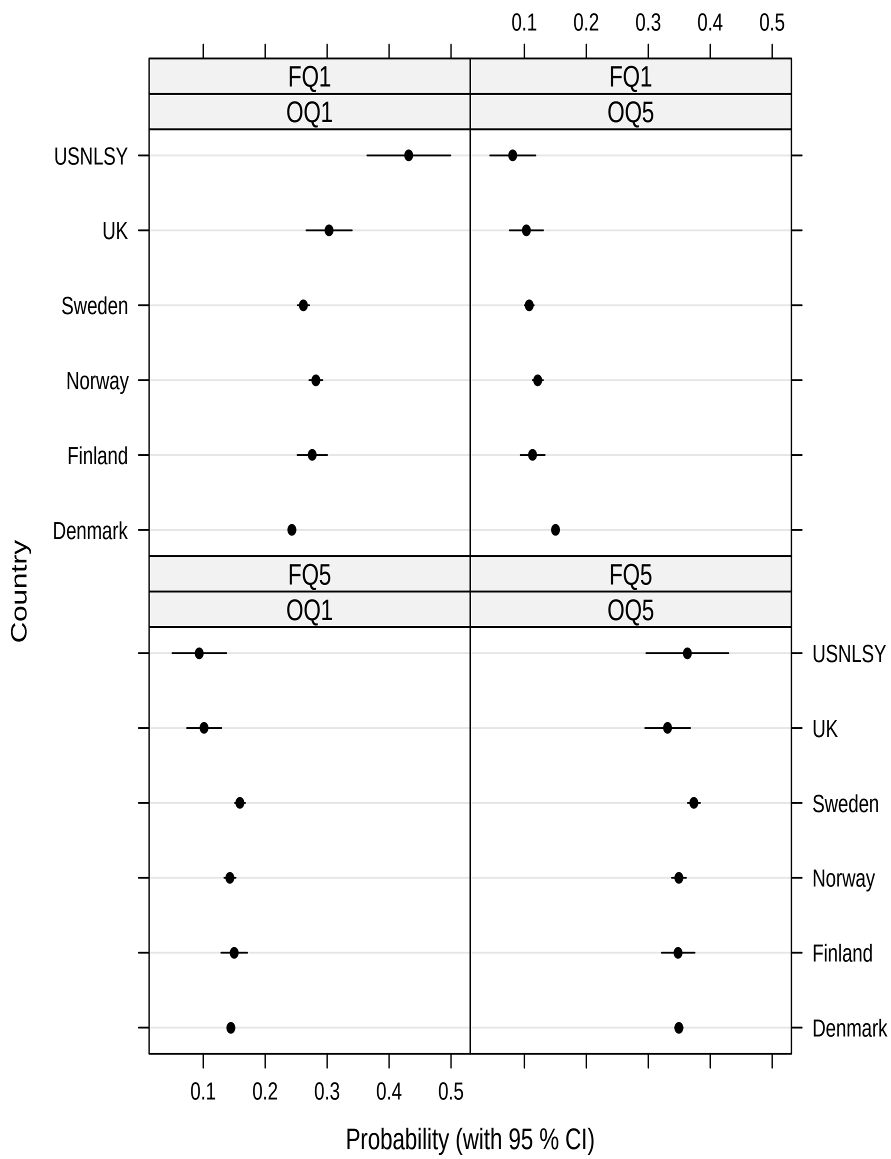
Father	oq1	oq2	oq3	oq4	oq5
	Daughter				
fq1	0.225	0.243	0.180	0.206	0.146
	[0.183,0.261]	[0.209,0.277]	[0.147,0.214]	[0.171,0.243]	[0.116,0.176]
fq2	0.225	0.223	0.225	0.184	0.143
	[0.184,0.269]	[0.185,0.260]	[0.191,0.259]	[0.147,0.222]	[0.114,0.175]
fq3	0.227	0.196	0.188	0.208	0.181
	[0.190,0.264]	[0.160,0.235]	[0.152,0.222]	[0.177,0.243]	[0.145,0.218]
fq4	0.191	0.175	0.230	0.202	0.202
	[0.159,0.226]	[0.141,0.209]	[0.193,0.267]	[0.165,0.242]	[0.166,0.240]
fq5	0.135	0.164	0.178	0.202	0.321
	[0.105,0.165]	[0.132,0.195]	[0.141,0.213]	[0.168,0.236]	[0.284,0.359]

USNLSY (n = 1326)

Father	oq1	oq2	oq3	oq4	oq5
	Daughter				
fq1	0.240	0.249	0.263	0.142	0.106
	[0.180,0.308]	[0.182,0.318]	[0.200,0.332]	[0.085,0.204]	[0.068,0.152]
fq2	0.206	0.238	0.203	0.205	0.147
	[0.139,0.274]	[0.179,0.308]	[0.141,0.277]	[0.142,0.267]	[0.090,0.210]
fq3	0.198	0.228	0.214	0.188	0.172
	[0.131,0.271]	[0.161,0.298]	[0.142,0.290]	[0.123,0.259]	[0.112,0.234]
fq4	0.147	0.201	0.199	0.242	0.211
	[0.082,0.219]	[0.138,0.269]	[0.139,0.262]	[0.175,0.311]	[0.141,0.285]
fq5	0.195	0.105	0.118	0.234	0.347
	[0.135,0.266]	[0.058,0.155]	[0.050,0.198]	[0.161,0.316]	[0.269,0.427]

Note: These results include only those father-offspring pairs that have non-zero earnings. The numbers in brackets below the point estimates show the bias corrected 95 percent bootstrap confidence interval.

Figure 15 Corner probabilities



Functional form

In trying to understand what lessons can be learned from the functional form of the generational dependence, it is important to be careful as to what model has been estimated.

Take, for instance, the quantile regresion approach, discussed above. Eide and Showalter (1999) find for the US using PSID data that the elasticities increase across the son's distribution. The 10th percentile, median and 90th percentiles slopes in their sample from the PSID are 0.77, 0.37 and 0.17, compared to a log-linear regression coefficient of 0.34. This suggests that the son income distribution conditional on father's income tends to get more, rather than less compressed as father's income increases. Grawe (2004a, Tables 4.34.6 p. 74-78) shows a similar pattern of a narrowing of the son's conditional distribution for Canada, but a diverging pattern for Germany and the UK. His US results vary depending on how which data source – PSID or NLS – he uses and how the sample has been defined, but mostly suggest a narrowing rather than a spreading out of the son's conditional distribution. In our exploration of Swedish data, we find that, while not monotonic, the quantile regression coefficient on father's income tends to increase across the son's income percentiles.

