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ABSTRACT

Interpreting Trends in Intergenerational Income Mobility*

We examine how intergenerational income mobility responds to structural changes in a simple theoretical model of intergenerational transmission, deviating from the existing literature by explicitly analyzing the transition path between steady states. We find that mobility depends not only on current but also on past transmission mechanisms, such that changing policies, institutions or economic conditions may generate long-lasting trends. Variation in mobility levels across countries may thus be partly explained by differences in former institutions; current mobility trends may be caused by institutional changes in the past. We further find that transitions between steady states tend to be non-monotonic. Changes in the relative returns to different skills or a shift towards a less plutocratic and more meritocratic economy raise mobility initially, but also generate a negative trend over subsequent generations. Times of change thus tend to be times of high mobility, and declining mobility today may not reflect a recent deterioration of equality of opportunity but rather major improvements made in the past.

JEL Classification: J62, D31

Keywords: intergenerational mobility, intergenerational income elasticity, mobility trends, steady state, transition path

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Introduction

Inequality in economic status and its evolution over time is an important topic in the social sciences and in public debate. Two central dimensions of interest are the degree of cross-sectional inequality between individuals and its persistence (or inversely, its mobility) across generations. Both dimensions of inequality have not only immediate and important implications for individual welfare, they also relate in fundamental ways to the functioning of political and economic systems. Intergenerational mobility is for example seen to contribute to the stability of liberal democracies, by legitimating income and status inequalities and by reducing the potential for class-based collective action (see Erikson and Goldthorpe, 1992). A large empirical literature seeks to obtain summary measures of the degree to which differences in economic outcomes (e.g., incomes) are transmitted across generations, and to quantify how such persistence differs across countries, groups and time (see Solon, 1999, and Black and Devereux, 2011).

While the significant rise in cross-sectional income inequality since the late 1970s in the US and other OECD countries is by now a well-documented fact, we still know much less about trends in intergenerational income mobility.[1] However, we do observe that mobility differs substantially across countries and that it is negatively correlated with cross-sectional inequality (Björklund and Jäntti, 2009; Blanden, 2011a). A central theme in the recent literature is thus if income inequality has not only increased but also become more persistent across generations. This question is much debated particularly in countries that recently experienced a strong rise in cross-sectional inequality, such as the US, where commentators argue that low mobility threatens social cohesion and the notion of "American exceptionalism".[2]

But how should evidence on mobility trends be *interpreted* – does declining mobility reflect a diminished effectiveness of current policies and institutions in the promotion of equal opportunities? Although central to many empirical and policy-related studies, the theoretical literature provides only little guidance on such questions. Almost all existing work examines the relationship between causal transmission mechanisms and the implied long-run *steady-state* level of intergenerational mobility (e.g., Conlisk, 1974a; Solon, 2004). In this paper we argue that an understanding of mobility trends requires a dynamic perspective, considering also how changing mechanisms affect mobility in the "short run" over subsequent generations. Such transitions between steady states are of particular importance in intergenerational research since a single transmission step corresponds to a whole genera-

[1] Autor and Katz (1999) discuss trends in wage inequality across countries. Atkinson, Piketty, and Saez (2011) find a substantial rise in top income shares in the US and various other countries.

[2] Exemplary are Bernstein (2003); Wooldridge (2005); Wessel (2005); Scott and Leonhardt (2005), and Noah (2012). The political importance of the topic is exemplified by a recent speech of Alan Krueger, Chairman of the Council of Economic Advisers, who warned that intergenerational mobility should be expected to decline further as of the recent rise in income inequality in the US (speech delivered at the Center for American Progress, January 12th, 2012).

tion. Structural changes may thus generate long-lasting mobility trends even if transitions are completed within few generations. For example, legislation designed to widen educational attainment of individuals in certain demographic groups may also raise opportunities of their children and grandchildren, and thus affect mobility trends over more than half a century. Transition paths between steady states are then important determinants of mobility levels and trends, in particular if the institutional and economic environment that families face changes substantially over such long time periods.

We thus contribute to the literature by examining the dynamic implications of a simultaneous equations model of intergenerational transmission. While otherwise consistent with standard models in the literature, we deviate from previous work by assuming that income depends on human capital through a vector of distinct productive characteristics instead of a single factor. This choice is in accordance with the growing evidence that recognizes the importance of several distinct, including noncognitive, types of skills (e.g., Carneiro and Heckman, 2003; Heckman, Stixrud, and Urzua, 2006). We show that such multiplicity also matters in the intergenerational context, as variation in the returns to those skills affects income mobility.

We first note that the level of intergenerational mobility depends not only on contemporaneous transmission mechanisms, but also on the distribution of income and skills in the parent generation – and thus on past mechanisms. This result leads to a number of implications. First, changes in policies and institutions can generate long-lasting mobility trends. Conversely, changes in mobility today might not be caused by recent structural changes, but by major events in the more distant past. Second, differences in mobility across countries, or across groups within countries, might reflect not only the consequences of current but also of past policies, institutions and conditions.

Particularly interesting is that a fairly general class of changes in transmission mechanisms cause non-monotonic transitions between steady states. First, changes in the relative returns to different types of human capital and endowments tend to *increase* mobility initially, followed by a *decreasing* trend that lasts over multiple generations. Changes in the relative heritability of different types have similar implications. Times of change (e.g., as of industrial or technological change) thus tend to be times of high mobility, while mobility is likely to decrease when the economic environment stabilizes. Second, a shift towards a more meritocratic society – i.e., parental status becomes less important relative to own skills – increases mobility initially, but also generates a negative trend over subsequent generations. Even structural changes that are clearly mobility-enhancing in the long-run can cause negative trends across some generations.

Declining intergenerational mobility today might then not signal that current policies and institutions promote equality of opportunity less effectively, but might instead be a repercussion of major *improvements* in the past. Relating current policies and institutions to current mobility levels may therefore result in misleading conclusions about their long-run effects on mobility; the interpretation of mobility trends becomes a rather complex matter. But a dynamic view of intergenerational transmission does not only reveal such pitfalls, it may also be useful for the identification of causal mechanisms (as different types of structural shocks have different dynamic implications), and aid our understanding of the mobility differences across countries and time that have been documented by the empirical literature. While our main objective is to illustrate the general relationship between causal transmission mechanisms and mobility trends, we will also briefly comment on the practical implications and potential applications of our findings.

The rest of the paper is structured as follows. In the next section we discuss the related literature. In Section 2 we present our model of intergenerational transmission, derive current and steady-state levels of intergenerational mobility in terms of its structural parameters, and analyze the dynamic content of the model. Our main findings and their practical implications are presented in Sections 3 and 4. We examine some extensions of the standard model in Section 5. Some further implications and conclusions are found in Section 6.

1 The Literature

Much theoretical research covers the relationship between causal transmission mechanisms and steady-state mobility levels, but there exists little work on transition paths between those steady states. In the standard simultaneous equations approach as developed by Conlisk (e.g., in Conlisk, 1974a) only Atkinson and Jenkins (1984) focus on systems that are not in steady state.[3] While they show that failure of the steady-state assumption impedes identification of invariable parameters of the structural model, we instead consider how changes in structural parameters affect intergenerational mobility in subsequent generations. Solon (2004) notes that the interpretation of mobility trends would benefit from a theoretical perspective, and examines how structural changes (such as in the return to human capital and the progressivity of public investment) affect mobility in the first affected generation. Davies et al. (2005) compare mobility and cross-sectional inequality under private and public education in a simple model of human capital accumulation. They note that the observation of mobility trends may help to distinguish between alternative causes of rising cross-sectional inequality.

While theoretical work is sparse, it exists much empirical work on mobility trends in the US and other countries. A long-standing and large sociological literature is concerned with *occupational* and class mobility (see Breen, 2004, and Hauser, 2010), examining both absolute (subject to changes in the occupational structure at the aggregate level) and relative mobility rates across countries and time. In an interesting contribution from the economic

[3]Moreover, Jenkins (1982) discusses stability conditions for systems of stochastic linear difference equations with constant coefficients, Conlisk (1974b) derives stability conditions for systems with random coefficients.

literature, Long and Ferrie (2013) argue that in the nineteenth century occupational mobility was higher in the US than in the UK, but that a subsequent decline in mobility in the US had erased this difference by the 1950s.

A more recent but fast-growing economic literature examines trends in relative *income* mobility. Some of the emerging evidence appears conflicting, perhaps as a result of the substantial data requirements that studies of intergenerational income mobility face. Measurement ideally requires long-run income data that fully span two generations, but often only sparse data are available or exploited.[4] Hertz (2007) and Lee and Solon (2009) find no evidence of a major trend in intergenerational mobility across cohorts of sons born 1952-1975, but due to imprecise estimates cannot reject more gradual changes over time. Levine and Mazumder (2007) as well as Aaronson and Mazumder (2008) argue that mobility has fallen in recent decades, the latter based on intergenerational estimates from synthetic families (constructed from census data), the former based on estimates of sibling correlations in various economic outcomes. Recent evidence for the UK shows decreasing income mobility between cohorts born in the 1950s and 1970s (Blanden et al., 2004, Nicoletti and Ermisch, 2007).[5]

A central concern in many of these papers, policy-related outlets, and the public press is that mobility may have declined in conjunction with the recent rise in income inequality, often fueled by the observation that income mobility correlates negatively with inequality across countries.[6] Many potential causal factors for observed mobility trends – such as educational expansion, rising returns to education, or changes in welfare policies – have been discussed in the literature (e.g., Levine and Mazumder, 2007, and further articles in the same issue). Common to all explanations is that they relate trends to recent events that may have directly affected the respective cohorts. We aim to illustrate why the key to an understanding of current mobility levels and trends might lie in the more distant past.

2 A Simple Model

Measuring intergenerational mobility. In our analysis we consider the intergenerational elasticity of income, which is a popular *descriptive* measure of persistence in relative economic status. Our main arguments also extend to other descriptive measures of mobility. Consider a simplified one-parent one-offspring family structure, with $y_{i,t}$ as log lifetime in-

[4]See Solon (1999) and Haider and Solon (2006) for a discussion of the early empirical literature and the currently preferred method to estimate mobility parameters based on incomplete income data. Nybom and Stuhler (2011) argue that the standard methods employed in the recent literature still suffer from substantial life-cycle bias. The bias can differ by cohort and may thus mask gradual changes of mobility over time, or generate a false impression of such trends.

[5]See Erikson and Goldthorpe (2010) and Blanden (2011b) for a debate of divergent findings in measures of income and occupational mobility.

[6]See references in footnote 2 for the US or Blanden and Machin (2008) and Blanden (2009) for the UK.

come of the offspring in generation t of family i and $y_{i,t-1}$ as log lifetime income of the parent. The intergenerational elasticity is given by the slope coefficient in a linear OLS regression of

$$y_{i,t} = \alpha_t + \beta_t y_{i,t-1} + \epsilon_{i,t}. \tag{1}$$

The elasticity β_t captures a *statistical* relationship and the error $\epsilon_{i,t}$ is uncorrelated with the regressor by construction. Under stationarity in the variance of $y_{i,t}$ (a case that we will frequently consider) it equals the intergenerational correlation, which adjusts the elasticity for changes in cross-sectional inequality. The elasticity is the most commonly estimated parameter in empirical studies of intergenerational income mobility and captures to what degree percentage differences in parents' incomes tend to be transmitted to the next generation. A low elasticity or correlation thus indicates high mobility.

