A Theory of Intergenerational Mobility*

Gary S. Becker, *University of Chicago*
Scott Duke Kominers, *Harvard University*
Kevin M. Murphy, *University of Chicago*
Jörg L. Spenkuch, *Northwestern University*

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Abstract

We study the link between market forces, cross-sectional inequality, and intergenerational mobility. Emphasizing complementarities in the production of human capital, we show that wealthy parents invest, on average, more in their offspring than poorer ones. As a result, economic status persists across generations even in a world with perfect capital markets and absent differences in innate ability. In fact, under certain conditions, successive generations of the same family may cease to regress towards the mean. We also consider how short- and long-run mobility are affected by changes in the returns to human capital.

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1. Introduction

Across countries, socioeconomic inequality and intergenerational persistence are strongly positively correlated—so much so that the relationship depicted in Figure 1 is sometimes referred to as "The Great Gatsby Curve" (Krueger 2012).[1] The United States has experienced a dramatic increase in inequality over the last forty years (Acemoglu 2002; Autor et al. 2008; Juhn et al. 1993; Katz and Murphy 1992; Katz and Autor 1999; Piketty and Saez 2003). Yet, empirical evidence on changes in intergenerational mobility remains ambiguous. Chetty et al. (2017) report a sharp decrease in absolute upward mobility. Chetty et al. (2014a), however, find only modest changes in relative persistence of earnings (see also Solon and Lee 2009; Aaronson and Mazumder 2008). We are, therefore, left to wonder how cross-sectional inequality relates to social mobility and whether the intergenerational transmission of resources tends to dampen or exacerbate changes in inequality.

In this paper, we consider how persistence of economic status depends on the distribution of human capital and income. Our model synthesizes—and in a few places extends—classic theories of intergenerational mobility (e.g., Becker and Tomes 1979, 1986; Loury 1981; Solon 2004).

An important, rapidly growing literature documents the relevance of various complementarities in the formation of skills, especially early in life (see Cunha and Heckman 2007; Heckman 2008; Cunha et al. 2010; Heckman and Mosso 2014). By emphasizing these complementarities, we depart from the classic Becker–Tomes approach. Specifically, following Cunha and Heckman (2007) and Heckman and Mosso (2014), we dispense with the implicit assumption that all parents are equally good at investing in their children. In our model, parental human capital increases productivity not only in the labor market, but also in the production of children's human capital.

Complementarities between parental human capital and investments in children imply that wealthy parents invest on average more in the human capital of their offspring than poorer ones. As a result, differences in economic status persists across generations, even in the upper parts of the income distribution. Confirming earlier findings by Corak and Heisz (1999) and Mazumder (2005a), Chetty et al. (2014b), report that 36.5% of children born to parents in the top quintile of the distribution remain there. This amounts to roughly twice the probability that a child of middle-quintile parents rises to the top quintile. It even slightly exceeds the probability that children of bottom-quintile parents remain at the bottom. While low intergenerational mobility among poor families is plausibly explained by credit constraints (as in Becker and Tomes 1979, 1986; Loury 1981; Solon 2004), high persistence in the right tail of the distribution presents more of a puzzle. Credit constraints are unlikely to be binding

[1] Ironically, Jay Gatsby exhibited tremendous social mobility in F. Scott Fitzgerald's well-known novel.

for well-to-do families, and inheritability in intelligence and other genetic traits is thought to be too low to drive much of the observed persistence (Bowles and Gintis 2002). The theory in this paper provides one potential explanation.

An implication of our theory is that the equilibrium relationship between parents' and children's human capital may be convex. Convexity results in especially high levels of persistence, as successive generations of well-to-do families need not regress toward the population mean. Our analysis suggests that societies may develop a "human capital elite," with considerable mobility within but not across the *endogenously* determined class boundaries. A necessary condition for separate classes to emerge despite diminishing marginal returns to each input in the human capital production function is that high human capital generates disproportionate returns in the market, i.e., that the elasticity between human capital and earnings exceeds 1.

We also discuss how changes in the marketplace affect intergenerational mobility. According to the theory, rising inequality due to a unifrom increase in the price of human capital has no impact on mobility. That is, a mere linear rescaling of the income distributions leaves the intergenerational earnings elasticity (IGE) unaffected. By contrast, the IGE increases when the returns to human capital become more skewed towards high-skilled individuals, i.e., as the *elasticity* between human capital and earnings rises. An increasing elasticity might be due to skill-biased technical change (see, e.g., Acemoglu 2002; Autor et al. 2003; Krusell et al. 2000), super-star economies (Rosen 1981), span of control complementarities causing large firms to compete for top talent (e.g., Rosen 1982; Lucas 1978), or positive assortative matching between workers and firms (Sattinger 1979). Our theory thus predicts that rising inequality may but need not be accompanied by reduced intergenerational mobility. Interestingly, we find that even if changes in the returns to human capital do lead to lower mobility, the short-run impact is strictly larger than that in the long-run.