Thus, based on the evidence of the log-linear and quantile regressions, we can note that in terms of equation 4, the deviation ε of son's income from the regression slope appears to have a heteroscedastic variance (as the shape of the conditional distribution changes across father's income), and that this heteroscedasticity may be of a quite different type in different countries.

The functional form for that links son's income to that of the father's may also have implications for what sorts of theoretical models appear plausible. For instance, as, among others, Grawe (2004b) and Bratsberg et al. (2007) point out, if the intergenerational elasticity is in part explained by parental investments in children's human capital/education, then the presence of credit constraints for those with low parental resources implies that the conditional expectation of son's income, given father's, might be concave.

However, credit constraints might lead to a convex profile just as well. For instance, if all families are credit constrained because the optimal level of investment in human capital increases with ability (which might be correlated with parental income) , but lower-level education is meritocratically available, the expected intergenerational income relationship might well be convex, instead (Grawe and Mulligan, 2002; Bratsberg et al., 2007).

Thus, while credit constraints may generate non-linearities, these may be convex, concave or S-shaped, depending on where in the distribution credit constraints occur. Bratsberg et al. (2007) find for the Nordic countries, that the slope of son's expected income as a function of father's income is flat for low levels of parental income, quite like we find above for Sweden, but increase thereafter. For the US, on the other hand, the log-linear regression appears to fit the data quite well. For the UK, Bratsberg et al. (2007) do find that adding a second-order term in father's income improves the fit (by the Bayesian information criterion) the log-linear regression appears to give a reasonable fit.

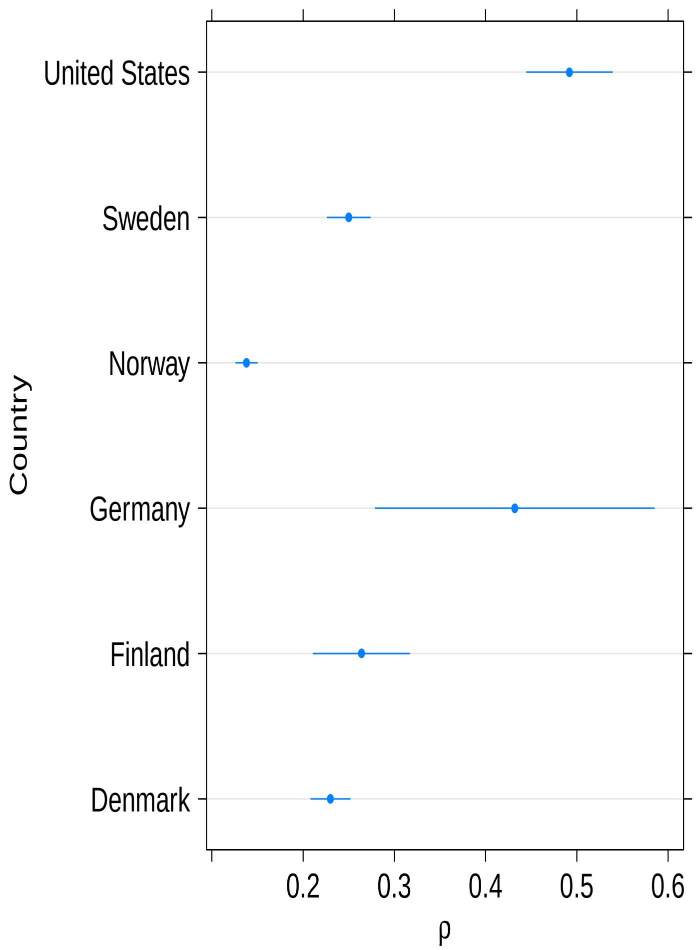
However, while the differences across countries in the shape of the father-son income profile are interesting, it is not clear what can be learned from those relative to the theoretical models within which such correlations and elasticities are interpreted. For instance, Grawe (2004b) critically examines the issue of whether or not non-linearities imply credit constraints in parental human capital investments in their children. He does so by examining non-linearities across son's distribution in Canada by estimating quantile regressions using a spline in father's income to examine non-linearities in also the quantile regression. He finds quite convex relationships between son's and father's income for quantiles above the median and S-shaped relationships up to and including the median (see Figure 4, p. 825 Grawe, 2004b). This, he suggests, points away from credit constraints as being the driver of the non-linearities and suggests that other elements of the standard Becker-Tomes model, such as the government expenditures on human capital instead.

5.4. Evidence on sibling correlations

Next, we turn international to sibling correlations, which, to the best of our knowledge, only exist for Germany, the four Nordic countries and the United States @Add the German estimates from Schnittslein@. Further, most studies are confined to men. We report the main findings in Figure 16. The most striking pattern is that these correlations are much larger in the United States than in the Nordic countries. Among the Nordic countries, Norway stands out as having much smaller correlations than Denmark, Finland and Sweden; .14 for Norway compared to around .25 for the other countries. These results corroborate our conclusion that family background is more important in the United States than in the Nordic countries.