A model of intergenerational transmission. We model intergenerational transmission as a system of stochastic linear difference equations, in the tradition of the simultaneous equation approach developed and elaborated by Conlisk (1969, 1974a) and Atkinson and Jenkins (1984). We do not explicitly model the optimizing behavior of parents (as in Becker and Tomes, 1979, or Solon, 2004), but the "mechanical" pathways represented by the structural equations can also be derived from such underlying utility-maximization framework (see Goldberger, 1989). The equations of our baseline model are

$$y_{it} = \gamma_{y,t}\, y_{it-1} + \boldsymbol{\delta}_t' \boldsymbol{h}_{it} + u_{y,it} \tag{2}$$

$$\boldsymbol{h}_{it} = \boldsymbol{\gamma}_{h,t}\, y_{it-1} + \boldsymbol{\Theta}_t\, \boldsymbol{e}_{it} + \boldsymbol{u}_{h,it} \tag{3}$$

$$\boldsymbol{e}_{it} = \boldsymbol{\Lambda}_t\, \boldsymbol{e}_{it-1} + \boldsymbol{v}_{it}. \tag{4}$$

From equation (2), income y_{it} in generation t of family i is determined by *parental income* y_{it-1}, own *human capital* $\boldsymbol{h}_{it}$, and *chance* $u_{y,it}$. The parameter $\gamma_{y,t}$ captures a direct effect of parental income that is independent from offspring productivity, which may arise as of nepotism, statistical discrimination under imperfect information on individual productivity, or other reasons.[7] Human capital consists of a $Jx1$ vector $\boldsymbol{h}_{it}$ with elements $h_{1,it}, ..., h_{J,it}$, which reflect distinct characteristics such as health, physical attributes, and cognitive and non-cognitive skills. These characteristics are valued on the labor market according to a $Jx1$ price vector $\boldsymbol{\delta}_t$ with elements $\delta_{1,t}, ..., \delta_{J,t}$. The random shock term $u_{y,it}$ captures factors that do not relate to parental background. For our analysis it makes no difference if these are interpreted as (labor market) luck or as the impact of other characteristics that are not transmitted within families.

[7]For example as of credit constraints influencing choices on the labor market, parental information and networks, or (if total market income is considered) returns to bequests. The exact mechanism and the distinction between earnings and income are not central for our purposes.

From equation (3), human capital $\boldsymbol{h}_{it}$ is affected by parental income y_{it-1}, own *endowments* $\boldsymbol{e}_{it}$, and chance $\boldsymbol{u}_{h,it}$. A role for parental income, as governed by the $Jx1$ vector $\boldsymbol{\gamma}_{h,t}$, may for example stem from parental investment into offspring human capital. Elements in $\boldsymbol{\gamma}_{h,t}$ may differ if parental investments are more targeted or more effective on some types of human capital than others. Parental income may thus affect offspring income directly (through $\gamma_{y,t}$) or indirectly (through $\boldsymbol{\gamma}_{h,t}$).[8] The JxK matrix $\boldsymbol{\Theta}_t$ governs the role that endowments such as abilities or preferences play in the accumulation of different types of human capital.[9] Those endowments, consisting of the $Kx1$ vector $\boldsymbol{e}_{it}$ with elements $e_{1,it}, ..., e_{K,it}$, are partly inherited from parental endowments $\boldsymbol{e}_{it-1}$ and partly due to chance $\boldsymbol{v}_{it}$. The elements of the KxK matrix $\boldsymbol{\Lambda}_t$ govern the *heritability* of each endowment. We consider $\boldsymbol{\Lambda}_t$ to represent a broad concept of intergenerational transmission potentially working through both nature (e.g. genetic inheritance) and nurture (e.g. family environment). For simplicity we assume no cross-correlations between endowments, so that $\boldsymbol{\Lambda}_t$ is diagonal with elements $\lambda_{1,t}, ..., \lambda_{K,t}$. The random shock $u_{y,it}$ and elements of $\boldsymbol{u}_{h,it}$ and $\boldsymbol{v}_{it}$ are assumed to be uncorrelated with each other and past values of $\{y_{it}, \boldsymbol{h}_{it}, \boldsymbol{e}_{it}, u_{y,it}, \boldsymbol{u}_{h,it}, \boldsymbol{v}_{it}\}$. In equations (2) to (4) we assume that earlier ancestors have only indirect influence, but we will consider independent effects from grandparents separately in Section 5.

For convenience we drop the individual subscript i in the subsequent analysis and make a few simplifying assumptions. As we focus on relative mobility assume that all variables are measured as trendless indices with constant mean zero (as in Conlisk, 1974a), such that we do not need to include constants. To avoid case distinctions assume further that those indices measure positive characteristics with a non-negative effect on income (such that $\gamma_{y,t}$ and the elements of $\boldsymbol{\gamma}_{h,t}$ and $\boldsymbol{\delta}_t'\boldsymbol{\Theta}_t$ are non-negative); that parent and offspring endowments are not negatively correlated (such that elements of $\boldsymbol{\Lambda}_t$ are non-negative); and that all slope parameters are non-zero, unless noted to the contrary, for all t.

Using equation (3) to substitute out $\boldsymbol{h}_{i,t}$ and introducing a shorter notation we have

$$y_t = \gamma_t \, y_{t-1} + \boldsymbol{\rho}_t' \, \boldsymbol{e}_t + u_t \tag{5}$$

$$\boldsymbol{e}_t = \boldsymbol{\Lambda}_t \, \boldsymbol{e}_{t-1} + \boldsymbol{v}_t, \tag{6}$$

where the parameter γ_t aggregates the direct and indirect effects of parental income,

$$\gamma_t = \gamma_{y,t} + \boldsymbol{\delta}_t' \boldsymbol{\gamma}_{h,t},$$

[8]The distinction may not be sharp in practice; for example, parental credit constraints might affect educational attainment and human capital acquisition of offspring, but might also affect their career choices for a given level of human capital.

[9]Some characteristics, such as cognitive or non-cognitive skills, may affect incomes both directly and indirectly through its effect on other types of human capital (e.g., education), and thus feature in both $\boldsymbol{h}_{it}$ and $\boldsymbol{e}_{it}$.

the $Kx1$ vector $\boldsymbol{\rho}_t$ captures the returns to inherited endowments and human capital (affected both by the importance of endowments in the accumulation of and the returns to human capital),

$$\boldsymbol{\rho}_t' = \boldsymbol{\delta}_t'\boldsymbol{\Theta}_t,$$

and where $u_t = u_{y,t} + \boldsymbol{\delta}_t'\boldsymbol{u}_{h,t}$ aggregates the random shocks in income and human capital. The reduced form of equations (5) and (6) is

$$\begin{pmatrix} y_t \\ \boldsymbol{e}_t \end{pmatrix} = \begin{pmatrix} \gamma_{y,t} + \boldsymbol{\delta}_t'\boldsymbol{\gamma}_{h,t} & \boldsymbol{\delta}_t'\boldsymbol{\Theta}_t\boldsymbol{\Lambda}_t \\ \boldsymbol{0} & \boldsymbol{\Lambda}_t \end{pmatrix} \begin{pmatrix} y_{t-1} \\ \boldsymbol{e}_{t-1} \end{pmatrix} + \begin{pmatrix} u_{y,t} + \boldsymbol{\delta}_t'\boldsymbol{u}_{h,t} + \boldsymbol{\delta}_t'\boldsymbol{\Theta}_t\boldsymbol{v}_t \\ \boldsymbol{v}_t \end{pmatrix}, \quad (7)$$

which we may shorten to

$$\boldsymbol{x}_t \quad = \quad \boldsymbol{A}_t\boldsymbol{x}_{t-1} + \boldsymbol{w}_t. \quad (8)$$

The stability condition $lim_{s\to\infty}\boldsymbol{A}_t^s = 0$ is satisfied by assuming that $\gamma_{y,t} + \boldsymbol{\delta}_t'\boldsymbol{\gamma}_{h,t}$ and all diagonal elements of $\boldsymbol{\Lambda}_t$ are strictly between zero and one, such that all eigenvalues of $\boldsymbol{A}_t$ are non-negative and below one. These conditions also ensure that the transitions of the first and second moments of $\boldsymbol{x}_t$ towards their steady state values are monotonic (see Jenkins, 1982), a property that however does not extend to the transition path of the intergenerational elasticity, as we will discuss in the next section.

Our model has a similar structure as the model in Conlisk (1974a), but in contrast to the previous literature we assume that income depends on human capital through a vector of distinct productive characteristics instead of a single factor. This generalization will prove to be central for some of our findings. Similarity to the existing literature in other dimensions is advantageous since it suggests that our findings do not arise due to non-standard assumptions. Our second deviation from previous work is the addition of t subscripts to all parameters, since we want to consider the effects of changes in the transmission framework over time. A parameter may change over time as of various underlying mechanisms. For example, an expansion of public childcare may affect the degree to which human capital is inherited across generations, or technological change on the labor market may affect relative demand and thus relative returns to different skills. For simplicity we do not model any such mechanism explicitly.

In the next sections we will consider how mobility trends evolve after a structural change occurs in generation $t = T$ and the system transitions from its initial to a new steady state. For convenience we normalize the variances of y_t and all elements of $\boldsymbol{h}_t$ and $\boldsymbol{e}_t$ in the initial steady state to one. The variances of $u_{y,t}$ and elements of $\boldsymbol{u}_{h,t}$ and $\boldsymbol{v}_t$ are then implicitly a function of the slope parameters of the model, and the requirement for those variances to be non-negative leads to additional constraints on the possible range of parameter values.[10] Cross-sectional inequality may change after a structural change occurs. However, we will frequently consider changes in the *relative* strength of different transmission mechanisms that do not affect the cross-sectional variances of income, human capital, and endowments. Abstracting from sources of dynamics that stem from the transition paths of those variances simplifies the discussion and helps to isolate other adjustment mechanisms that are of particular interest.

2.1 The Importance of Past Transmission Mechanisms

Assume for now that cross-sectional inequality remains constant, $Var(y_t) = Var(e_{j,t}) = 1$ $\forall j, t$, such that the intergenerational elasticity coincides with the intergenerational correlation. It is derived by plugging equations (5) and (6) from our model of intergenerational transmission into equation (1),

$$\beta_t = \frac{Cov(y_t, y_{t-1})}{Var(y_{t-1})} = \gamma_t + \boldsymbol{\rho}_t' \boldsymbol{\Lambda}_t Cov(\boldsymbol{e}_{t-1}, y_{t-1}). \tag{9}$$

Thus, β_t depends on current transmission mechanisms (parameters γ_t, $\boldsymbol{\rho}_t$ and $\boldsymbol{\Lambda}_t$) and on the cross-covariance between income and endowments in the parent generation. Expression (9) illustrates that two populations that are subject to similar transmission mechanisms (e.g., similar institutions and policies) can nevertheless differ in their levels of intergenerational mobility, since current mobility depends also on the joint distribution of income and endowments in the parent generation.