By emphasizing complementarities in the production of children's human capital our paper is closely related to existing models of poverty traps due to neighborhood effects (see e.g., Bénabou 1993; Durlauf 1996a,b). The neighborhood effects literature shows how spillovers within distinct social environments can generate persistent poverty, resulting in low intergenerational mobility (see also Durlauf 2006 and Durlauf and Shaorshadze 2015).[2] In our model, high intergenerational persistence is due to the technology of skill formation; thus high persistence would obtain even when neighborhood effects are not present. Neighborhood effects and endogenous stratification would amplify the mechanism we consider. We, therefore, think of our work as a complement to the neighborhood effects literature.

Another difference between our work and models of poverty traps is that, in our the-

[2]Durlauf and Sheshadri (2018) show that neighborhood effects can rationalize the Great Gatsby curve.

ory, families are not credit-constrained. As a result, human capital investments are efficient and government interventions to increase intergenerational mobility would be subject to an important equity–efficiency tradeoff (see Becker et al. 2015 for details).

The remainder of the paper is organized as follows. The next section develops a model of the intergenerational transmission of resources that links cross-sectional inequality and intergenerational mobility. Section 3 discusses how changes in the marketplace affect mobility, and Section 4 considers dynasties' evolution in the long run. The last section concludes.

2. A Model of Intergenerational Mobility

We assume two periods of life: childhood and adulthood. Each parent has one child at the beginning of adulthood, which means that parents and children overlap when the latter are young (cf. Figure 2). Adults use the human capital accumulated as children to generate labor income; these earnings can be spent on consumption, investing in the human capital of their children, and possibly leaving bequests.[3]

Parental preferences are assumed to depend not only on parents' own consumption, z, but also on the well-being of their children. A natural formulation is

$$(1) \qquad V(I_p) = u(z) + \delta U_c\left(\overline{I}_c\right),$$

where the intergenerational discount factor $\delta \in (0,1)$ denotes parents' degree of altruism toward their children, I_p denotes parental monetary resources, and $\overline{I}_c$ are the expected resources of children. For simplicity, we assume $u' > 0$, $u'' < 0$, $U_c' > 0$, $U_c'' < 0$, and $\lim_{\overline{I}_c \to 0} U_c' = \infty$, so that all parents would want to invest at least a little bit in the human capital of their children.[4]

We model earnings by assuming an isoelastic relationship with human capital, H, as in

$$(2) \qquad E = rH^{\sigma}\varepsilon.$$

It is useful to think of $r > 0$ as the overall price level of human capital in the economy, while $\sigma > 0$ denotes the individual-level elasticity between human capital and earnings. Both types of returns are determined by the stock of human capital, the stock of physical capital, and technological progress. We distinguish between r and σ in order to flexibly model changes in inequality. Increases in r lead to higher inequality by stretching the income distribution, but

[3] Here, we do not pay much attention to bequests. For an in-depth analysis of the link between human capital investments and bequests, see Becker et al. (2016).

[4] If we assumed that parents care about their children's expected utility rather than their expected income, then we could take ε additive rather than multiplicative in (2), and the main relationships we derive below—(10) and (11)—would still hold up to a first-order Taylor expansion.

do not introduce additional skewness.[5] Increases in σ, by contrast, also raise the skewness of the distribution. The random term ε is distributed independently of H with a mean of 1; it refers to unmodeled income shocks that parents can neither foresee nor control, such as good or bad luck in the search for jobs or temporary recessions.[6] Every parent takes r and σ as given and uses equation (2) to determine the optimal investment in his child's human capital, without knowing the realization of ε.

Following Cunha and Heckman (2007) and Cunha et al. (2010), a general function for the production of children's human capital is

$$(3) \qquad H_c = F\left(y, G, A_c, H_p, \nu_c\right),$$

where H_c and H_p are the human capital of children and parents, respectively, y denotes parental investments in children, and G denotes government spending on education. Here, A_c stands for the abilities of children, while ν_c records other influences on the formation of human capital.

Considerable evidence suggests that parental human capital and investments in children are complements (see, for instance, Lareau 2011; Heckman and Mosso 2014; and the studies cited therein). To make our analysis tractable, we specialize (3) to a Cobb–Douglas production function of only A_c, y, and H_p:

$$(4) \qquad H_c = A_c y^{\alpha} H_p^{\beta}.$$

A Cobb–Douglas production function is general enough to introduce complementarities between the different determinants of H_c, yet specialized enough to produce closed-form solutions.[7]

Naturally, we expect that $\alpha > 0$ and $\beta > 0$, that is, increases in parental investments and increases in parental human capital both raise the human capital of children. Presumably, there are also diminishing returns to y—at least eventually—as it becomes harder and harder to instill more knowledge into children with fixed mental capacity. Hence, $0 < \alpha < 1$. Children's ability, A_c, acts as a productivity shifter. Becker and Tomes (1979, 1986) assume that ability follows a Markov process, as in $A_c = \mu + \gamma A_p + \iota_c$. In order to sharpen our main results, we impose $A_c = 1$ instead, effectively turning off the ability channel. That is,

[5] Note, r is closely related to typical measures of inequality based on log-earnings.