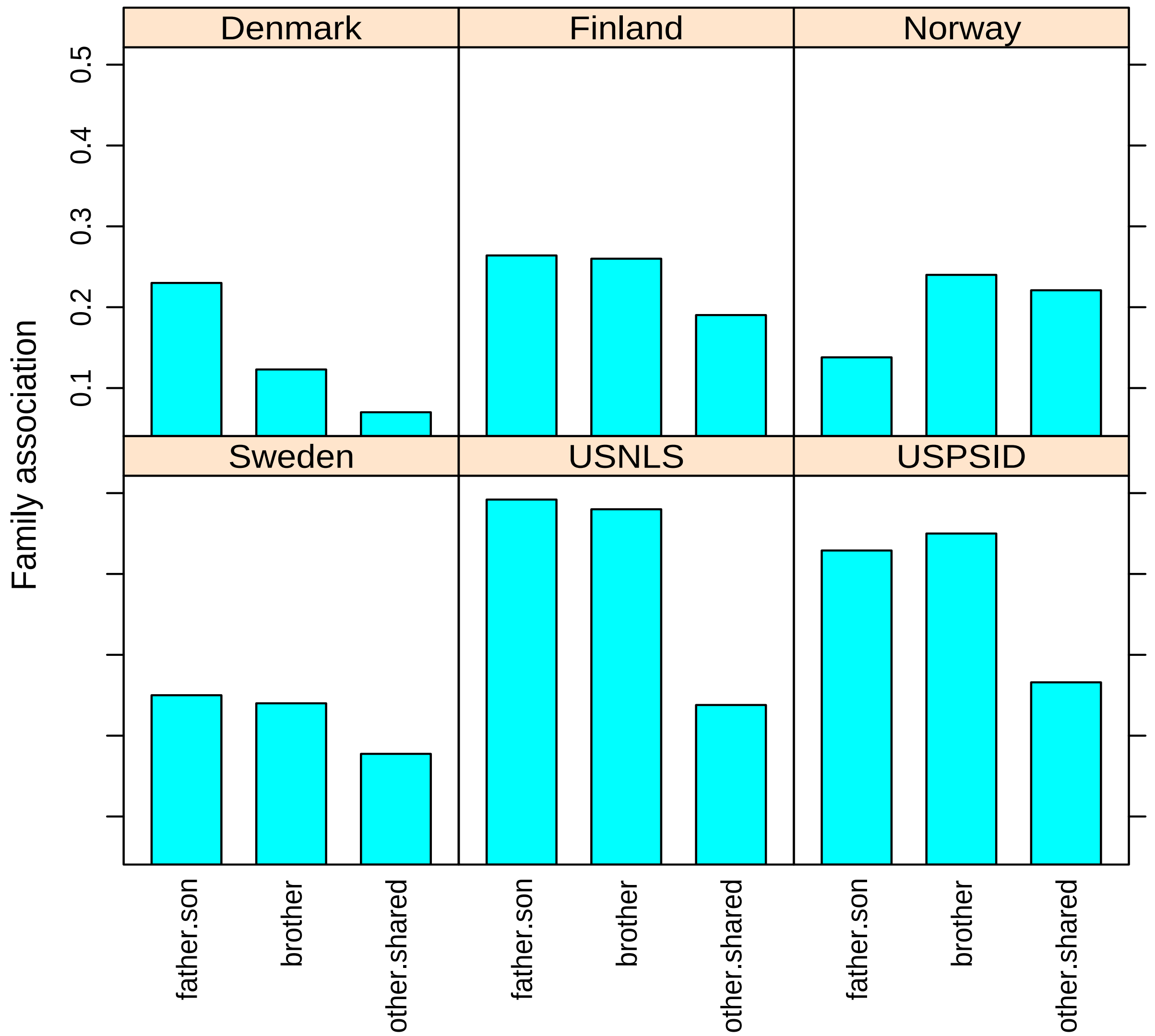
We have only presented results for father-son pairs and for brothers. The literature on fathers and daughters and for sisters or mixed-gender siblings is smaller but growing. The general impression from these studies is that intergenerational elasticities and sister correlations are at bit lower, but that the overall cross-national pattern remains. But it is important to note – and this is another

Figure 16 Evidence on sibling associations



Source: Björklund and Jäntti (2009)

Figure 17 Father-son and brother correlations compared



Source: Björklund and Jäntti (2009)

reason for not reporting results for daughters – that women's life-cycle earnings pattern is more complicated than that for men. As we noted above, there is no simple rule saying at what age women's annual income is a useful proxy for long-run income.

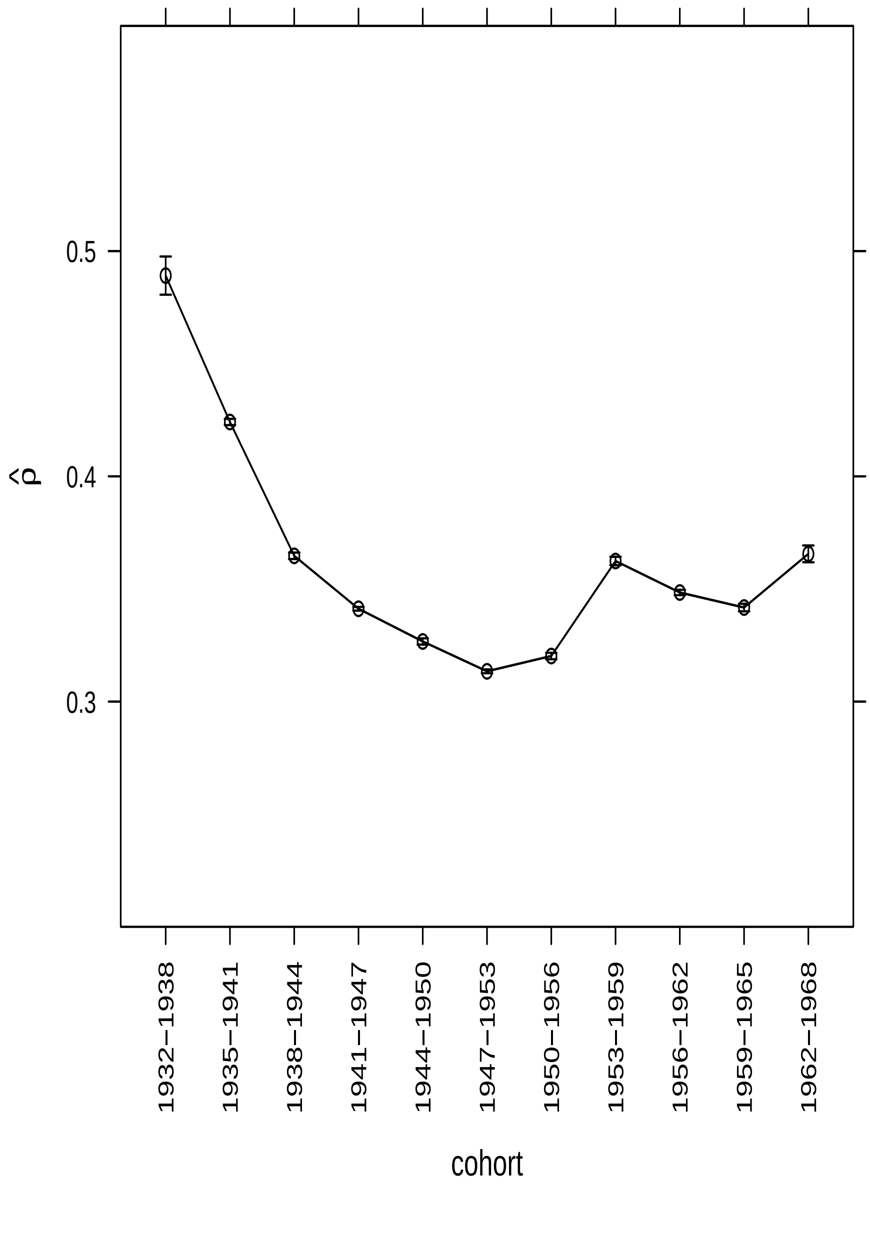
We have also presented results only for earnings. It is sometimes claimed that intergenerational associations tend to be somewhat stronger when broader measures of family income are used instead of fathers' income, and that the use of total income yields stronger associations than only earnings. However, more systematic comparisons are needed to rationalize these claims.