The cross-covariance between income and endowments in the parent generation is in turn determined by past transmission mechanisms, and thus depends on past values of $\{\gamma_t, \boldsymbol{\rho}_t, \boldsymbol{\Lambda}_t\}$. We can iterate equation (9) backwards to express β_t in terms of parameter values,

$$\begin{aligned} \beta_t &= \gamma_t + \boldsymbol{\rho}_t' \boldsymbol{\Lambda}_t \left(\boldsymbol{\Lambda}_{t-1} Cov(\boldsymbol{e}_{t-2}, y_{t-2}) \gamma_{t-1} + \boldsymbol{\rho}_{t-1} \right) \\ &= \ldots \\ &= \gamma_t + \boldsymbol{\rho}_t' \boldsymbol{\Lambda}_t \boldsymbol{\rho}_{t-1} + \boldsymbol{\rho}_t' \boldsymbol{\Lambda}_t \left(\sum_{r=1}^{\infty} \left(\prod_{s=1}^{r} \gamma_{t-s} \boldsymbol{\Lambda}_{t-s} \right) \boldsymbol{\rho}_{t-r-1} \right), \end{aligned} \tag{10}$$

[10] Take the covariance of (8) and denote the covariance matrices of x_t and w_t by $\boldsymbol{S}_t$ and $\boldsymbol{W}_t$, respectively, such that

$$\boldsymbol{S}_t = \boldsymbol{A}_t \boldsymbol{S}_{t-1} \boldsymbol{A}_t' + \boldsymbol{W}_t.$$

Denote by γ, $\boldsymbol{\rho}$, and $\boldsymbol{\Lambda}$ the steady-state parameter values before a structural change occurs in generation $t = T$. Note that in steady state $\boldsymbol{S}_t = \boldsymbol{S}_{t-1} = \boldsymbol{S}$, normalize all diagonal elements of $\boldsymbol{S}$ to one, and solve for the variances of $u_{y,t}$ and elements of $\boldsymbol{u}_{h,t}$ and $\boldsymbol{v}_t$. For example, $Var(e_{j,t}) = 1 \, \forall j$ iff $Var(v_{j,t}) = 1 - \lambda_j^2 \, \forall j$; the variances are non-negative iff $\lambda \leq 1$, as was also required for stability of the system.

where for simplicity we assume that the process is infinite.[11] The level of intergenerational mobility today thus depends on current and past transmission mechanisms.[12] If parameters have been constant for past generations, $\gamma_s = \gamma,\ \boldsymbol{\rho}_s = \boldsymbol{\rho},\ \boldsymbol{\Lambda}_s = \boldsymbol{\Lambda}\ \forall s \leq t$, then equation (11) simplifies to the *steady-state* intergenerational elasticity

$$\begin{aligned}\beta &= \gamma + \boldsymbol{\rho}'\boldsymbol{\Lambda}\sum_{s=0}^{\infty}(\gamma\boldsymbol{\Lambda})^s\boldsymbol{\rho} \\ &= \gamma + \boldsymbol{\rho}'\boldsymbol{\Lambda}\left(\boldsymbol{I}_{KxK} - \gamma\boldsymbol{\Lambda}\right)^{-1}\boldsymbol{\rho}, \qquad (11)\end{aligned}$$

where the second line follows since the geometric series $\sum_{s=0}^{\infty}(\gamma\boldsymbol{\Lambda})^s$ converges (the absolute value of each eigenvalue of $\gamma\boldsymbol{\Lambda}$ is below one). The literature has almost exclusively focused on how changes in structural parameters affect intergenerational mobility in steady state given by (11). We will instead analyze the *transition path* towards the new steady state as determined by equation (10).

Some of its properties can be readily generalized. The transition path of $Cov(\boldsymbol{e}_{t-1}, y_{t-1})$ is governed by the eigenvalues of the reduced form coefficient matrix in equation (8), and is thus monotonic. From (9) it however follows that income mobility in the *first* generation subject to a structural change is directly affected by changes in the parameter values, not indirectly by changes in the covariance between parental income and endowments. Trends in income mobility are thus not necessarily monotonic, even when cross-sectional inequality remains constant, as we will show in the next section. Other properties, such as the speed of convergence, depend on the parameterization of the model and can thus not be generalized.

3 From Simple Examples to Non-Monotonic Trends

For illustration we will start with simplified versions of our baseline model and then move progressively to more general models. It will be sufficient for our first set of examples to consider a single endowment e_t and thus scalar versions of equations (5) and (6) , such that

$$y_t = \gamma_t y_{t-1} + \rho_t e_t + u_t \qquad (12)$$

$$e_t = \lambda_t e_{t-1} + v_t. \qquad (13)$$

Our main findings do not rely on specific parameter choices, but the quantitative implications of our supplemental numerical examples will be more relevant if we choose values that are consistent with empirical evidence. The evidence in the literature, and our cross-validations

[11]For a finite process, β_t will depend on past parameter values and the initial condition $Cov(\boldsymbol{e}_0, y_0)$.

[12]Under variable cross-sectional inequality the derivation of equation (10) would require backward iteration of the variances of y_t and $\boldsymbol{e}_t$. Accordingly, β_t would also depend on the variances of u_t and $\boldsymbol{v}_t$ in past generations.

within the model, suggest the following rough order of magnitudes for the US case:

$$0.45 \leq \beta \leq 0.55, \quad 0.15 \leq \gamma \leq 0.25, \quad 0.60 \leq \rho \leq 0.70, \quad 0.50 \leq \lambda \leq 0.65.$$

We provide a detailed motivation of our choices of parameter values in Appendix A1. It will be useful to first look at an even simpler case in which parental income has no effect on offspring income.

EXAMPLE 1: A SIMPLE MERITOCRATIC ECONOMY. Assume that the *heritability* of endowments (λ_t) or the *returns* to endowments and human capital (ρ_t) change in a simple meritocratic economy ($\gamma_t = 0\ \forall t$).

Assume first that cross-sectional inequality remains constant because changes in λ_t or ρ_t are offset by corresponding changes in the variance of u_t or v_t, respectively (e.g., the importance of factors related to parental background *relative* to unrelated factors change). From equation (10), a change in the heritability of endowments in generation T from $\lambda_{t<T} = \lambda_1$ to $\lambda_{t \geq T} = \lambda_2$ leads then to a shift in the intergenerational elasticity (or correlation) that equals

$$\Delta\beta_T = \beta_T - \beta_{T-1} = \rho(\lambda_2 - \lambda_1)\rho. \tag{14}$$

Mobility remains constant afterwards. A change in returns from ρ_1 to ρ_2 in generation T instead leads to a transition in β_t that lasts over two generations. The first shift equals

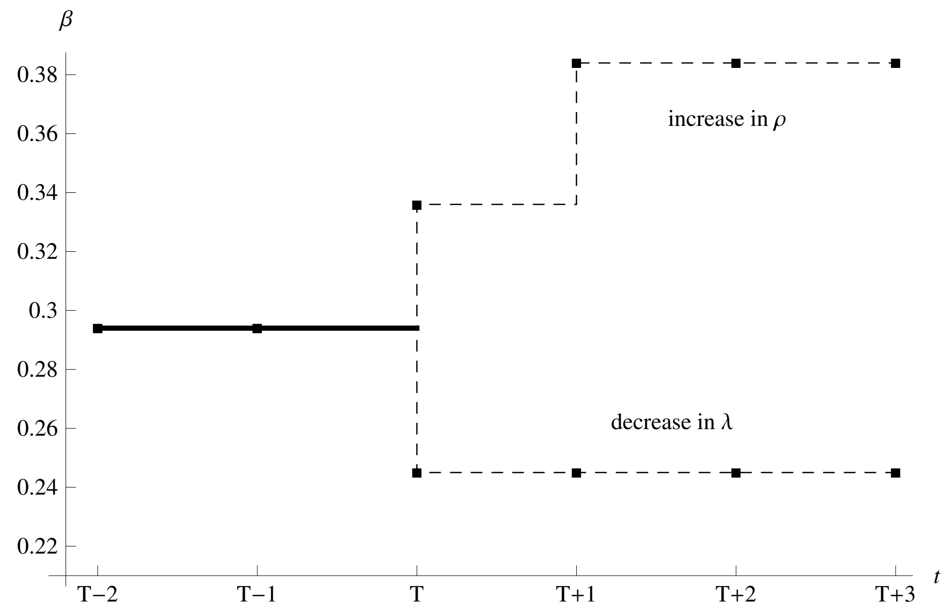
$$\begin{aligned} \Delta\beta_T = \beta_T - \beta_{T-1} &= (\rho_2 - \rho_1)\lambda Cov(e_{T-1}, y_{T-1}) \\ &= (\rho_2 - \rho_1)\lambda\rho_1, \end{aligned} \tag{15}$$

and is induced by the change in returns for the *offspring* generation in T. The second shift,

$$\begin{aligned} \Delta\beta_{T+1} = \beta_{T+1} - \beta_T &= \rho_2\lambda\left(Cov(e_T, y_T) - Cov(e_{T-1}, y_{T-1})\right) \\ &= \rho_2\lambda(\rho_2 - \rho_1), \end{aligned} \tag{16}$$

is induced by the change in the correlation between income and endowments among the *parents* of the offspring generation $T+1$, in turn caused by changing returns to those endowments in generation T. The second shift is larger than the first if returns increase ($\rho_2 > \rho_1$). Mobility remains constant afterwards. Figure 1 gives a numerical example.

Figure 1: A change in the heritability of, or returns to, endowments



Note: Mobility trend over generations in two numerical examples. Example 1a: in generation T the heritability of endowments λ decreases from $\lambda_1 = 0.6$ to $\lambda_2 = 0.5$ (assuming $\rho = 0.7$). Example 1b: the returns to endowments and human capital ρ increase from $\rho_1 = 0.7$ to $\rho_2 = 0.8$ (assuming $\lambda = 0.6$).

An additional source of dynamics stems from changes in cross-sectional inequality. If the changing heritability of endowments affects its cross-sectional variance (e.g., because the variance of v_t remains constant) then the elasticity shifts not only in the first but also subsequent generations, since

$$\Delta\beta_{T+1} = \rho\lambda_2 \left(\frac{Var(e_T)}{Var(y_T)} - \frac{Var(e_{T-1})}{Var(y_{T-1})} \right) = \rho\lambda_2 \left(\frac{1 + (\lambda_2^2 - \lambda_1^2)}{1 + \rho^2(\lambda_2^2 - \lambda_1^2)} - 1 \right) \tag{17}$$

is non-zero for $\lambda_1 \neq \lambda_2$. Intuitively, if *individual characteristics* are linked over generations due to inheritance within families then *cross-sectional inequality* will also be linked over generations; formally we can take the variance of equation (13) and iterate backwards to find

$$Var(e_t) = \lambda_{t-k}^{2k} Var(e_{t-k}) + \sum_{s=0}^{k-1} \lambda_{t-s}^{2s} Var(v_{t-s}) \qquad \forall k \geq 1. \tag{18}$$

As equation (18) exemplifies, models of intergenerational transmission imply that the impact of a structural change on cross-sectional inequality propagates in subsequent generations, thereby also affecting mobility measures over the course of multiple generations. However, since the dynamic effect from changes in the *variance* of a characteristic will often be minor compared to the effect from changes in its *correlations* with other variables we will focus our discussion on the latter.

We found that a change in the returns to skills shifts intergenerational mobility measures potentially more in the second than in the first affected generation. Its effect on steady state mobility levels may thus not become fully evident before both the parent and child generations experienced the new price regime. We can illustrate the practical implications of this argument by relating it to the evidence on rising skill differentials in wages from the late 1970s in the US and UK (and more recently in other OECD countries). The notion that widening wage differentials could decrease intergenerational mobility (e.g., Blanden et al., 2004, and Solon, 2004) is one of the main motivations for the current interest in mobility trends. But recent trend studies do not yet observe offspring cohorts whose parents have fully experienced the changing wage regime; its impact on mobility may thus become fully evident only in future empirical studies.[13] This argument may also help to explain why US studies find a sharp increase in *sibling* correlations since 1980 (Levine and Mazumder, 2007), while there seems to be less evidence for such shift in *intergenerational* measures of persistence (see Section 1). The former are directly affected by changing wage differentials, but the latter also depend on conditions in the parent generation. The effect of rising returns to skills should thus be more immediate on sibling than on intergenerational measures of persistence.

Our comparison between two different types of structural shocks further illustrates that the dynamic response of the elasticity between steady states can be informative on the type of structural shock that occurred. Changes in the heritability of skills will have a more immediate effect than changes in the returns to those skills, since income mobility depends directly on returns in both the parent and the offspring generation.