[6] Cunha and Heckman (2016) show that income has an empirically important unforcastable component, which has been rising over time.

[7] In a previous version of this paper, we worked with a quadratic production technology. Our conclusions were qualitatively similar, except for how intergenerational mobility is affected by changes in the skewness of the returns to human capital (which we did not consider in that version). Ultimately, which production technology provides the best approximation is an open empirical question.

all children and adults are equally able. As a consequence, in our model, intergenerational persistence is solely due to economic forces and not genetic endowments.[8]

The assumption of complementarity between y and H_p reflects the idea that human capital does not only raise productivity in the marketplace, but also in household production (Becker 1965). For instance, education helps parents choose more effective inputs in order to achieve the same outcome, educated parents might be more adept at navigating the intricacies of public school systems, or knowledgeable adults may be in a better position to help children with their schoolwork. Although we favor the interpretation of high-human capital parents being literally better at investing, we note that our conclusions would continue to hold for many other, unmodeled sources of complementarity. The crux of our analysis is that children of well-educated parents are more likely to grow up in home environments that complement investments in their human capital.

Although recent evidence suggests that credit constraints are empirically important (see Hai and Heckman 2017; Lochner and Monge-Naranjo 2016), we restrict attention to the case of perfect capital markets, as this allows us to simplify the analysis and focus on the key economic forces that drive the difference between our results and standard models of intergenerational mobility.[9] By a perfect capital market we mean that parents can borrow as much as they want at a fixed rate $R_k > 0$ and can arrange for the debt to be repaid out of the adult earnings of their children (e.g., by leaving negative bequests).[10] In a world with perfect capital markets, all parents who care at least a little bit about their children (i.e., for whom $\delta > 0$) invest in their offspring's human capital until the marginal return is driven down to R_k. That is, parents will choose to invest the efficient amount.

Efficient investment is often taken to imply perfect intergenerational mobility, so that the earnings of children depend only on innate ability and not on the income of parents (see Becker and Tomes 1986). The analysis in this section illustrates that perfect mobility is generally not obtained in the presence of human capital complementarities. As in Cunha et al. (2006), parental investments are efficient in the absence of credit constraints but child income does depend on parental human capital. Hence, child income will be correlated with parental resources—even when capital markets are perfect and all children are assumed to

[8] Of course, A_c and y may also be complements, implying higher parental investments into more able children (see Becker and Tomes 1986). This type of complementarity would not, however, affect the abilities and investments of the next generation. Thus, in contrast to our results in Section 4, sucessive generations would continue to regress towards the mean.

[9] In Becker et al. (2015), we also model credit constraints. Credit constraints imply especially high intergenerational persistence in the bottom of the income distribution, which would tend to amplify our conclusions regarding intergenarational dynamics in Section 4. Mulligan (1997) derives a "Great Gatsby Curve"-like relationship in his framework because credit constraints affect both inequality and intergenerational mobility.

[10] For an analysis of how human capital investments and bequests interact when the latter are restricted to be positive, see Becker et al. (2016).

be equally able.

Parents choose consumption level z, investments y, and bequests b_c in order to maximize V subject to the production function of human capital in equation (4), the determinants of earnings in (2), and the lifetime budget constraint

$$(5) \qquad z + \frac{b_c}{R_k} + y = I_p \equiv E_p + b_p.$$

Combining the first-order conditions for y and b_c, we find the usual relation determining efficient investment in children's human capital:

$$(6) \qquad R_y \equiv \frac{d\bar{I}_c}{dy} = r\alpha\sigma y^{\alpha\sigma-1} H_p^{\beta\sigma} = R_k.$$

In words, when capital markets are perfect, parents invest in their children's human capital until the marginal return on these investments equals the exogenously given return on capital.[11]

We use equation (6) to solve for the optimal investment:

$$(7) \qquad y^* = \left(\frac{r\alpha\sigma}{R_k}\right)^{\frac{1}{1-\alpha\sigma}} H_p^{\frac{\beta\sigma}{1-\alpha\sigma}}.$$

Parental investments decrease with the return on physical capital (R_k) and increase with the returns to human capital (i.e., r and σ), as well as parents' own human capital (H_p).