We also show in Figure 17 the decomposition of the sibling correlation into the share associated with parental income (see equation 7). As we can see, between one half (United States) and three quarters (Sweden) of the sibling correlation is accounted for by the "other" factors – that is, those that are orthogonal to parental income.

One of the most striking ones is the clear cross-national pattern that family background is more important for labor market achievement in the United States than in most other rich countries. The Nordic countries turn out to have among the weakest associations between family background and labor market outcomes. Both estimated intergenerational income elasticities and sibling income correlations reveal such results. However, these results are limited in the sense that they have been obtained using data covering offspring (or siblings) that were born in the 1950s and early 1960s.[15] It is, therefore, natural to ask whether this cross-national

[15]See Solon (2002) and Corak (2006) for surveys of intergenerational elasticities. See Björklund et al. (2002) for comparable estimates of brother correlations in earnings for Denmark, Finland, Norway, Sweden and the United States; Björklund et al. (2004) also report sister correlations for the Nordic countries. Regarding studies that explicitly focus on trends, the recent Norwegian trend

Figure 18 The estimated sibling correlation – baseline case



Source: Björklund et al. (2009)

pattern has existed for a very long time, or if it is a more recent phenomenon, perhaps related to the rise of the ambitious Nordic welfare states.

The main goal of this analysis is to examine trends in the importance of family background for determining adult income in Sweden, starting with cohorts born in 1932. Data must satisfy the following requirements: First, we must be able to connect family members – either siblings or parents and children – to each other over a long period of time. Second, we need income data that are comparable across time for these family members. Third, we need large samples to get estimates that are precise enough to allow us to detect significant changes in family associations over time. To meet these requirements, we make use of the opportunity offered by Swedish administrative register data sets held by Statistics Sweden. Its multigenerational register records the parents of all children born from 1932 onward. Income data from 1968 and later are available from the tax assessment procedure. We use these data to estimate brother correlations in long-run income observed at ages 30–38 for closely spaced full siblings born 1932–38, 1935–41 and so on until 1962–68.

The cohorts that we analyze have grown up under markedly different circumstances. For example, several educational reforms took place during this period. A central theme of these reforms was to make the Swedish educational system more comprehensive and to extend the length of compulsory schooling. The fraction of each cohort that has gone to college has also increased substantially. To accommodate this expansion, new colleges have been established all over the country.

studies by Bratberg et al. (2005, 2007) only go back to the cohort of offspring born 1950. Pekkala and Lucas (2007) study intergenerational mobility using Finnish data going back to cohorts born in 1930 and find a decline in the intergenerational elasticity from the cohorts born in 1930 through the early 1950s.

The last cohorts were also affected by the expansion of preschool that started in the 1960s. Another change that could potentially affect the role of family background is that the inequality of hourly earnings and disposable income fell during the 1960s and 1970s.[16] Significant changes in the Swedish family structure also took place during this period. Divorce rates started to increase in the 1960s and cohabitation (rather than formal marriage) became more frequent. At the same time, many women entered the labor market, first in the 1960s and 1970s to mainly part-time jobs, and in the 1980s to full-time jobs.[17]

We have found that family background was more important for the incomes of Swedish men born in the 1930s and 1940s than for those born during the 1950s and have been reasonably stable since then for cohorts born through 1968 (see Figure 18). Our estimated brother correlations in total factor income fell from 0.49 for men born in the early 1930s to 0.32 for men born some 15 years later. Thus, the fraction of income inequality attributable to family and community factors shared by closely spaced full brothers fell by 17.6 percentage points. We find this decline sizeable. Although 0.489 is below the estimates obtained for the United States for later cohorts when the time-series structure is not just white noise, it is striking that a decline of this magnitude took place over such a short period. During the subsequent 15 years, the estimated brother correlations are quite stable but reveal a slight increase. Our conclusion that there is a substantial decline in the importance

[16]See Gustafsson and Uusitalo (1990) for an analysis of disposable income inequality and Edin and Holmlund (1995) for hourly earnings inequality for this period. Gustafsson and Uusitalo also show that there was no corresponding decline in total pre-tax factor income – the income concept we employ – inequality over the same period.

[17]Women's change from part-time to full-time work during our observation period would complicate the interpretation of changes in sister correlations. Thus, we only estimate brother correlations in this study.

of family background is robust to a number of sensitivity tests.

In order to explore the mechanisms driving this decline, we introduced schooling into the analysis. While we found some suggestive evidence that schooling, or something related to it, can account for much of the decline, we could refer the decline to changes in neither the return to schooling nor the brother correlation in years of schooling.

A more promising avenue for future research might be to relate the decline to specific educational reforms. One candidate explanation is the compulsory school reform that was gradually introduced from around 1945 to 1955 and that increased the length of compulsory schooling and delayed tracking. Meghir and Palme (2005) show that this reform had intergenerational effects, and the same applies to results by Pekkarinen et al. (2006) for a similar reform in Finland, and Black et al. (2005) for Norway. A challenge for future research is to estimate the impact of such reforms on a broader family-background measure such as the sibling correlation. Another interesting reform in these countries is the large-scale introduction of daycare or pre-school. But these reforms mainly affected children born from 1970 onward, so this is a topic for research some years ahead.

Recent years have seen an upsurge of studies on intergenerational associations in income and education. For example, recent surveys show estimates of intergenerational income elasticities for several countries, and corresponding estimates of years of schooling for a very large number of countries (Björklund and Jäntti, 2009; Corak, 2006; Hertz et al., 2007) . As a complement and in order to understand the mechanisms behind these associations, it is also of interest to learn about the intergenerational transmission of skills and abilities, for example those called IQ.

The literatures in various disciplines offer a number of estimates of intergenerational IQ correlations, but most of these stem from small and non-representative samples (Bowles and Gintis, 2002; Bouchard and McGue, 1981). Recently, however, Black et al. (2009) used data covering the whole Norwegian male population to estimate the father-son correlation in the IQ scored in the compulsory enlistment tests to the country's military service. Using log scores, they obtain a precisely estimated correlation of 0.32.