We next consider our more general model in which parental income has causal effects ($\gamma \neq 0$), starting with two simple examples on "equalizing opportunities", in the sense that offspring outcomes become less dependent upon parental income.[14]

EXAMPLE 2: EQUALIZING OPPORTUNITIES (TYPE I). Assume that the relative importance of parental income diminishes while the importance of factors that do not relate to parental background increases.

Assume that in generation T the effect of parental income declines from γ_1 to γ_2, such that $\gamma_1 > \gamma_2$. Income mobility of the first affected generation shifts according to

$$\Delta\beta_T = \gamma_2 - \gamma_1. \tag{19}$$

[13] For example, the most recent offspring cohort observed in Lee and Solon (2009) was born in 1975. The early careers of their parents have not yet been subject to the widening skill differential.

[14] As noted by Conlisk (1974a), "opportunity equalization" is an ambiguous term that may relate to different types of structural changes in models of intergenerational transmission.

From the previous example we saw that a single structural change may have a sustained effect on mobility trends as cross-sectional inequality propagates over generations. But repeated shifts in mobility may also stem from another source if parental income has a causal effect on offspring ($\gamma \neq 0$), either because parental status matters on the labour market ($\gamma_y \neq 0$) or because parental investments affect the accumulation of human capital of their offspring ($\gamma_h \neq 0$). To isolate this second source, assume that cross-sectional inequality remains constant (because the decrease in γ is offset by an increase in the variance of factors u_t that do not relate to parental background), such that from equation (10) we have

$$\Delta\beta_{T+1} = \rho\lambda^2(\gamma_2 - \gamma_1)Cov(e_{T-1}, y_{T-1}) \qquad (20)$$

$$\Delta\beta_{T+2} = \rho\lambda^2(\gamma_2 - \gamma_1)(\gamma_2\lambda)Cov(e_{T-1}, y_{T-1})$$

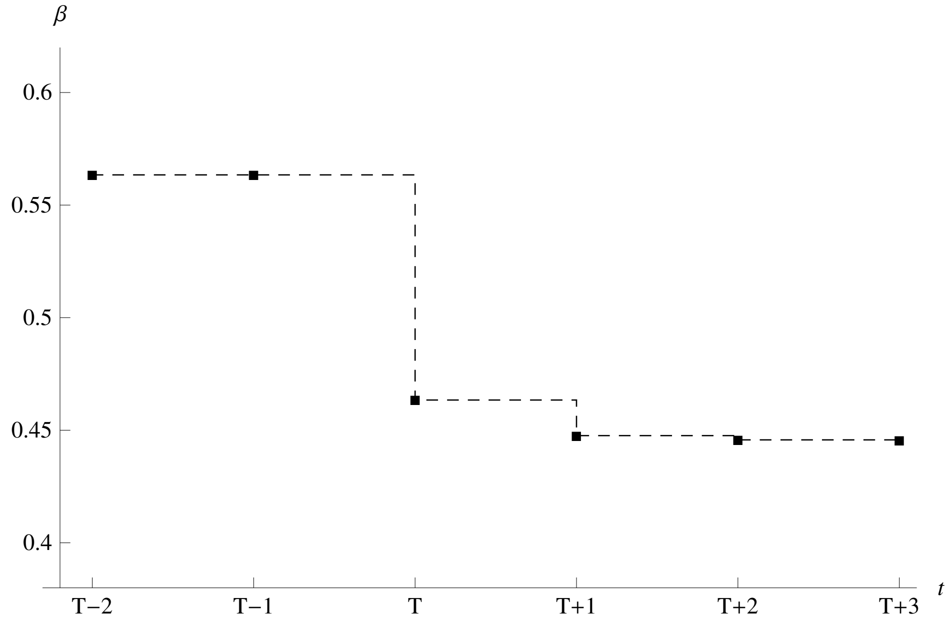
$$\vdots \qquad (21)$$

The intergenerational elasticity decreases over subsequent generations as it depends positively on the covariance between endowments and income in the parent generation, which in turn depends on the covariance in previous generations, and so forth. Using equations (12) and (13) we can iterate backwards,

$$Cov(e_t, y_t) = (\gamma_{t-k}\lambda_{t-k})^k\, Cov(e_{t-k}, y_{t-k}) + \sum_{s=0}^{k-1} (\gamma_{t-s}\lambda_{t-s})^s\, \rho \qquad \forall k \geq 1, \qquad (22)$$

illustrating how a decrease in the importance of parental income in the transmission process diminishes the correlation between endowments and income in subsequent generations. Mobility increases therefore monotonically in subsequent generations, at a decreasing rate. Figure 2 shows a numerical example.

Figure 2: A declining impact of parental income



Note: Mobility trend over generations in numerical example. In generation T the impact of parental income γ declines from $\gamma_1 = 0.3$ to $\gamma_2 = 0.2$ (assuming $\rho = 0.6$ and $\lambda = 0.6$).

Other types of structural changes also have dynamic implications as of similar mechanisms. For example, a lower degree of heritability (a fall in λ) increases income mobility not only directly by decreasing the similarity of offspring to parent endowments (our focus in example 1), but also indirectly by decreasing the correlation between endowments and income within a generation (because the offspring from rich families become less likely to inherit productive endowments). The effect of parental income, captured in the parameter γ, then becomes less detrimental to income mobility. This second, indirect effect generates a transition path that lasts over multiple generations, as apparent from equation (22).

Examples 1 and 2 illustrate that a change in policies or institutions may affect mobility trends over long time periods. This result has implications for the interpretation of observed trends: current trends may not reflect the changing effectiveness of current policies and institutions in the promotion of equality of opportunity, but the lagged effect of major changes in the more distant past. The next example illustrates that such repercussions can be both sizable and non-monotonic.

EXAMPLE 3: EQUALIZING OPPORTUNITIES (TYPE II). Assume that the importance of parental status diminishes while skills that are partially inherited within families are instead more strongly rewarded.

In other words, assume that in generation T the economy becomes less *plutocratic* and more *meritocratic*; for example, parental status may become less and own merits more important for the appointment of individuals into jobs. Such change corresponds in our model to the assumption that $\gamma_1 > \gamma_2$ and $\rho_1 < \rho_2$. Mobility initially shifts according to

$$\Delta\beta_T \quad = \quad (\gamma_2 - \gamma_1) + (\rho_2 - \rho_1)\lambda Cov(e_{T-1}, y_{T-1}), \tag{23}$$

with

$$\frac{\partial \Delta\beta_T}{\partial \gamma_2} = 1 \quad \text{and} \quad \frac{\partial \Delta\beta_T}{\partial \rho_2} = \lambda Cov(e_{T-1}, y_{T-1}).$$

The elasticity in the first affected generation is affected both by the declining importance of parental income and the increasing returns to endowments or skills. However, the effect of the second compared to the first channel is attenuated, for two reasons. First, individuals' own endowments e_T are only imperfectly correlated with parental endowments ($\lambda < 1$). Second, parental endowments e_{T-1} explain only a fraction of the variation of incomes in the parent generation ($Cov(e_{T-1}, y_{T-1}) < 1$). Income mobility thus tends to increase if a generation is subject to more meritocratic institutions and policies than their parent generation, as might be expected.

However, income persistence will also shift in the second generation, according to

$$\Delta\beta_{T+1} \quad = \quad \rho_2\lambda\left[\frac{Cov(e_T, y_T)}{Var(y_T)} - \frac{Cov(e_{T-1}, y_{T-1})}{Var(y_{T-1})}\right]. \tag{24}$$

Apart from changes in the cross-sectional variance of income, the elasticity may also shift because of changes in the correlation between income and endowments in the parent generation. The relative importance of parameter changes on the latter is now reversed, since

$$\frac{\partial Cov(e_T, y_T)}{\partial \gamma_2} = \lambda Cov(e_{T-1}, y_{T-1}) \quad \text{and} \quad \frac{\partial Cov(e_T, y_T)}{\partial \rho_2} = 1.$$

Changing returns naturally have an immediate effect on the correlation between own endowments and incomes. In particular, a change to a more meritocratic society tends to increase the correlation between endowments and income, thereby *decreasing* income mobility from the second affected generation onwards.

The dynamic response of the intergenerational elasticity thus tends to be *non-monotonic*, with an initial rise in mobility and a subsequent decline. Intuitively, when a society becomes more meritocratic, talented individuals become more likely to earn high incomes. This process initially increases mobility since their parents were less likely to earn similarly high incomes even if they had similar skills, as they were still subject to less meritocratic institutions and policies. Mobility is thus highest while the transition takes place, when a generation faces a new set of institutions, policies and opportunities that differs markedly from conditions in their parents' generation. But the offspring of those families who thrived under the meritocratic setting will also do relatively well, due to the inheritance of talent; mobility therefore decreases subsequently.

The idea that a shift towards "meritocratic" principles may eventually depress mobility was already noted by the sociologist Michael Young, who coined the term in the book *The Rise of the Meritocracy* (1958).[15] Our model allows us to illustrate that societal changes have indeed interesting (and perhaps surprising) dynamic effects on the degree of mobility over generations. In particular, changes that are mobility-enhancing in the long run may nevertheless cause a long-lasting *decreasing* trend in mobility measures over several generations.

Exact conditions for such non-monotonic adjustment can be given if we consider a special case, in which the shifting importance of parental background and own characteristics does not affect cross-sectional inequality, such that $Var(y_t) = 1 \, \forall t$. From equation (10), a change to a more meritocratic society will then increase mobility initially iff

$$\frac{\gamma_1 - \gamma_2}{\rho_2 - \rho_1} > \lambda Cov(e_{T-1}, y_{T-1}). \tag{25}$$

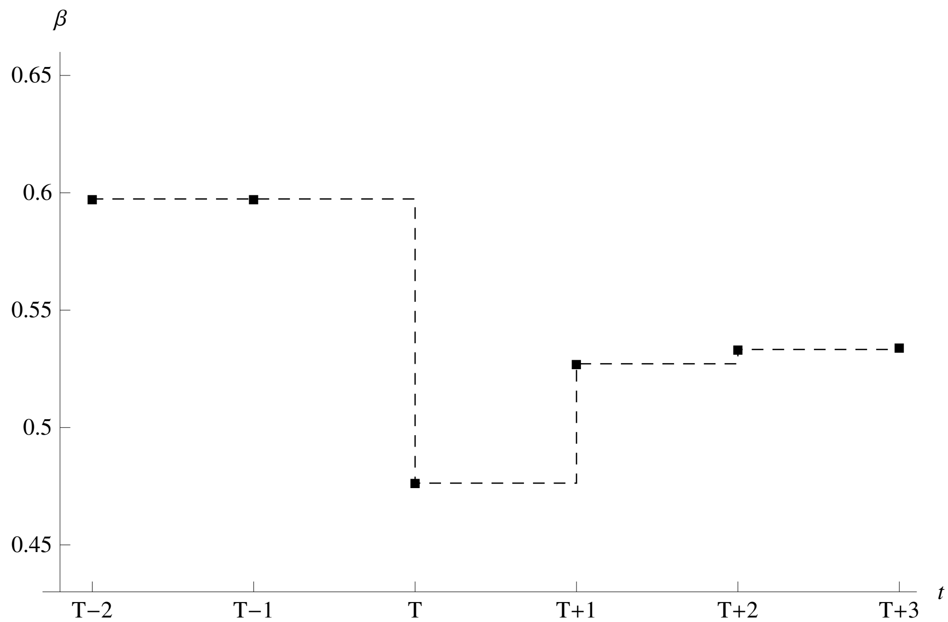
However, mobility *decreases* in subsequent generations iff

$$\frac{\rho_2 - \rho_1}{\gamma_1 - \gamma_2} > \lambda Cov(e_{T-1}, y_{T-1}). \tag{26}$$

Conditions (25) and (26) will be satisfied for any changes $\gamma_1 - \gamma_2$ and $\rho_2 - \rho_1$ that are of similar magnitude in absolute terms.