In line with the last prediction, college-educated parents in the U.S. not only spend more monetary resources on enhancing their children's human capital (Duncan and Murnane 2011), but also invest considerably more time than less educated parents (Ramey and Ramey 2010; Guryan et al. 2008). Given that the former face a higher opportunity cost—their time is more valuable—these patterns are consistent with strong complementarities.[12]

By choosing optimal investments that depend positively on parental human capital, parents affect the equilibrium mapping between their own human capital and that of their children. We can see this by using equation (7) to eliminate y from the production function for H_c. The result differs greatly from the production function in equation (4):

$$(8) \qquad H_c = \left(\frac{r\alpha\sigma}{R_k}\right)^{\frac{\alpha}{1-\alpha\sigma}} H_p^{\frac{\beta}{1-\alpha\sigma}}.$$

[11] Equation (6) implicitly assumes that there exists an interior solution for y. This will be the case if $\alpha\sigma < 1$, i.e., whenever there are diminishing marginal *monetary* returns to human capital investments. If $\alpha\sigma > 1$, then the optimal investment in children would be infinite. In what follows, we assume that $\alpha\sigma < 1$.

[12] They are also consistent with highly educated parents deriving utility from educating their children. A preference-based explanation, however, runs the risk of being tautological (Stigler and Becker 1977).

Even if $\alpha + \beta < 1$, i.e., if the production of human capital exhibits decreasing returns to scale, the equilibrium relationship between parents' and children's human capital will be convex whenever $\alpha\sigma + \beta > 1$. This condition is more likely to hold the higher the production elasticity between parental and child human capital (β), and the higher the elasticity of children's earnings with respect to parental investments ($\alpha\sigma$). The latter fact is a direct consequence of complementarities in production.

Importantly, a necessary condition for convexity despite decreasing returns to scale is $\sigma > 1$. That is, increases in human capital must generate disproportionate rewards. Greater than proportional rewards may be the result of a superstar economy (Rosen 1981), complementarities within firms that drive up the salaries of top performers (Lucas 1978; Rosen 1982), or positive assortative matching between workers and firms (Sattinger 1979). Piketty and Saez (2003) and Kaplan and Rauh (2013) suggest that rising labor incomes and surging market returns to talent have been the main drivers of increasing inequality in the right tail of the income distribution, even among the top 1%. (Think, for instance, of CEOs, investment bankers, or other corporate executives.)

Earlier work typically assumed that the intergenerational transmission of human capital depends linearly on parental endowments (see, e.g., Becker and Tomes 1979, 1986). By taking the complementarity between parental own human capital and investments in children into account, our analysis highlights important consequences for the persistence of economic status.

The analysis above shows that in the presence of human capital complementarities, parents have a major influence on the human capital of their children. Yet the human capital of children gets transformed into earnings by market forces that are largely beyond parental control. Although parents take account of the labor market when deciding on their investments in the human capital of children, the family loses some (but by no means all) of its influence in the transition from human capital to earnings.

To bring out the influence that the family does have on the earnings of children, we combine equations (2) and (8) to obtain

$$\log(E_c) = \frac{1}{1-\alpha\sigma_c}\log(r_c) + \frac{\alpha\sigma_c}{1-\alpha\sigma_c}\log\left(\frac{\alpha\sigma_c}{R_k}\right) + \frac{\beta\sigma_c}{1-\alpha\sigma_c}\log(H_p) + \log(\varepsilon_c), \tag{9}$$

where subscripts continue to indicate the respective generation. Aside from σ_c, the elasticity between human capital and earnings in the children's generation, the coefficients in equation (9) are all determined by parameters in the production function for H_c and by the way these parameters affect parental investments in children through equation (7). By using (2) to substitute for H_p, the above relationship can be transformed into an equation that describes the intergenerational transmission of earnings:

$$\text{(10)} \qquad \log(E_c) = \mu + \frac{\beta}{1-\alpha\sigma_c}\frac{\sigma_c}{\sigma_p}\log(E_p) + \tilde{\varepsilon},$$

where $\mu \equiv \frac{1}{1-\alpha\sigma_c}\log(r_c) - \frac{\beta}{1-\alpha\sigma_c}\frac{\sigma_c}{\sigma_p}\log(r_p) + \frac{\alpha\sigma_c}{1-\alpha\sigma_c}\log\left(\frac{\alpha\sigma_c}{R_k}\right)$ and $\tilde{\varepsilon} \equiv \log(\varepsilon_c) - \frac{\beta}{1-\alpha\sigma_c}\frac{\sigma_c}{\sigma_p}\log(\varepsilon_p)$. It follows from equations (8) and (10) that in steady state, i.e., when $\sigma_c = \sigma_p$, the intergenerational earnings elasticity (IGE) is equals the intergenerational human capital elasticity:

$$\text{(11)} \qquad \frac{d\log E_c}{d\log E_p} = \frac{d\log H_c}{d\log H_p} = \frac{\beta}{1-\alpha\sigma}.$$