Is such a number low or high? Does it motivate popular expressions in the intergenerational literature such as "Like Father, Like Son" and "The Apple Does Not Fall Far From The Tree"? This is a matter of judgement. On the one hand, as stressed by the authors, the number exceeds the corresponding ones for long-run earnings in Norway. Further, the interpretation is that a 10 percent differential in fathers' IQ at age 18 is associated with an expected differential of 3.2 percent for sons at the same age. Although this implies some "regression toward the mean", there is also substantial transmission from one generation to the next. On the other hand, the implication is that the explanatory power of father's IQ is quite low. A correlation of 0.32 implies an R^2 close to 10 percent, leaving 90 percent to factors uncorrelated with father's IQ. From an equality-of-opportunity perspective, we interpret family background factors as such factors that the individual cannot influence and be held accountable for. Thus, if father's IQ captures the bulk of family background factors, we would conclude that only a small fraction (around 10%) of inequality in IQ violates equality-of-opportunity norms.

A less recognized, but in our view important, literature has instead explored the role of family background by using measures of sibling similarity, such as the sibling correlation. It has long been known that a sibling correlation is a broader measure of the impact of family and community background than an intergenerational one.[18] The reason is that siblings share not only the observed parental characteristic that can be used in an intergenerational study – be it income, education, occupational class or IQ that is examined – but also many unobserved factors of great importance for their outcomes.

In this study, we estimate both intergenerational and sibling correlations in IQ on a large representative sample. We use a Swedish data set that is constructed in a similar way as the Norwegian data set but is complemented with information about brothers. We find an estimate of the intergenerational correlation that is very close to the Norwegian one. However, when we use data on brothers, we find that close to half of the variation in IQ is accounted for by family and community background factors. And this number is a lower bound on the role of family and community background because siblings are unlikely to share all of those inherited factors that influence the outcome.

We continue the paper in the next section in which we explain the interpretation of the sibling correlation and its relationship to the intergenerational coefficient. In the third section, we present the data. The main results are shown in the fourth section, followed by a brief concluding section.

We report our estimated intergenerational IQ correlations in Table 6. Our results, which are obtained from models that also include birth year-indicators for both fathers and sons, are strikingly similar to the Norwegian estimates (Black et al., 2009). When we use a linear model, our estimate is 0.347 (compared to 0.38

[18]This insight goes back at least to Corcoran et al. (1976). See also, for example, Hauser and Mossel (1985); Erikson (1987); Sieben and De Graaf (2003) for studies in sociology using occupational and educational variables. Solon (1999) offers a formal exposition of the interpretation of the sibling correlation and its relationship to the intergenerational correlation discussed here.

Table 6 Estimated intergenerational IQ correlations

Dependent variable	IQ	Log(IQ)	Adjusted R^2
Father's IQ	0.347 (0.006)	-	0.132
Log (father's IQ)	-	0.327 (0.007)	0.120
Father's IQ in nine levels	Not reported	-	0.132

Note: The reported estimates are unstandardized regression coefficients, but since the standard deviations for fathers' and sons' IQ are almost the same, the estimates can be interpreted as correlations. The equations also include birth year controls for fathers and sons.
Source: Björklund et al. (2010)

Table 7 Estimated brother IQ correlations

Years of birth and spacing	All	Twins	Only non-twins
All brothers born 1951-68	0.473 (0.002)	0.654 (0.036)	0.470 (0.003)
All brothers born 1951-56	0.489 (0.009)	0.664 (0.063)	0.480 (0.003)
All brothers born 1957-62	0.488 (0.003)	0.645 (0.065)	0.480 (0.003)
All brothers born 1963-68	0.513 (0.010)	0.653 (0.060)	0.507 (0.020)

Note: Estimates obtained using the lme function from package nlme in R (Pinheiro and Bates, 1999; Ihaka and Gentleman, 1996). Standard errors are computed using the the delta method from the estimated variance matrix of the variance components.
Source: Björklund et al. (2010)

for Norway), and when we use a log-log model the coefficient (elasticity) is 0.327 (0.32 for Norway). We also report the adjusted R^2, which are 0.132 and 0.120 respectively. Because a model with father's IQ entered as 8 dummy variables might have higher explanatory value in that it could capture results reported in the last row of Table 6 show that the adjusted R^2 from such a specification is not higher than in the linear model.

Because of data availability, we were forced to use father-son pairs with rather young fathers. Although we have no specific reason to believe that this sample criterion will bias the results in any specific direction, it is a concern that the results might be sensitive to this property of our sample. It is comforting, however, that Black et al. (2009) found no significant interaction with "first son". We also experimented with our sample and included only father-son pairs in which the father was at least 24 years old the year the son was born. The estimates were virtually identical.

We report our brother correlation estimates in Table 7. When we include all brothers born 1951 to 1968, we get an estimate of 0.473 with a negligible standard error. In the next rows we have split the sample into cohorts of brothers born in 1951-56, 1957-62 and 1963-68. In this way, we examine closely spaced brothers and will be able to detect a trend for such brothers. We do find an increase from 0.489 (the first two cohort groups) to 0.513. This change is statistically significant but substantially insignificant.

The last two rows show estimates for brothers who are more widely spaced, being at least 5 calendar years apart. These estimates are only marginally lower than those for closely spaced brothers, 0.436 and 0.449 respectively. The difference in sibling similarity in years of schooling between siblings with small (four years or less) and large (more than four years) age spread has also been found to be small (Conley and Glauber, 2008). Because more widely spaced siblings are likely to interact less and be exposed to more different "shocks", we infer that such factors are not very important for sibling similarity; permanent family and community characteristics are more likely determinants.

These results suggest that almost half of the variation in IQ can be attributed to factors shared by siblings. As emphasized above, this number is a lower bound on the importance of family and community background factors. For example, all our genes are inherited from our parents, but we share on average only half of them with our full biological siblings. The exception is monozygotic (identical) twins, who have identical genes. In the second column, we report estimates for twins only. Because our register data does not contain information about zygosity, we have to stick to a mixture of identical and fraternal twins. Our estimates are clearly higher for such brothers, around 0.65 for all cohort groups. This number might be both an under- and an overestimate of the "true" impact of family and community background. Two arguments speak in favour of an underestimate. First, based on information from the Swedish Twins Registry, the sample likely contains roughly 40 percent fraternal twins (see Lichtenstein et al., 2006, Table 2, p 876). Second, even twins might be exposed to different "shocks" or differential treatment that are part of their family and community background but are not shared with their twin sibling. The argument in favour of an overestimate is that twins might interact very closely and in a way that has no counterpart among non-twin siblings and thus in the majority of the population.[19] Our results above regarding the low

[19] Indeed, Björklund et al. (2005), using MZ- and DZ-twins reared together and apart but earnings as outcome variable, find that their best-fitting model is one in which MZ- and DZ-twins do

importance of spacing suggest, however, that this argument might be weak.