[15] In his book Young provides a futuristic vision of Britain, where the class-based elite has been replaced by a hierarchy of talent. In contrast to its usage today, he intended the term "meritocracy" to have a derogatory connotation: "*It is good sense to appoint individual people to jobs on their merit. It is the opposite when those who are judged to have merit of a particular kind harden into a new social class without room in it for others*." (The Guardian, June 29, 2001).

Figure 3: A declining impact of parental income and increasing returns to skills



Note: Mobility trend over generations in numerical example. In generation T the impact of parental income γ declines from $\gamma_1 = 0.4$ to $\gamma_2 = 0.2$ while the returns to endowments and human capital ρ increase from $\rho_1 = 0.5$ to $\rho_2 = 0.7$ (assuming $\lambda = 0.6$).

Figure 3 plots a numerical example, illustrating that the non-monotonic response in mobility trends can be long-lasting; it becomes insignificant only in the third generation, or more than half a century after the structural change (we illustrate the timing of mobility trends over cohorts further in Section 5). These findings imply that we need to be careful in the interpretation of observed mobility trends; declining mobility today may not reflect a recent deterioration of equality of opportunity, but rather major gains made long ago.

In the numerical example, mobility changes much more strongly in the first two than in subsequent generations. Can we then conclude that more distant structural changes have only a negligible effect on current mobility trends? We believe not, for two reasons. First, our model is very simple, and various extensions (e.g., considering wealth or direct causal effects from grandparents on their grandchildren) could generate slower transitions between steady states. Second, in many countries past events may have had more dramatic effects on intergenerational transmission than more recent changes. For example, in the late 19th and early 20th century the US experienced rapid industrialization and urbanization, a declining share of agriculture and self-employment, strong immigration and internal migration, and a large-scale expansion of public schooling. The country participated in two world wars and went through a highly turbulent interwar period. These events may have affected intergenerational transmission to a greater degree than more recent changes that have been considered as potential determinants of current mobility trends, such as an increase in private schooling or increased attainment in higher education.[16]

Much of the recent empirical literature measures trends in income mobility for offspring cohorts born from around 1950 to the 1970s, cohorts that are separated by only one or two generations from events in the early 20th century. Trends observed over these cohorts may thus not only reflect contemporaneous changes in policies or institutions, but also the repercussions of major changes in the more distant past. This argument applies in particular to those countries whose political, institutional and societal structure has changed more dramatically in the first than in the second half of the 20th century. Finally, our model illustrates that if those changes led to a more meritocratic society, mobility should perhaps be *expected* to decline in more recent cohorts.

4 Intergenerational Mobility in Times of Change

Our finding that a change to a more meritocratic society can lead to long-lasting and non-monotonic mobility trends is important for the interpretation of recent trends. But it relates to a rather specific type of structural change; one may thus expect that non-monotonic responses are more of an exception than a rule. In our next two examples we illustrate that such responses are instead quite typical, as they also tend to occur when the relative returns to different types of human capital or the relative heritability of endowments change.

For these examples we consider the general transmission framework with multiple types of human capital and endowments, as in equations (5) and (6). The notion of individual ability has recently shifted from a one-dimensional concept primarily related to IQ, such as in the single-skill signaling model (Arrow, 1973) and the *g* factor (see, e.g., Herrnstein and Murray, 1994), to a multidimensional set of traits that for example recognizes the importance of noncognitive skills. A stream of evidence has supported this idea, showing that several distinct types of skills are important for various labor market and social outcomes (e.g., Heckman, Stixrud, and Urzua, 2006; Lindqvist and Vestman, 2011). Although typically not discussed in the intergenerational context (an exception is Bowles and Gintis, 2002), our analysis illustrates that such multiplicity may provide additional implications that cannot be captured by models that are based on a single inheritable characteristic.[17]

[16]The hypothesis that major societal transformations can strongly affect mobility is consistent with studies on long-run trends in intergenerational occupational mobility (see Hauser 2010 for a discussion of this alternative measure of economic mobility), which imply that US mobility has changed substantially between the 19th and 20th century (e.g., Grusky, 1986, and Long and Ferrie, 2013); or with observations from Finland, where rapid industrialization and educational expansion after the second world war were accompanied by a strong increase in income mobility for cohorts born around 1950 compared to cohorts born in the early 1930s (see Pekkala and Lucas, 2007).

[17]Multiplicity of skills matters also for other questions in the literature. For example, Stuhler (2013) notes that income persistence over generations may decline more slowly than at a geometric rate if the degree of

Example 4: Changing returns to skills. Assume that the returns to different types of human capital or endowments change on the labor market ($\boldsymbol{\rho}_1 \neq \boldsymbol{\rho}_2$).

Changes in the returns to different types of skills could stem from changes in demand (e.g., as of trade and industrial or technological change) or in relative supplies (e.g., as of immigration or changes in the production of skills). A specific example is the decrease in the demand for physical relative to cognitive ability as a labor market moves from agricultural to white-collar jobs, but relative returns may change also in periods that are much shorter than the time scale underlying our intergenerational analysis.[18] More potential causes for changing returns come to mind if we interpret the endowment vector more broadly. For example, $\boldsymbol{e}_t$ could capture the geographic location of individuals ("inherited" with some probability from their parents), and local wage levels may vary over time as of area-specific demand shocks.

To grasp the intuition consider first a simple symmetric case in which two endowments k and l are equally transmitted within families ($\lambda_k = \lambda_l = \lambda$), but their prices on the labor market are swapping at time T ($p_{2,k} = \rho_{1,l} \neq p_{1,k} = \rho_{2,l}$). Adapting equations (5) and (6) for $K = 2$ endowments and iterating backwards we find

$$\begin{aligned}\Delta\beta_T &= (\rho_{k,2} - \rho_{k,1})\lambda Cov(e_{k,T-1}, y_{T-1}) - (\rho_{l,1} - \rho_{l,2})\lambda Cov(e_{l,T-1}, y_{T-1}) \\ &= \frac{-(\rho_{k,2} - \rho_{k,1})^2 \lambda}{1 - \gamma\lambda}, \end{aligned} \tag{27}$$

which is negative. The intergenerational elasticity in the second generation shifts according to

$$\Delta\beta_{T+1} = \lambda(\rho_{k,2} - \rho_{k,1})^2 + \lambda\left(\rho_{k,2}^2 + \rho_{k,1}^2 + \frac{2\rho_{k,1}\rho_{k,2}\lambda\gamma}{1 - \gamma\lambda}\right)\left(\frac{1}{Var(y_T)} - 1\right), \tag{28}$$

which is positive since

$$Var(y_T) = 1 - 2\gamma\lambda\frac{(\rho_{k,2} - \rho_{k,1})^2}{1 - \gamma\lambda} < 1. \tag{29}$$

These findings are not due to shifts in cross-sectional inequality; if instead $Var(y_t) = 1$ for all t (assuming that changes in ρ_k and ρ_l are offset by changes in the variance of u_t) we still find from equations (27) and (28) that $\Delta\beta_T < 0$ and $\Delta\beta_{T+1} > 0$. Figure (4) provides a numerical example.

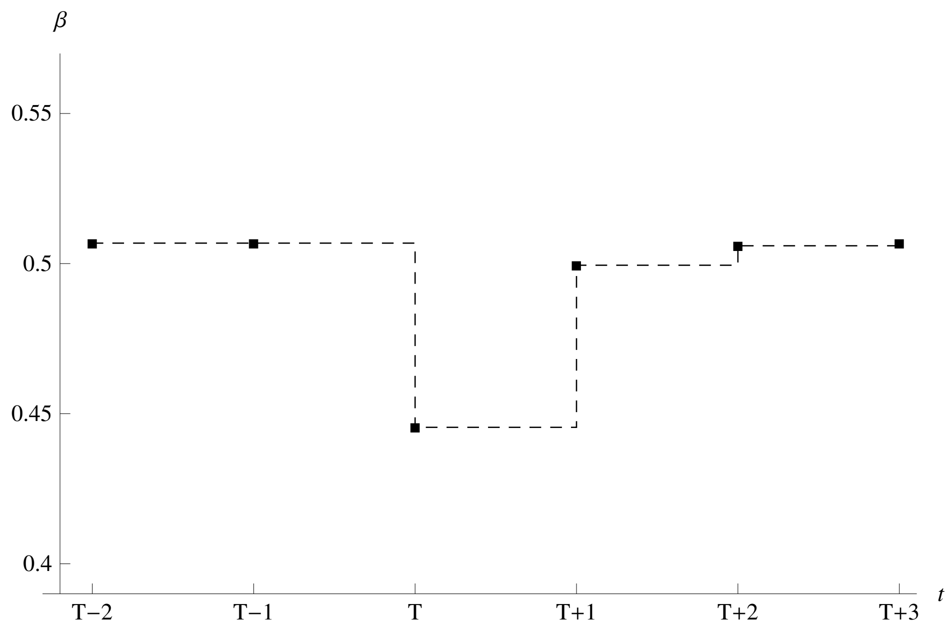
Intuitively, those endowments or skills that have been more strongly rewarded in past generations are also more strongly correlated with parental income. As a consequence, mobility

heritability varies across characteristics.

[18] A typical example is the job-polarization literature which highlights how the IT revolution has implied a shift in demand from substitutable manual skills to complementary abstract skills (e.g., Levy, Murnane, and Autor, 2003).

tends to initially increase if relative prices change, since characteristics for which prices increase from low levels are less prevalent among the rich than characteristics for which prices decrease from high levels. In subsequent generations, the characteristics for which prices increased become increasingly correlated with parental income, generating a decreasing mobility trend. Note that the central assumption underlying these results is that endowments and skills are positively correlated within families, and that different skills are imperfectly correlated (uncorrelated in our simple model) within individuals..

Figure 4: A swap in prices



Note: Mobility trend over generations in numerical example. In generation T the returns to skill k increase from $\rho_{k,1} = 0.3$ to $\rho_{k,2} = 0.6$ and the returns to skill l decrease from $\rho_{l,1} = 0.6$ to $\rho_{l,2} = 0.3$ (assuming $\gamma = 0.2$ and $\lambda = 0.6$).

We can derive that such v-shaped responses in mobility are typical for the general case, in which the prices of any number of skills change, by expressing the elasticity in generation T as a function of the steady-state elasticities before and after the structural change (β_{T-1} and $\beta_{t\to\infty}$). If the steady-state variance of income remains unchanged we have

$$\beta_{T-1} = \gamma + \boldsymbol{\rho}_1' \boldsymbol{\Lambda} \left(\boldsymbol{I} - \gamma \boldsymbol{\Lambda} \right)^{-1} \boldsymbol{\rho}_1 \tag{30}$$

and

$$\beta_{t\to\infty} = \gamma + \boldsymbol{\rho}_2' \boldsymbol{\Lambda} \left(\boldsymbol{I} - \gamma \boldsymbol{\Lambda} \right)^{-1} \boldsymbol{\rho}_2, \tag{31}$$

such that

$$2\beta_T = \beta_{T-1} + \beta_{t\to\infty} - (\boldsymbol{\rho}_2' - \boldsymbol{\rho}_1')\boldsymbol{\Lambda}\left(\boldsymbol{I} - \gamma\boldsymbol{\Lambda}\right)^{-1}(\boldsymbol{\rho}_2 - \boldsymbol{\rho}_1). \tag{32}$$

The quadratic form in the last term is greater than zero for $\boldsymbol{\rho}_2 \neq \boldsymbol{\rho}_1$ since $\boldsymbol{\Lambda}\left(\boldsymbol{I} - \gamma\boldsymbol{\Lambda}\right)^{-1}$ is positive definite. Price changes then increase intergenerational mobility temporarily (β_T is below *both* the previous steady state β_{T-1} and the new steady state $\beta_{t\to\infty}$) as long as the steady-state elasticity does not shift too strongly, specifically iff

$$|\beta_{t\to\infty} - \beta_{T-1}| < (\boldsymbol{\rho}_2' - \boldsymbol{\rho}_1')\boldsymbol{\Lambda}\left(\boldsymbol{I} - \gamma\boldsymbol{\Lambda}\right)^{-1}(\boldsymbol{\rho}_2 - \boldsymbol{\rho}_1). \tag{33}$$

This argument also holds if cross-sectional inequality is lower in the new than in the old steady state.[19] Any symmetric changes (as in the numerical example) fulfill this condition and will thus lead to non-monotonic trends as in Figure 3. More generally, changes in the returns to individual characteristics that do not affect long-run mobility much (e.g., some prices go down while others go up) increase mobility in the short-run but cause a decreasing trend in subsequent generations.