Our analysis shows that the earnings of parents and children are directly related through the intergenerational transmission of human capital, even when capital markets are pefect and there are no differences in innate ability. This result differs notably from Becker and Tomes (1986), who ignore complementarities in production. The mechanisms underlying the positive intergenerational correlations in Becker and Tomes (1979), Loury (1981), and Solon (2004) are credit constraints and heritable endowments. Credit constraints, however, are unlikely to be binding for well-to-do families and inheritability in intelligence and other genetic traits is thought to be too low to explain much of the observed intergenerational persistence (see Bowles and Gintis 2002). Thus unlike our model, these prior theories offer no clear explanation for the low mobility in upper parts of the income distribution that has been documented by Corak and Heisz (1999), Mazumder (2005a), Clark (2014), and Chetty et al. (2014b).[13]

3. How Changes in the Marketplace Affect Intergenerational Mobility

So far, we have assumed that families take all macroeconomic parameters as given and that those parameters are constant. Although analytically convenient, the latter assumption is clearly false. The returns to education and other human capital increased dramatically in the decades after 1980, especially in the United States (see, e.g., Katz and Murphy 1992; Juhn et al. 1993). In what follows, we study how changes in the returns to human capital impact intergenerational mobility. Since these returns are a key determinant of inequality, our analysis links changes in inequality to changes in intergenerational mobility.

Based on the observation that inequality and intergenerational mobility are strongly negatively correlated across countries, it is often claimed that higher returns to human capital

[13] The literature finds much higher persistence in *both* tails of the income distribution than in the middle. Low mobility among poor families, however, is plausibly explained by credit constraints and poverty traps (see Lochner and Monge-Naranjo 2016; Hai and Heckman 2017 on the former, and Durlauf 2006 on the latter).

will not only increase cross-sectional inequality but also reduce the degree of intergenerational mobility (see, e.g., Corak 2013; Krueger 2012; Council of Economic Advisors 2012; Solon 2004). Our analysis indicates that such conjectures are not true in general.

According to equation (11), the IGE depends positively on the production function parameters α and β, as well as the elasticity of earnings with respect to human capital (σ). It does *not*, however, depend on r, the economy-wide "base price" of human capital. As a result, our model predicts that changes in the marketplace that simply stretch the income distribution do not affect the IGE (i.e., $\frac{d}{dr}\left(\frac{d\log E_c}{d\log E_p}\right) = 0$). The reason is that, as r rises, all families proportionally increase investments in their offspring. By contrast, market forces that further skew the distribution of earnings—and hence spread the distribution of log-earnings—do not only cause higher inequality but also lower intergenerational mobility ($\frac{d}{d\sigma}\left(\frac{d\log E_c}{d\log E_p}\right) > 0$). To see why, note that, as σ increases, complementarities in production lead to greater-than-proportional changes in investments among high-human capital families. Our theory thus predicts that rising inequality may but need not be accompanied by reduced intergenerational mobility. The key question is whether high-skilled workers benefit disproportionally from changes in how the market values human capital, say because new technologies disproportionately raise the productivity of highly skilled individuals.

Interestingly, our model also predicts that even if changes in the returns to human capital do lead to lower mobility, the short-run impact (i.e., holding the returns to human capital in the parents' generation fixed) is strictly larger than that in the long-run, when $\sigma_c = \sigma_p$ (cf. equation (10)). Although parents may fully anticipate rising returns in their children's generation, increases in σ_c magnifiy the earnings consequences of preexisting dynastic differences in human capital. As a consequence, intergenerational mobility in income will initially drop only to increase again to its new, but ultimately lower long-run level.

Consistent with the prediction of overshooting, Olivetti and Paserman (2015) find that, lagging the rising returns to education in the aftermath of the Civil War by about one generation, intergenerational mobility fell substantially at the beginning of the twentieth century, followed by a partial recovery between 1920 and 1940. If correct, our theory suggests that, absent further changes in the marcoecnomic environment, earnings mobility may rise again over the next few decades.

4. Intergenerational Dynamics and the Long-Run Evolution of Dynasties

The analysis so far has focused on a snapshot of two generations—parents and their children—but the model we have developed also has implications for dynasties' evolution in the long run. To clearly bring out the implications of our theory, we first discuss the case in which children's status depends linearly on that of their parents, as in Becker and Tomes (1979, 1986).