5.5. Intergenerational associations and the equality of opportunity

A quite different approach to examining the importance of family background arises in the literature that attempts to examine whether equality of opportunity has been realised or not. This research has been inspired by development in political and social philosophy – see Arneson (1989); Cohen (1989); Roemer (1993, 1998). The point of departure is that not all inequality need be ethically unacceptable (see Almås et al., 2011). Persons can be held accountable for that part of their outcomes for which they are responsible, so inequalities that are due to the effort exerted by individuals tends to be viewed as ethically acceptable. Inequality that is due to circumstances beyond their control is, in turn, ethically unacceptable. There are many interpretations of both what part of an outcome a person can be held responsible for, and how to define those circumstances that a person should not be accountable for, and, consequently, what part of inequality should be viewed as a violation of fairness standards.

One interpretation that has much appeal is to partition outcomes into a part that is due to circumstances over which the individual has not been able to exert any influence in a sense in which he can be held accountable for it, and a part that is due to choices and personal effort. The former is thought to represent inequality of opportunity. Roemer (1998) proposed a way of formalizing this concept along the following lines. Suppose that the outcome of interest is a function $u(e,t)$, e is the effort the individual, and t indexes the circumstances of the individual. Society is partitioned into a finite number of *types*, t, each type consists of individuals with

not share environmental influences to the same extent.

the same circumstances. Presently, u would be income and t would include family background.

The function u is not a utility function. Effort e tends to enter negatively into individual preferences, but enters positively into u. Individual preferences do not matter in this formulation. We are concerned with the distribution of effort within type t, denoted $G^t(e)$. While this distribution is determined by the choices of individuals, after some maximization of individual utility, we only need to consider the 'reduced form' of these distributions. Opportunities for achievement are equalized relative to the outcome u when the distribution of outcomes u are as insensitive as possible to circumstances, measured by t. Outcomes may and indeed should depend on effort, but not on circumstances.

The outcome for the individual depends upon his circumstances through two channels: first, the 'direct' effect of his circumstances and second, an 'indirect' effect, through the effect of his circumstances on the distribution of effort in his type . Circumstances generally affect one's preferences and therefore the level of effort. Since a person should not be held accountable for circumstances, the influence of circumstances on the distribution of preferences and effort in his type should also be viewed as something he is not responsible for. Thus, we should hold an individual accountable for where in the distribution of effort within their type they are, not the properties of the distribution itself.

Most operationalizations of the equality-of-opportunity approach define type to consist of a few observable parental traits – typically, parental income, occupation, and education (see Roemer et al., 2003) – and interpret largely inequality within cells of individuals with identical circumstances as due to effort. One of the most extensive efforts to compare inequality of opportunity in rich countries is that by Roemer et al. (2003) and his coauthors. The purpose of that paper was to examine to what extent tax policy contributed to equalizing inequality of opportunity – the ethical evaluation of a particular policy, rather than of society at large. They use data from Belgium, France, (West) Germany, Italy, the Netherlands, Norway, Sweden, the UK and US. They found that countries taxes income at close to and sometimes possibly in excess of equality-of-opportunity norms. They thus found that especially northern European countries – Sweden and Denmark in particular – tended to do well in realizing equality of opportunity.

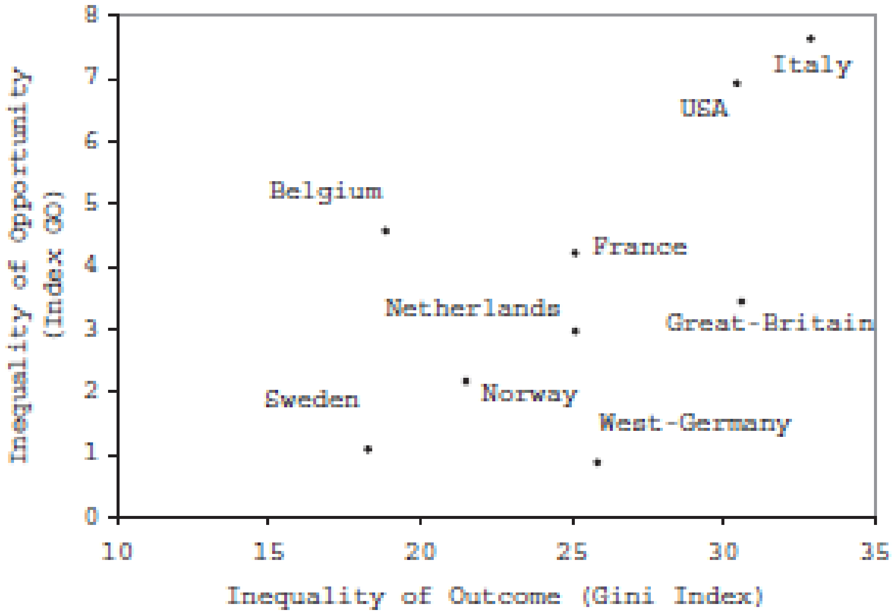
Lefranc et al. (2008) re-examine these data to compare equality of opportunity in the income distribution with inequality of outcomes. Figure 19 shows the results. We observe a remarkable similarity in the country ordering in this figure with that in Figure 13 that relates intergenerational persistence to inequality of disposable income. The main difference is that in the data that Björklund and Jäntti (2009) summarize, intergenerational income persistence in France is much closer to that in the US and Italy than in this graph.

6. Models of income mobility

6.1. Intragenerational mobility models

@ Here follows, in this subsection, text that is copy/pasted directly from Jenkins (OUP 2011), chapter 6. [It draws on Solon's work] It is proposed as the 'sandpit' from which to start a revised version in which these parametric models are directly related back to earlier discussion, including e.g. measures of income mobility in the form of income risk, proxied by the transitory variance ... @

Figure 19 Inequality of outcome and inequality of opportunity



Source: Lefranc et al. (2008), Figure 6.

6.1.1. Models of the transitory and permanent variance components of income

To fix ideas, suppose that the dynamics of income can be described using the canonical random effects model:

$$y_{it} = u_i + v_{it} \tag{8}$$

The logarithm of income for person i in year t, y_{it}, is equal to a fixed 'permanent' random individual-specific component, u_i, with mean zero and constant variance σ_u^2 (common to all individuals), plus a year-specific idiosyncratic random component with mean zero and variance σ_v^2 (common to all individuals) that is uncorrelated with u_i. Thus total inequality as measured by variance of log income is equal to the sum of the variance of 'permanent' individual differences plus the variance of 'transitory' shocks:

$$\sigma_t^2 = \sigma_u^2 + \sigma_{vt}^2. \tag{9}$$

Assuming that permanent differences are relatively fixed over time, changes over time in income inequality arise mostly through changes in the variance of the transitory component. The interpretation of this latter component as idiosyncratic unpredictable income change leads to the association of changes in its variance with changes in income risk.