We should thus expect that mobility is positively affected if returns change, but observed mobility gains may not persist. These results have general implications on how we expect institutional or technological change to affect mobility. Previous authors have shown that technological progress can lead to non-monotonic mobility trends through *repeated* changes in returns to characteristics.[20] We find that even a *one-time* change tends to generate such non-monotonic trends.

EXAMPLE 5: CHANGES IN THE HERITABILITY OF ENDOWMENTS. Assume that the heritability of different types of endowments change ($\boldsymbol{\Lambda}_1 \neq \boldsymbol{\Lambda}_2$).

As with changes in prices, when some endowments become more and some less transmitted within families, mobility tends to increase initially but then follows a negative trend in subsequent generations. The intuition is similar as well.[21] If the steady-state variance of income

[19]If steady-state inequality changes then eq. (32) includes the additional term

$$\boldsymbol{\rho}_2'\boldsymbol{\Lambda}\left(\boldsymbol{I} - \gamma\boldsymbol{\Lambda}\right)^{-1}\boldsymbol{\rho}_2\left(1 - \frac{1}{Var(y_{t\to\infty})}\right),$$

which is negative if $Var(y_{t\to\infty}) < Var(y_{T-1}) = 1$.

[20]For example, Galor and Tsiddon (1997) consider how the life-cycle of technological progress might lead to repeated changes in the relative returns to ability and parent-related human capital, and thus to non-monotonic trends in cross-sectional inequality and intergenerational mobility over time.

[21]Endowments that are more strongly inherited are also more strongly correlated with parental income. Characteristics for which heritability increase from low levels are thus less prevalent among the rich than characteristics for which heritability decrease from high levels, which tends to increase mobility initially. The characteristics for which heritability increased then become increasingly correlated with parental income in subsequent generations, leading to a decreasing mobility trend.

remains unchanged mobility first increase and then decrease ($\beta_T - \beta_{T-1} < 0 < \beta_{t\to\infty} - \beta_T$) iff

$$\boldsymbol{\rho}'(\boldsymbol{\Lambda}_2 - \boldsymbol{\Lambda}_1)\left(\boldsymbol{I} - \gamma\boldsymbol{\Lambda}_1\right)^{-1}\boldsymbol{\rho} < \quad 0 \quad < \boldsymbol{\rho}'\boldsymbol{\Lambda}_2\left(\left(\boldsymbol{I} - \gamma\boldsymbol{\Lambda}_2\right)^{-1} - \left(\boldsymbol{I} - \gamma\boldsymbol{\Lambda}_1\right)^{-1}\right)\boldsymbol{\rho} \tag{34}$$

Again, any symmetric parameter changes, as considered in the previous numerical example, satisfy this condition.

The last two examples have quite general implications that do not depend much on the particular nature of changes in transmission mechanisms. Relative changes in the returns to or heritability of characteristics tend to raise intergenerational mobility of directly affected generations. Times of change thus tend to be times of high mobility. Second, such mobility gains will be succeeded by longer-lasting negative trends in intergenerational income mobility if no further structural changes occur. Countries experiencing a period of stable economic conditions will thus tend to be characterized by negative mobility trends if they were preceded by more turbulent times.

As noted in the last section, countries such as the US may have experienced much greater societal transformations in the first than in the second half of the 20th century. Mobility will have been facilitated if those transformations altered the returns to (or heritability of) different skills, as seems likely. For example, a strong decline in agricultural and increase in (salaried) white-collar jobs may have altered relative returns to physical and cognitive abilities, but also affected how important the inheritance of family-owned land, resources or businesses were for individual economic success. Our model illustrates that such mobility gains diminish in subsequent generations, providing another reason why mobility of more recent cohorts should perhaps be *expected* to decline.

We can relate our findings also to the empirical evidence on mobility differences between countries. For example, Long and Ferrie (2013) find that US occupational mobility was comparatively high in the 19th century, perhaps explaining why the US are known as a "land of opportunity" even though more recent measures of income mobility are among the lowest of all developed countries (e.g., Björklund and Jäntti, 2009). Long and Ferrie suggest that an exceptional degree of internal *geographic* mobility may have caused such high levels of intergenerational mobility. Our framework provides arguments in support of this hypothesis, but with a twist. Intergenerational mobility may not necessarily increase due to internal migration itself (that depends on who migrates), but certainly due to one of its underlying *causes*: strong variation in local labor demand across areas and time not only incentivizes internal migration, it also increases intergenerational mobility by increasing the difference in local demand conditions that non-migrating parents and children face during their lifetimes.

5 Extensions

Our model is broadly in line with the previous literature, but some of its simplifying assumptions deserve further discussion. First, we relax its coarse generational perspective by introducing an additional cohort dimension into our model. Our initial motivation was merely to provide a closer match between theoretical models of transmission between generations and the empirical literature on mobility trends across cohorts. However, an explicit consideration of variation in parental age at birth also reveals additional determinants of mobility trends and a prospective avenue for identification of past structural changes in current trends. To probe the sensitivity of our results to the way we model the influence of parental income we then revisit one of our examples under the assumption that parental income has a sustained effect on the intergenerational transmission of endowments, in addition to its effects on offspring human capital and income. Lastly, we consider how more recursive causal mechanisms, such as an independent effect from grandparents, affect our conclusions. For simplicity we consider the scalar case with a single skill, as in equations (12) and (13), throughout the section.

5.1 From Generations to Cohorts

While the theoretical literature considers how intergenerational mobility evolves over *generations*, the empirical literature instead typically estimates mobility trends across *cohorts*.[22] These two dimensions, which do not match if parental age at birth varies across families or time, have to our knowledge not previously been linked in the literature.

We thus introduce a cohort (or birth-year) dimension into our model, adopting the following notation to distinguish cohorts and generations. Let the random variable C_t denote the cohort into which a member of generation t of a family is born. Let $A_{t-1,C(t)}$ be a random variable that denotes the age of the parent at birth of the offspring generation t born in cohort C_t. For simplicity we assume $A_{t-1,C(t)}$ to be independent of parental income and characteristics, but we allow for dependence on C_t so that the distribution of parental age at birth can change over time. Member $t-j$ of a family is then born in cohort

$$C_{t-j} = C_t - A_{t-1,C(t)} - \dots - A_{t-j,C(t-j+1)}. \tag{35}$$

Denote realizations of these random variables by lower case letters. Our reduced two-equations model for intergenerational transmission between offspring born into cohort $C_t =$

[22]Mobility measures are usually indexed to offspring cohorts, a convention that we will follow here.

c_t and a parent born in cohort $C_{t-1} = c_{t-1}$ is then given by

$$y_{t,c(t)} = \gamma_{c(t)} y_{t-1,c(t-1)} + \rho_{c(t)} e_{t,c(t)} + u_{t,c(t)} \tag{36}$$

$$e_{t,c(t)} = \lambda_{c(t)} e_{t-1,c(t-1)} + v_{t,c(t)}, \tag{37}$$

where we keep the simplifying assumptions on parameters and variables as in our baseline model in equations (5) and (6).

By considering a single set of equations for each generation we abstract from life-cycle effects within a given generation. The transmission parameters in (36) and (37) can thus be interpreted as representing an average of effective transmission mechanisms over the life-cycle. For example, the price parameter $\rho_{c(t)}$ reflects average returns throughout the working life of an individual born in year c_t.

Assume for simplicity again that cross-sectional inequality remains constant, such that $Var(y_{t,c(t)}) = Var(e_{t,c(t)}) = 1 \; \forall t, c(t)$. Using (36) and (37), the intergenerational income elasticity of the offspring generation t born in cohort c_t is then

$$\begin{aligned} \beta_{t,c(t)} &= \frac{Cov\big(y_{t,c(t)}, y_{t-1,C(t-1)}\big)}{Var\big(y_{t,c(t)}\big)} \\ &= \gamma_{c(t)} + \rho_{c(t)} \lambda_{c(t)} Cov\left(e_{t-1,C(t-1)}, y_{t-1,C(t-1)}\right), \end{aligned} \tag{38}$$

where we for convenience do not explicitly note that all random variables are conditional on $C_t = c_t$. Income mobility for a given cohort thus depends on cohort-specific transmission mechanisms ($\gamma_{c(t)}$, $\rho_{c(t)}$ and $\lambda_{c(t)}$) and the covariance of income and endowments in the parent generation. This cross-covariance may vary with parental age, since different cohorts of parents might have been subject to different policies and institutions. Using eq. (35) and the law of iterated expectations, we can rewrite eq. (38)

$$\begin{aligned} \beta_{t,c(t)} &= \gamma_{c(t)} + \rho_{c(t)} \lambda_{c(t)} E_{A(t-1)} \left(Cov\big(e_{t-1,c(t)-A(t-1)}, y_{t-1,c(t)-A(t-1)} | A_{t-1,c(t)}\big)\right) \\ &= \gamma_{c(t)} + \rho_{c(t)} \lambda_{c(t)} \sum_{a_{t-1}} f_{c(t)}\big(a_{t-1}\big) Cov\big(e_{t-1,c(t)-a(t-1)}, y_{t-1,c(t)-a(t-1)}\big), \end{aligned} \tag{39}$$

where $f_{c(t)}$ is the probability mass function for parental age at birth of cohort c_t. Income mobility thus depends on current transmission mechanisms and a weighted average of the cross-covariance of income and endowments in previous cohorts, where the weights are given by the cohort-specific distribution of parental age in the population.