When the transmission of human capital is governed by the autogressive relationship $H_c = \kappa + \widetilde{\beta} H_p + \nu_c$, the degree of intergenerational mobility is determined by the value of $\widetilde{\beta}$. For $\widetilde{\beta} > 1$, successive generations of the same family accumulate ever more human capital, and initial differences between families magnify over time. The empirically relevant case, however, is the one in which $\widetilde{\beta} < 1$. In fact, virtually all empirical work finds rates of intergenerational transmission below unity (see, e.g., Clark 2014; Mazumder 2005b; Solon 1992; and the studies cited in Solon 1999 and Black and Devereux 2011). With $\widetilde{\beta} < 1$, the distribution of human capital in a society is stable, and all dynasties regress toward the population mean. Figure 3 illustrates this prediction by depicting dynasties' expected path over time, i.e., ignoring any short-run fluctuations introduced through ν_c. Although families' fortunes may diverge over short and medium time horizons due to successive realizations of good and bad luck, in the long run the influence of the first generation vanishes completely.

In what follows we provide an important qualification of this result. In particular, whether families regress to the population mean depends critically on the shape of the human capital transmission function in equation (8). The leftmost panel in Figure 4 depicts the case most similar to traditional analyses. Here, parental human capital raises the productivity of investments in children's human capital, but neither complementarities in production nor the elasticity between earnings and human capital are large enough for $\beta + \alpha\sigma > 1$. As a result, the intergenerational transmission function is globally concave and successive generations regress towards the "steady state" at H^* (which need not coincide with the average level of human capital in the population).

When either complementarities in the production of children's human capital are strong enough to overcome diminishing marginal returns, or when competition for top talent generates significantly greater than proportional returns to human capital, then $\alpha\sigma + \beta$ may be larger than 1, so that the transmission function becomes convex. If, as in the middle panel, the intergenerational transmission function crosses the 45-degree line a second time, then the offspring of parents whose human capital exceeds $\widetilde{H}$ will gravitate away from the "mean." Taken literally, this would produce bifurcation and rules out a stable distribution of human capital.

Since the prediction of an ever-accelerating growth in dynasties' human capital is clearly unrealistic, it is reasonable to assume that once parental human capital reaches a certain level, its marginal return in the production of H_c dimishes quickly enough for there to be an inflection point above which the transmission function becomes concave again. If that is the case, then the transmission function would intersect the 45-degree line from above for a second time, resulting in another "steady state" at H^{**}. Families with parental human capital below $\widetilde{H}$ would, on average, move toward H^*, whereas dynasties that start above $\widetilde{H}$ can expect to transition to H^{**}. Put differently, when α, β, and σ are large enough for the human capital transmission function to be convex (over some of its range), then there might exist multiple basins of attraction, and successive generations of different families need no longer regress toward the same "mean." As a consequence, even modern societies might be divided into two classes with considerable mobility within but not across the *endogenously* determined class boundaries. Thus, our theory allows for a family's initial position to exert a great deal of influence over the well-being of future generations.

A very similar prediction about the dynamics of dynasties was first derived by Durlauf (1996a,b). Durlauf even formally describes the evolution of the distribution of income. An important difference between his theory and ours is that the former relies on social interactions and endogenous stratification across neighborhoods, whereas we focus on parental traits, motivated by evidence on complementarities in the technology of human capital formation (again, see Cunha and Heckman 2007; Cunha et al. 2010; Heckman and Mosso 2014). Furthermore, there are no credit constraints in our model and no inefficencies from a suboptimal provision of public schooling. While our approach and that of Durlauf (1996a,b) both rely on complementarities to produce high persistence in economic status, our framework also points to an interesting interaction between properties of the production function and the returns to human capital. In particular, if parental inputs into the human capital production function exhibit diminishing marginal returns (i.e., $\alpha + \beta < 1$), then, for bifurcation to obtain in our model, the market must reward high-human capital individuals disproportionately (i.e., $\sigma > 1$).

5. Concluding Remarks

We study the link between cross-sectional inequality and intergenerational mobility. Our theory of the intergenerational transmission of resources clarifies why mobility is low in the upper part of the income distribution, as documented empirically by Corak and Heisz (1999), Mazumder (2005a), and Chetty et al. (2014b), among others. By explicitly considering complementarities in the production of children's human capital, we show that wealthy parents invest on average more in their offspring than poorer ones. As a result, differences in economic status persists across generations, even among dynasties that have equivalent genetic endowments and are not credit-constrained.

Our main contribution is to analyze how changes in the returns to human capital affect intergenerational mobility. Our model predicts that increases in inequality may or may not go hand-in-hand with lower mobility. We thus show that the claim that higher returns to education increase both cross-sectional inequality and intergenerational persistence is not true in general. According to the theory, changes in the returns to human capital that lead to a mere stretching of the income distribution have no effect on the IGE. However, increases in returns that disproportionately benefit high-skilled individuals do lead to a short-run drop in mobility, followed by a partial recovery. Hence, a key question is whether changes in how the market values human capital skew rather than stretch the distribution of income.

Our model also predicts that different dynasties need not regress to the same long-run mean. If the market offers disproportionate rewards to high human capital, then even modern societies may develop social classes, with considerable mobility within but not across class boundaries.