This canonical model is patently unrealistic in several respects and three types of extension have been incorporated. The first additional factor allows the relative importance for overall inequality of the permanent and transitory components to change with calendar time. For example, if there is an increase in the demand for skilled labour, and permanent component of income represents relatively fixed personal characteristics related to skills (for example human capitals of various kinds), then greater inequality resulting from widening differences over time in returns to skilled versus unskilled labour can be represented as the growing importance of the permanent component. In contrast, a secular trend towards greater labour market flexibility can be represented as a growth in the importance of transitory variations.

First, to allow for calendar time changes, equation (8) is modified to suppose instead that

$$y_{it} = \kappa_t u_i + v_{it} \tag{10}$$

where κ_t is a year-specific 'factor loading' on the permanent component of income. Inequality trends and the permanent/transitory variance decomposition now also depend on trends in this weighting factor:

$$\sigma_t^2 = (\kappa_t)^2 \sigma_u^2 + \sigma_{vt}^2. \tag{11}$$

The second additional feature is persistence in transitory variation. The factors leading to a temporary fall (or rise) in income in one year are likely to have effects that last longer than a year: a transitory shock persists but with diminishing impact and eventually dies out. An example might be an accidental injury leading to a reduction in work hours that diminishes over time. This is characterized using a so-called autoregressive moving average process for v_{it}, labelled ARMA(p, q), in which parameters p and q characterize the nature of the persistence over time. For example, an ARMA(1, 1) process has the form

$$v_{it} = \rho v_{it-1} + \varepsilon_{it-1} + \varepsilon_{it}. \tag{12}$$

If $\theta = 0$, then the variance of the transitory component this year is equal to a fraction – the square of the autoregression parameter (ρ^2) – of its variance in the previous year, a fraction ρ^4 of the variance two years ago, and so on. Transitory shocks die out quickly if ρ is small ($0.3^4 = 0.0081$ but $0.9^4 = 0.6561$). If $\rho = 0$, then the variance of the transitory component this year is equal to a weighted average of the variance of shocks this year and last year, with the latter receiving less weight (the weight is square of the moving average parameter θ). Whereas we expect ρ to be positive (but no more than one), θ may be positive or negative. If someone is struck by bad luck two years in a row (ε_{it-1} and εit both negative), a negative value for ε implies that the effect of the past bad luck is dampened. The larger that p or q is in the ARMA(p, q) process, the longer the shadow that past shocks cast over present outcomes.

The third modification to the canonical model is to allow the fixed individual component to change over time. Two main approaches have been followed, originally distinct but now commonly combined. One is to allow u_i to vary over time via a 'random walk': this year's value is equal to last year's value plus or minus a random element. Instead of u_i, the 'permanent' component in (8) becomes

$$\mu_{it} = \mu_{it-1} + \pi_{it} \tag{13}$$

Consider, for example, the case of a low-skilled car assembly plant operative who is laid off when the plant is closed and assembly transferred abroad (Gottschalk and Moffitt 2009). Although the worker may get another job later, this is likely to be at a lower wage - the change in earnings represents a permanent difference. Major health changes may have similar long-lasting impacts on income. The second approach allows for individual-specific rates of growth in income. The expression for the permanent component in (8) is modified so that it varies directly with time. Instead of u_i, we have

$$\mu_{it} = \mu_i + \beta_i a_t \tag{14}$$

This is a 'random growth' model: β_i is the growth rate in income with age a_t (or work experience), equal to zero on average but varying across individuals. Both a random walk and random growth lead to a fanning out of the income distribution over time, other things being equal. Rankings are preserved: those at the bottom stay at the bottom but fall further behind those at the top, who stay at the top. It is increases in the transitory variance that increase mobility in the sense of reranking.

Using the terms 'permanent' and 'transitory' to label the components of income variability is potentially confusing if 'permanent' components vary over time and 'transitory' components persist. (Adoption of the more complicated specifications for the dynamics of income also makes it more difficult to straightforwardly identify the components of income variability that constitute idiosyncratic unpredictable risk.) The main distinction is between variations that do not change a person's long-run average income – they are mean-reverting shocks ('transitory') – and those that do ('permanent'). The permanent/transitory terminology remains in common use, largely through inertia and the convenience of familiarity and brevity, and so I follow custom in this book.

6.1.2. Estimation of the transitory variance: econometric methods

How are the transitory variance and its contribution to the overall variance of income estimated from longitudinal data? There is a long tradition of fitting econometric models to specifications incorporating one or more of the three extensions to the canonical model that have just been discussed. Applications of these 'variance components' models to the dynamics of men's earnings include Abowd and Card (1989), Baker (1997), Baker and Solon (2003), Chamberlain and Hirano (1999), Haider (2001), Gottschalk and Moffitt (2007), Guvenen (2009), Hause (1980), Lillard and Willis (1978), Lillard and Weiss (1979), MaCurdy (1982), Meghir and Pistaferri (2004), and Moffitt and Gottschalk (1995, 2002, 2008a, 2008b). Extensions include Browning, Ejrnas, and Alvarez (2010) and Geweke and Keane (2000). All this research fits models to US or Canadian data for men. Two applications to British men's earnings data are Dickens (2000) and Ramos (2003) // Additional reference re UK: Kalwij, A. S. and Alessie, R. (2007). 'Permanent and transitory wages of British men, 1975-2001: year, age and cohort effects', Journal of Applied Econometrics, 22: 1063-93.// . Daly and Valletta (2008) compare earnings dynamics in Britain, Germany, and the USA. An excellent review of variance component modelling and recent extensions is provided by Meghir and Pistaferri (2010). There have been few applications to broader measures of household income: notable exceptions are Biewen (2003) for Germany, and Duncan (1983) and Stevens (1999) for the USA. The only studies applying these methods to British data on household income that I am aware of are Devicienti (2001) and Blundell and Etheridge (2010).

@ somewhere note the difference between econometric models in which earnings change is the dependent variable and variance components structure placed on residuals of this (e.g. Abowd and Card), versus what set out above, in which earnings per se is the dependent variable. Also need to cite the earlier regression model approach followed by e.g. Creedy, and Hart. ABM 1992 comprehensive review of data and evidence on longitudinal sources and mobility evidence on *earnings* – note explosion since then @

@ end of copy/paste @

6.2. Intergenerational mobility models

The "canonical" reference for the empirical literature on income mobility is Becker and Tomes (1986), a contribution that is lucidly discussed by Goldberger

(1989). The monograph by Mulligan (1999) is a very thorough treatment of the theoretical literature.