As before we can iterate backwards to express $\beta_{t,c(t)}$ in terms of parameter values only,

$$\begin{aligned}\beta_{t,c(t)} &= \gamma_{c(t)} + \rho_{c(t)}\lambda_{c(t)}E_{A(t-1)}\left(\gamma_{C(t-1)}\lambda_{C(t-1)}Cov\left(e_{t-2,C(t-2)}, y_{t-2,C(t-2)}\right) + \rho_{C(t-1)}|A_{t-1}\right) \\ &= \dots \\ &= \gamma_{c(t)} + \rho_{c(t)}\lambda_{c(t)}\sum_{a_{t-1}} f_{c(t)}(a_{t-1})\rho_{c(t)-a(t-1)} + \rho_{c(t)}\lambda_{c(t)}\sum_{r=1}^{\infty} z_r, \qquad (40)\end{aligned}$$

where

$$z_r = \sum_{a_{t-1}}\Big(f_{c(t)}(a_{t-1})\dots\sum_{a_{t-r-1}}\Big(f_{c(t-r)}(a_{t-r-1})\prod_{s=1}^{r}\Big(\gamma_{c(t-s)}\lambda_{c(t-s)}\Big)\rho_{c(t-r-1)}\Big)\Big).$$

Equation (40) can be used to analyze the dynamic response to parameter changes of mobility trends across cohorts. The insights from the generations-only model still hold (e.g., past transmission mechanisms affect mobility trends today), but the explicit consideration of cohorts leads to a number of additional implications.[23]

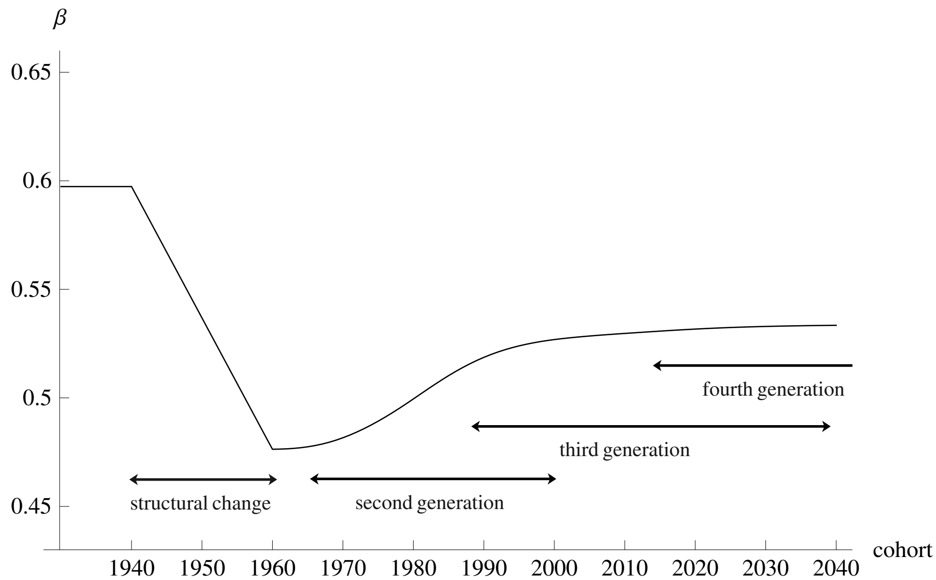
First, while rapid structural changes may initially have a sudden impact on mobility levels, their effect on subsequent mobility trends will be gradual due to variation of parental age at birth. We compute a variant of our Example 3 (a shift from a plutocratic to a more meritocratic society) to illustrate this idea. Assume that for cohorts born between 1940 and 1960 parental status becomes a less (γ declines) and own merits become a more important (ρ increases) determinant of incomes. Figure 5 plots the implied mobility trends over offspring *cohorts*. It illustrates that past events have a gradual impact on subsequent trends, but also our argument that such impact may be long-lasting even if transitions between steady states are completed within few generations – events that occurred already in the mid-20th century can still be expected to affect mobility trends in very recent cohorts.

Second, from (40) it also follows that the importance of past transmission mechanisms (and thus of past institutions and policies) on current mobility rises with parental age at birth.[24] Likewise, the impact of structural changes on mobility trends will die out faster in populations in which individuals become parents at younger ages. These findings might be of interest for cross-country comparisons, especially between developed and developing

[23]Note that both equations (10) and (40) simplify to the same steady-state elasticity as given in equation (11). The explicit consideration of cohorts has consequences only for transitions between steady states, which may explain why existing steady-state models have not yet been explicitly linked to cohort-specific measures of mobility.

[24]A consideration of life-cycle effects (as in Conlisk, 1969 or Cunha and Heckman, 2007) would be interesting in this context, but the general implications that we discuss here hold as long as some intergenerational transmission mechanisms tend to be effective in early life (e.g., genetic transmission, childhood environment, and education).

Figure 5: Declining impact of parental income and increasing returns to skills, over cohorts



Note: Mobility trend over cohorts in numerical example. Between 1940 and 1960 the impact of parental income γ declines linearly from $\gamma_1 = 0.4$ to $\gamma_2 = 0.2$ while the returns to endowments and human capital ρ increase from $\rho_1 = 0.5$ to $\rho_1 = 0.7$ (assuming $\lambda = 0.6$). Distribution of parental age as observed for fathers of the 1960 birth cohort in Swedish administrative registers (the 25th, 50th and 75th percentiles are at age 26, 30 and 36). The labels illustrate in which generation each cohort is affected.

countries. They imply that cross-country mobility differentials are not only driven by differences in both current and past transmission mechanisms, but also by different *weights* on past mechanisms. Various arguments in the literature suggest that developing countries could be characterized by lower levels of intergenerational mobility than developed countries (see for example Levine and Jellema, 2007).[25] Our results point to a novel aspect in this debate: mobility levels in developing countries are less dependent on past institutions if parents tend to be younger. Differences in mobility levels between developed and developing countries will then not capture differences in current institutions, even if countries share common trends (e.g., towards more meritocratic institutions and policies).

Finally, equation (40) points to a potential avenue for identification of *past* structural changes in *current* levels of income mobility, exploiting the fact that the influence of the former on the latter is a function of parental age at birth. As an example, assume that from cohort c^* onwards an expansion of public childcare reduces the heritability of endowments

[25] The examples in section (4) illustrate one potential source for *high* levels of mobility in developing countries; returns to certain skills or regional wage levels may be comparatively variable over time (e.g., due to internal conflict or rapid technological progress), which tends to increase income mobility.

from λ_1 to λ_2.[26] Assume further that not all parents of generation t were yet subject to the new regime such that

$$\lambda_{C(t-1)} = \begin{cases} \lambda_1 & for\ C_{t-1} < c^* \\ \lambda_2 & for\ C_{t-1} \geq c^* \end{cases}.$$

Other parameters remain unchanged and all grandparents have been subject to the old regime. From the first line in equation (40), the *conditional intergenerational elasticities* among children with old ($C_{t-1} < c^*$) or young ($C_{t-1} \geq c^*$) parents then equal

$$\beta_{t,c(t)}\Big|_{C_{t-1}<c^*} = \gamma + \rho\lambda_2\gamma\lambda_1 Cov\left(e_{t-2,C(t-2)}, y_{t-2,C(t-2)}\right) + \rho^2\lambda_1 \tag{41}$$

and

$$\beta_{t,c(t)}\Big|_{C_{t-1}\geq c^*} = \gamma + \rho\lambda_2\gamma\lambda_2 Cov\left(e_{t-2,C(t-2)}, y_{t-2,C(t-2)}\right) + \rho^2\lambda_1. \tag{42}$$

Quite intuitively, the expansion of public childcare will have a different effect on income mobility among children with older parents, who were already subject to the reform themselves. The introduction of a cohort dimension into a model of intergenerational transmission thus illustrates that children of the same cohort may experience different rates of mobility merely because their parents were differently affected by past events. Differencing equations (41) and (42),

$$\beta_{t,c(t)}\Big|_{C_{t-1}\geq c^*} - \beta_{t,c(t)}\Big|_{C_{t-1}<c^*} = \rho\lambda_2\gamma\left(\lambda_2 - \lambda_1\right) Cov\left(e_{t-2,C(t-2)}, y_{t-2,C(t-2)}\right),$$

then reveals the dynamic, or second-generation impact of the childcare reform on current mobility levels.

Of course, in practice we may encounter various obstacles that are ignored in our simple model. Reforms may be gradual instead of instantaneous, and the classification of offspring-parent groups will be straightforward only if the time of effectiveness of a policy is known. Correlation between parental age at birth and other parental characteristics (and thus mobility) may be addressed by comparing differences in conditional elasticities over time, but such strategies will still be vulnerable if certain policies or institutional reforms affect families with older and younger parents differently. However, a comparison of conditional elasticities or correlations over cohorts may give a first clue about the potential importance of dynamic effects in observed mobility trends, and a targeted analysis of a specific and major policy reform may reveal more conclusive evidence on its lagged effects on mobility.

[26]Consistent with Havnes and Mogstad (2011), who find that access to subsidized childcare in Norway benefited children with low-educated parents the most.

5.2 Causal Pathways of Parental Income

Parental income may affect children via various direct and indirect causal pathways. Its primary effect may relate to human capital investments, a mechanism emphasized by Becker and Tomes (1979, 1986). We do not model the investment behavior of parents explicitly, but our "mechanical" transmission equations can also be derived from such underlying utility-maximizing frameworks.[27] In addition to its indirect effect through human capital accumulation (captured in γ_h), we allowed for a more direct effect of parental on offspring income (captured in γ_y). Consistent with the previous literature, however, we assumed that parental income does not feature in the autoregressive process for endowments e_t, which reflect abilities, skills or preferences determined instead by genetic inheritance or cultural influences from parental upbringing.

To examine if our results depend on this assumption we introduce a new parameter that governs the impact of parental income y_{t-1} on offspring endowments e_t, such that equation (13) becomes

$$e_t = \lambda_t e_{t-1} + \phi_t y_{t-1} + v_t. \tag{43}$$

Assuming again that cross-sectional inequality remains constant, the intergenerational elasticity in generation *t* is then given by

$$\beta_t = \gamma_t + \rho_t \phi_t + \rho_t \lambda_t Cov(e_{t-1}, y_{t-1}), \tag{44}$$

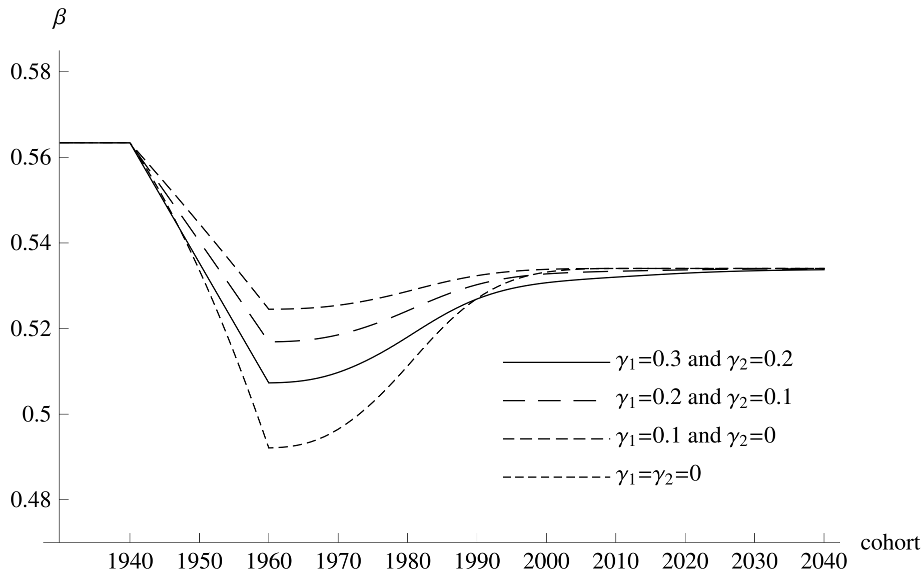
and the corresponding steady-state elasticity becomes

$$\beta = \gamma + \phi\rho + \frac{\rho\lambda(\rho + \phi\gamma)}{1 - \lambda\gamma}. \tag{45}$$

Parental income may thus have an impact through its effects on offspring human capital and income (γ_t), or through its effect on offspring endowments (ϕ_t). To explore how the implications of these channels differ we revisit Example 3, in which we documented a non-monotonic mobility trend after an increase in the return to human capital and a decrease in the relevance of parental income. For illustration we consider parametrizations that lead to the same steady-state elasticities before and after the structural change, but that give different weights on each of the two income channels. Figure 6 shows the transition paths for four different choices for the initial level and change in γ_t, computed from the cohort-variant of our model (see previous section). The values for ϕ_t follow implicitly from those choices and

[27] Our baseline model is for example similar to the transmission equations that Solon (2004) derives from a modified Becker and Tomes model, in which mobility does not depend on the parameters that govern parental investment decisions (e.g., the "altruism" parameter) as preferences are assumed to be log-linear. More evolved models of utility-maximizing behavior of parents, for example involving public human-capital investments (also Solon, 2004), poverty traps, or alternative assumptions regarding parental preferences, may provide additional implications.