References

Aaronson, D., and B. Mazumder (2008). "Intergenerational Economic Mobility in the United States, 1940 to 2000." *Journal of Human Resources*, 43(1): 139–172.

Acemoglu, D. (2002). "Technical Change, Inequality, and the Labor Market." *Journal of Economic Literature*, 40(1): 7–72.

Autor, D. H., F. Levy, and R. J. Murnane (2003). "The Skill Content of Recent Technological Change: An Empirical Exploration." *Quarterly Journal of Economics,* 118(4): 1279–1333.

———, L. F. Katz, and M. S. Kearney (2008). "Trends in U.S. Wage Inequality: Revising the Revisionists." *Review of Economics and Statistics*, 90(2): 300–323.

Becker, G. S. (1965). "A Theory of the Allocation of Time." *Economic Journal*, 75(299): 493–517.

———, and N. Tomes (1979). "An Equilibrium Theory of the Distribution of Income and Intergenerational Mobility." *Journal of Political Economy*, 87(6): 1153–1189.

———, and ——— (1986). "Human Capital and the Rise and Fall of Families." *Journal of Labor Economics*, 4(3): S1–S39.

———, S. D. Kominers, K. M. Murphy, and J. L. Spenkuch (2015). "A Theory of Intergenerational Mobility." MPRA Paper 66334.

———, K. M. Murphy, and J. L. Spenkuch (2016). "The Manipulation of Children's Preferences, Old Age Support, and Investments in Children's Human Capital." *Journal of Labor Economics*, 34(2): S3–S30.

Bénabou, R. (1993). "Workings of a City: Location, Education, and Production." *Quarterly Journal of Economics*, 108(3): 619–652.

Black, S. E., and P. J. Devereux (2011). "Recent Developments in Intergenerational Mobility," (pp. 1487–1541) in D. Card and O. C. Ashenfelter (eds.), *Handbook of Labor Economics, Vol. 4B.* Amsterdam: Elsevier.

Bowles, S., and H. Gintis (2002). "The Inheritance of Inequality." *Journal of Economic Perspectives*, 16(3): 3–30.

Chetty, R., N. Hendren, P. Kline, E. Saez, and N. Turner (2014a). "Is the United States

Still a Land of Opportunity? Recent Trends in Intergenerational Mobility." *American Economic Review: Papers & Proceedings*, 104(5): 141–147.

———, ———, ———, and ——— (2014b). "Where is the Land of Opportunity? The Geography of Intergenerational Mobility in the United States." *Quarterly Journal of Economics*, 129(4): 1553–1623.

———, D. Grusky, M. Hell, N. Hendren, R. Manduca, and J. Narang (2017). "The Fading American Dream: Trends in Absolute Income Mobility since 1940." *Science,* 356(6336): 398–406.

Clark, G. (2014). *The Son also Rises: Surnames and the History of Social Mobility.* Princeton, NJ: Princeton University Press.

Corak, M. (2013). "Income Inequality, Equality of Opportunity, and Intergenerational Mobility." *Journal of Economic Perspectives*, 27(3): 79–102.

———, and A. Heisz (1999). "The Intergenerational Earnings and Income Mobility of Canadian Men: Evidence from Longitudinal Income Tax Data." *Journal of Human Resources*, 34(3): 504–533.

Council of Economic Advisors (2012). *The Annual Report of the Council of Economic Advisors.* Washington, D.C.: U.S. Government Printing Office.

Cunha, F., J. J. Heckman, L. Lochner, D. V. Masterov (2006). "Interpreting the Evidence on Life Cycle Skill Formation," (pp. 697–812) in E. Hanushek, S. Machin and L. Woessmann (eds.), *Handbook of the Economics of Education*, *Vol. 5.* Amsterdam: Elsevier.

———, and ——— (2007). "The Technology of Skill Formation." *American Economic Review: Papers and Proceedings*, 97(2): 31–47.

———, ———, and S. M. Schennach (2010). "Estimating the Technology of Cognitive and Non-Cognitive Skill Formation." *Econometrica*, 78(3): 883–931.

———, and ——— (2016). "Decomposing Trends in Inequality in Earnings into Forecastable and Uncertain Components." *Journal of Labor Economics*, 34(2): S31–S65.

Duncan, G., and R. Murnane (2011). "Introduction: The American Dream, Then and Now," (pp. 3–25) in G. Duncan and R. Murnane (eds.), *Whither Opportunity? Rising Inequality, Schools, and Children's Life Chances.* New York: Russell Sage.

Durlauf, S. N. (1996a). "A Theory of Persistent Income Inequality." *Journal of Economic Growth*, 1(1): 75–93.

——— (1996b). "Neighborhood Feedbacks, Endogenous Stratification, and Income Inequality," (pp. 505–534) in W. Barnett, G. Gandolfo, and C. Hillinger (eds.), *Dynamic Disequilibrium Modelling: Proceedings of the Ninth International Symposium on Economic Theory and Econometrics.* Cambridge, UK: Cambridge University Press.