A simple model that exemplifies a few important determinants of intergenerational mobility, albeit under highly simplified assumptions is due to Solon (2004), who constructs a model that has parents choosing levels of investment in their children's human capital. A child's human capital depends on how much parental and public resources are spent on their education and on their human capital endowment, a kind of innate ability, which in turn in part depends on the endowment of her parents. The adult income of the child depends on her human capital and the return to that human capital. The parents are assumed to care about their children's future income level, balancing the investment in their education with their own consumption.

Assuming that it is always optimal for parents to allocate some funds toward their children's education, Solon (2004, p. 43) shows that a child's and her parent's long-run ln incomes are related by

$$y_{i,o} = \mu^* + [(1-\gamma)\theta p] \ln y_{i,p} + pe_{i,o}. \tag{15}$$

Here o indexes the child ("offspring") and p the parent, so $y_{i,o}$ and $y_{i,p}$ are the the natural logarithm of long-run income, p is the return to human capital, e is the human capital endowment of the child, γ is a measure of how progressive public education spending is (capturing the ratio of public education spending per child to parental income) and θ measures how effectively schooling spending is translated into human capital. The human capital endowment is assumed to follow a first-order auto-regressive process, with the AR parameter λ capturing the the heritability of the human capital endowment. The intergenerational income equation captured in equation 15 is a first-order auto-regression (with offspring and parents being the periods) whose error, pe, also follows a first-order autoregression.

If the economy were in steady-state, that is that the variances of the offspring and parent incomes were the same, the regression slope coefficient of y_o on y_p, β, could be expressed in terms of the parameters above as (Solon, 2004; Bratsberg et al., 2007):

$$\beta = \frac{(1-\gamma)\theta p + \lambda}{1 + (1-\gamma)\theta p \lambda} \tag{16}$$

In steady-state, the intergenerational persistence is *increasing* in the heritability of human capital endowments λ, the productivity of human capital investments θ, the income or earnings return to human capital and *decreasing* in the progressivity of public education spending γ. Abstracting from the requirement that equation 16 holds in *steady-state*, see Atkinson and Jenkins (1984) for a discussion, since all of these parameters can very across countries, differences in β will reflect those differences in underlying processes.

Intergenerational associations play an important role in many models in macroeconomics – witness the bulky chapters on intergenerational economics in a recent graduate economics text, Heijdra and van der Ploeg (2002).

The relationship between intergenerational mobility, cross-sectional inequality and economic institutions has been the subject of many studies. For instance, Hassler et al. (2007) examine how labor market institutions and educational policies affect both inequality and mobility. Education subsidies may lead to inequality and mobility being negatively correlated, whereas differences in labor markets may lead to inequality and mobility being positively correlated. Another example is the study by Checchi et al. (1999), who examine how the centralisation of education policies affect both inequality and mobility. Their theoretical model suggests that the relationship between inequality and mobility may be either positive or negative, depending on the particular parameter values that apply.

7. Conclusions

(a) What have we learnt?

* remains the case that mobility assessment is a complicated matter, reflecting its multiple facets. But important to persist. Perhaps cite UK social mobility strategy documents espousing more mobility but being somewhat unclear about whether all can be upwardly mobile ...

* related: comment on extent to which can look at intra- and inter-generational mobility using same frameworks and tools

* ... but looking more positively: compared to, say, the Atkinson, Bourguignon and Morrisson (1992) survey focusing on earnings mobility, there has been a substantial increase in the amount of information available about both within and between generation mobility, largely (?) reflecting the much greater availability of longitudinal data – new household panels and cohorts; growing availability of longitudinal administrative record data (and other surveys e.g. of employers such as ASHE in UK; more generally linked employer-employee data sets)

(b) Where should future research effort (and, related, data collection) be devoted?

Potential examples might include the following:

* E.g. in the within-generation literature, has insufficient attention been given to mobility in the sense of summarising individual income trajectories over multiple periods? Similarly measures of poverty persistence ...

* What scope for looking at mobility within- and between-generations in a single framework? Theory and data.

* Which of the various mobility concepts really appear to the most important to the public at large and policy-makers, and have researchers actually been providing information in relation to them? Note e.g., in the intragenerational context the substantial policy interest in poverty dynamics (and low pay dynamics perhaps), but relatively little interest in year-to-year income mobility by policy-makers (except perhaps income growth aspects)

* Are diminishing returns setting in on the measurement of mobility as described in this chapter? Do we need to devote more attention to, say, modelling of income changes and estimation of causal effects? (But note the difficulties of doing so.) Related: problems of isolating mobility as income risk (and distinguishing it from e.g. mobility as inequality reduction. First step might be greater descriptive evidence about differences across different subgroups of the population.

* Do mobility concepts need fine-tuning (e.g. are intergenerational elasticities still useful relative to EOpp information of the Roemer et al type?)

* Better data: More and better quality especially in between-generation context. Hark back to Goldthorpe et al critique of UK literature on income mobility by economists claiming downward trend (based on two birth cohort surveys, with imperfect and not always corresponding measures for parent and child generations. (Paper is at $http://www.spi.ox.ac.uk/fileadmin/documents/pdf/Goldthorpe_{S}ocial_{M}ob_{p}aper.pdf$)

* Better data: role of surveys versus linked administrative register data. Nordic countries leading the way on this; can this experience become more universal? First steps using e.g. income tax data in USA (Kopchuk, Saez and Song) and other admin data on earnings from e.g. SIPP and social security earnings data used

by Dragoset and Fields, and Gottschalk and Huynh. [Dragoset, L. M. & Fields, G. (2006). U.S. earnings mobility: Comparing survey-based and administrative-based estimates (ECINEQ WP 2006-55). Palma de Mallorca, Spain: The Society for the Study of Economic Inequality. http://digitalcommons.ilr.cornell.edu/workingpapers/88/] Some UK parallels (e.g. Dickens and McKnight) but note issues of data access, privacy and confidentiality.

* Empirical evidence: more information about intergenerational correlations is required to match what we know about intergenerational elasticities? (But see earlier discussion in measurement section.)

* Empirical evidence: the relative dearth of evidence about income mobility for women (especially about earnings). Evidence here has been for rich countries (mainly OECD) – what about in middle- and low-income countries. Longitudinal sources much less common (but note exceptions ...) ... but similar Big Questions. E.g. noting substantial decline in the global poverty rate (Chen and Ravallion QJE 2010), has this been accompanied by changes in relative position in the population (some moving up more than others who've fallen down or not moved up as quickly?)

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