Figure 6: Declining impact of parental income and increasing returns to skills, various cases



Note: Mobility trend over cohorts in numerical example. Between 1940 and 1960 the returns to endowments and human capital ρ increase linearly from $\rho_1 = 0.6$ to $\rho_1 = 0.7$ (assuming $\lambda = 0.6$). Four cases are considered: (1) a simultaneous linear decline in the impact of parental income γ from $\gamma_1 = 0.3$ to $\gamma_2 = 0.2$; (2) from $\gamma_1 = 0.2$ to $\gamma_2 = 0.1$; (3) from $\gamma_1 = 0.1$ to $\gamma_2 = 0$; and (4) $\gamma_1 = \gamma_2 = 0$. Distribution of parental age as observed for fathers of the 1960 birth cohort in Swedish administrative registers. The respective values of ϕ_1 and ϕ_2 follow implicitly, as explained in footnote 28.

the requirement for the steady-state elasticities to coincide in all parametrizations.[28]

The mobility trends are similar for the baseline ($\phi = 0$) and the extreme alternative case ($\gamma = 0$). The initial increase in mobility is larger if parental income works exclusively through offspring endowments, and potentially smaller if both channels play a role. Mobility does not trend much after two generations and, most importantly, all mobility trends follow a non-monotonic pattern. Although the relative weights on different causal pathways of parental income have quantitative implications, the qualitative pattern remains robust.

5.3 Beyond Parents

We so far assumed that intergenerational transmission works exclusively through the parent generation, such that earlier ancestors have no independent effect on offspring. But the possibility that grandparents may directly affect their grandchildren has recently received much interest (e.g., Mare, 2011), also fuelled by evidence that income persistence over generations

[28]From equation (45) we have $\phi_s = (\beta_s + \gamma_s^2\lambda - \gamma_s - \lambda\rho_s^2 - \beta_s\gamma_s\lambda)/\rho_s$, where $s = 1, 2$ indicates steady-state parameter and elasticity values before and after the structural change, respectively.

declines more slowly than at a geometric rate (e.g., Lindahl et al, 2012). Grandparents may matter through their reputation or networks, through direct bequests, or their assistance in the upbringing of a grandchild (most notably if parents are partly or fully absent).

How are our conclusions affected when such mechanisms matter, so that our model understates the degree of recursiveness? To explore this question we will assume that grandparents have an effect on offspring income that is independent from their indirect effect through the parent generation, such that

$$y_t = \gamma_t^P y_{t-1} + \gamma_t^{GP} y_{t-2} + \rho_t e_t + u_t \quad (46)$$

$$e_t = \lambda_t e_{t-1} + v_t, \quad (47)$$

where γ_t^P and γ_t^{GP} are the respective impacts of parents and grandparents on the offspring generation t. Assuming again that cross-sectional inequality remains constant, the transition path of the intergenerational elasticity equals

$$\beta_t = \gamma_t^P + \gamma_t^{GP} \beta_{t-1} + \rho_t \lambda_t Cov(e_{t-1}, y_{t-1}), \quad (48)$$

indicating that current mobility depends also on past mobility levels if grandparents matter ($\gamma^{GP} > 0$). This result illustrates an important point: transmission mechanisms that allow for a greater role of past family characteristics also imply a greater role for past institutions and thus slower convergence to a new steady state. Extending our baseline model to contain more evolved family effects will thus yield richer dynamics, strengthening our argument that the effect of past institutions on current mobility trends are important.

6 Conclusions

Transitions between steady states are of particular importance in models of intergenerational persistence since a single transmission step corresponds to a very long time interval. Motivated by this notion we examined the dynamic relationship between income mobility and its underlying structural factors. We based our analysis on a simple simultaneous equations model that is consistent with standard models used in the literature, deviating only in our focus on its dynamic properties and our consideration of a multidimensional skill vector.

We showed that income mobility today depends not only on current transmission mechanisms, but also on the distribution of income and characteristics in past generations – and thus on past mechanisms. Policy or institutional reforms can therefore generate long-lasting mobility trends, and variation in income mobility across countries or across groups within countries may be partly explained by differences in past institutions. Considering different types of structural changes, we noted that the transition paths between two steady states are often non-monotonic. Some implications may be surprising, especially our finding that negative mobility trends today can stem from gains in equality of opportunity in the past. Other implications, such that mobility will tend to be higher in times of structural changes, may have a more intuitive appeal.

We focused on the general relationship between causal transmission mechanisms and mobility trends, but we also touched upon a number of practical implications. For example, we noted that the impact of rising wage differentials on mobility levels may not yet have been fully realized, as changing returns to skills tend to shift mobility over multiple generations. This argument may help to explain why the empirical literature finds evidence for an increase in sibling correlations (Levine and Mazumder, 2007) but less evidence for an increase in intergenerational persistence (e.g., Lee and Solon, 2009) in the US. The latter has been surprising given that both theoretical work (e.g., Solon, 2004) and cross-country empirical evidence (e.g., Corak, 2013) suggest a negative relationship between cross-sectional inequality and intergenerational mobility.

Such implications may concern mobility proponents, since they suggest that a recent decline in mobility might yet to be uncovered by empirical research. But our results also imply that such declining trends may have a rather innocuous explanation. We showed that a shift towards more meritocratic institutions and policies (diminishing the influence of parental income and raising the importance of own skills in the determinantion of income) tends to generate non-monotonic mobility trends – increasing mobility in the first affected generation, followed by a longer-lasting negative trend. A decline in mobility in more recent cohorts might then just be a rebounding effect that we should expect to occur in any country that became more meritocratic and more mobile in the early or mid-20th century.

Finally, the empirical literature on mobility differences across countries or longer time periods can be related to our finding that variation in the returns to different skills over time tends to raise mobility. For example, Long and Ferrie (2013) find that US occupational mobility was comparatively high in the 19th century, and suggest that an exceptional degree of internal geographic mobility may have raised intergenerational mobility. Our framework illustrates that the latter may have been raised not only by migration itself, but also by its underlying cause: strong variation in local demand across areas and time incentivizes internal migration, but also increases mobility by altering the local demand conditions that parents and children face during their lifetimes.

Our model is of course highly stylized, and a thorough analysis of these or other applications would require a careful discussion of various issues that we only touched upon (such as the timing of intergenerational transmission over an individual's life-cycle). We also did not comment on the considerable difficulties that hinder reliable estimation of trends in intergenerational economic mobility – observation of short snapshots of income may generally not suffice to detect gradual changes over time, in particular because the shape of and heterogeneity in income profiles may change over time as well. Analysis of trends in sibling correlations, with its weaker data requirements, may often be more feasible (see Björklund, Jäntti, and Lindquist, 2009; Levine and Mazumder, 2007).

Our main objective was to demonstrate why the analysis of intergenerational mobility benefits from a dynamic view of the underlying transmission framework, and to illustrate potential pitfalls in the interpretation of mobility trends. In our discussion we also touched upon various promising avenues for future empirical research, which in our view could lead to a better understanding of the underlying causes of rising or declining mobility. In particular, we noted that different causes could be distinguished by their divergent dynamic implications; that the covariance between income and characteristics in the *parent* generation plays a central role in the evolution of income mobility over generations; and that the estimation of income mobility conditional on parental age at birth may provide direct evidence on the effects of past events on current mobility trends.

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Appendix

A.1 Choice of Parameter Values

Our main findings do not rely on specific parameter choices, but our numerical examples will benefit from parametrizations that are consistent with the empirical literature. One difficulty is that some variables in our model represent broad concepts (e.g., human capital $\boldsymbol{h}_t$ may include any productive characteristic of an individual), which are only imperfectly captured by data. In addition, the parameters of the model reflect total effects from those variables. While estimates of (intergenerational) correlations and other moments are widely reported, there exists less knowledge about the relative importance of the various underlying causal mechanisms. Although only indicative, we can at least choose parameter values that are consistent with the available evidence.

Lefgren et al. (2012) examine the relative importance of different mechanisms in a transmission framework that is similar to ours. Using imperfect instruments that are differentially correlated with parental human capital and income they estimate that in Sweden the effect from parental income (captured by the parameter γ) explains about a third of the intergenerational elasticity, while parental human capital explains the remaining two thirds. In our model we further distinguish between a direct and indirect (through human capital accumulation) effect from parental income, as captured by the parameters γ_y and γ_h, but the total effect is sufficient for the parameterization of our examples.

The literature provides more guidance on the transmission of physical traits such as height or cognitive and non-cognitive abilities, for which we use the term *endowments*. Common to these are that genetic inheritance is expected to play a relatively important role. From the classic work of Galton to more recent studies the evidence implies intergenerational correlations in the order of magnitude of about 0.3-0.4 when considering one and much higher correlations when considering both parents.[29] Those estimates may reflect to various degrees not only genetic inheritance but also correlated environmental factors; we capture both in the *heritability* parameter λ (estimates of genetic transmission are then a lower bound), for which values in the range 0.5-0.8 seem reasonable. Note that we use the term "heritability" in a broad sense, while the term refers only to genetic inheritance in the biological literature.

Finally, a reasonable lower-bound estimate of the *returns* ρ to endowments and *human capital* can be approximated by evidence on the explanatory power of earnings equations. Studies that observe richer sets of covariates, including measures of cognitive and non-cognitive ability, typically yield estimates of R^2 in the neighborhood of 0.40.[30] On the one

[29]For estimates of correlations in measures of cognitive ability, see Bowles and Gintis (2002) and the studies they cite; for measures of both cognitive ability and non-cognitive ability, see Grönqvist et al. (2010).

[30]Examples include Zax and Rees (2002) for the US and Lindqvist and Vestman (2011) for Sweden. Fixed-effects models yield higher estimates, although some of the difference may be capturing persistent luck rather

hand, such estimates are likely to underestimate the explanatory power of (broadly defined) human capital as of imperfect measurement and omitted variables. On the other hand, we want to only capture returns to the component of human capital that is not due to parental income and investment; we capture the latter channel instead in the parameter γ_h (and its contribution to offspring income in γ). In any case, values of ρ in the range of 0.6-0.8 should be at least roughly consistent with the empirical evidence.[31]

These parameter ranges are consistent with recent estimates of the intergenerational income elasticity β in the US, which are typically in the range of 0.45-0.55 (see Mazumder, 2005; Lee and Solon, 2009). Given reliable elasticity estimates we can also cross-validate and potentially narrow down the implied range for the structural parameters of the model. We write each parameter as a function of the others in steady state,

$$\beta = \gamma + \frac{\rho^2\lambda}{1-\gamma\lambda} \qquad \gamma = \frac{\beta\lambda + 1 \pm \sqrt{\beta^2\lambda^2 - 2\beta\lambda + 4\lambda^2\rho^2 + 1}}{2\lambda}$$
$$\rho = \sqrt{\frac{(\beta-\gamma)(1-\gamma\lambda)}{\lambda}} \qquad \lambda = \frac{\beta-\gamma}{\beta\gamma + \rho^2 - \gamma^2}, \tag{49}$$

and plug in the discussed values on the right-hand sides to impute parameter ranges that are consistent with our reading of the empirical literature. Specifically we rule out too high values of λ and ρ as they cause γ to approach zero, to arrive at

$$0.45 \leq \beta \leq 0.55, \;\; 0.15 \leq \gamma \leq 0.25, \;\; 0.60 \leq \rho \leq 0.70, \;\; 0.50 \leq \lambda \leq 0.65.$$

These implied ranges should not be taken literally, but are sufficient to provide a reasonable illustration of the potential quantitative implications of our findings.

than unobserved characteristics.

[31] In the initial steady state we standardize $Var(y) = Var(e) = 1$, such that $R^2 = 0.4$ translates into $\rho \approx 0.63$.