——— (2006). "Groups, Social Influences, and Inequality: A Memberships Theory Perspective on Poverty Traps," (pp. 1–14) in R. Scott, and S. Kosslyn (eds.), *Emerging Trends in the Social and Behavioral Sciences.* Hoboken, NJ: John Wiley & Sons.

——— , and I. SHAORSHADZE (2015). "Intergenerational Mobility," (pp. 141–175) in S. BOWLES, S. DURLAUF, and K. HOFF (eds.), *Poverty Traps*. Princeton, NJ: Princeton University Press.

——— , and A. SHESHADRI (2018)."Understanding the Great Gatsby Curve," in M. S. EICHENBAUM and J. PARKER (eds.), *NBER Marcoeconomics Annual, Vol. 32*. Chicago: University of Chicago Press.

GURYAN, J., E. HURST, and M. KEARNEY (2008). "Parental Education and Parental Time with Children." *Journal of Economic Perspectives*, 22(3): 23–46.

HAI, R., and J. J. HECKMAN (2017). "Inequality in Human Capital and Endogenous Credit Constraints." *Review of Economic Dynamics*, 25: 4–36.

HECKMAN, J. J. (2008). "Schools, Skills, and Synapses." *Economic Inquiry*, 46(3): 289–324.

——— , and S. MOSSO (2014). "The Economics of Human Development and Social Mobility." *Annual Review of Economics*, 6(1): 689–733.

HURST, E. (2010). "The Rug Rat Race: Comments and Discussion." *Brookings Papers on Economic Activity*, Spring 2010: 177–184.

JUHN, C., K. M. MURPHY, and B. PIERCE (1993). "Wage Inequality and the Rise in the Returns to Skill." *Journal of Political Economy*, 101(3): 410–442.

KAPLAN, S. N., and J. RAUH (2013). "It's the Market: The Broad-Based Rise in the Return to Top Talent." *Journal of Economic Perspectives*, 27(3): 35–56.

KATZ, L. F., and K. M. MURPHY (1992). "Changes in Relative Wages, 1963-1987: Supply and Demand Factors." *Quarterly Journal of Economics*, 107(1): 35–78.

——— , and D. H. AUTOR (1999). "Changes in the Wage Structure and Earnings Inequality," (pp. 1463–1555) in O. C. ASHENFELTER and D. CARD (eds.), *Handbook of Labor Economics, Vol. 3a*. Amsterdam: Elsevier.

KRUEGER, A. (2012). "The Rise and Consequences of Inequality in the United States." speech at the Center for American Progress, Washington D.C.

LAREAU, A. (2011). *Unequal Childhoods: Class, Race, and Family Life* (2nd ed.). Berkeley, CA: University of California Press.

LOCHNER, L., and A. MONGE-NARANJO (2016). "Student Loans and Repayment: Theory, Evidence, and Policy," (pp. 397–478) in E. HANUSHEK, S. MACHIN and L. WOESSMANN (eds.), *Handbook of the Economics of Education*, *Vol. 5*. Amsterdam: Elsevier.

LOURY, G. C. (1981). "Intergenerational Transfers and the Distribution of Earnings." *Econometrica*, 49(4): 843–867.

LUCAS, R. E. (1978). "On the Size Distribution of Business Firms." *Bell Journal of Economics*, 9(2): 508–523.

KRUSELL, P., L. OHANIAN, J. V. RIOS-RULL, and G. L. VIOLANTE (2000). "Capital Skill Complementarity and Inequality: A Macroeconomic Analysis." *Econometrica,* 68(5): 1029–1054.

MAZUMDER, B. (2005a). "The Apple Falls Even Closer to the Tree than We Thought: New and Revised Estimates of the Intergenerational Inheritance of Earnings," (pp. 80–99) in S. BOWLES,

H. Gintis, and M. O. Groves (eds.), *Unequal Chances: Family Background and Economic Success*. New York: Russell Sage.

——— (2005b). "Fortunate Sons: New Estimates of Intergenerational Mobility in the United States Using Social Security Earnings Data." *Review of Economics and Statistics*, 87(2): 235–255.

Mulligan, C. (1997). *Parental Priorities and Economic Inequality.* Chicago: University of Chicago Press.

Olivetti, C., and D. Paserman (2015). "In the Name of the Son (and the Daughter): Intergenerational Mobility in the United States, 1850-1940." *American Economic Review*, 105(8): 2695–2724.

Piketty, T., and E. Saez (2003). "Income Inequality in the United Sates, 1913-1998." *Quarterly Journal of Economics*, 118(1): 1–39.

Ramey, V., and G. Ramey (2010). "The Rug Rat Race." *Brookings Papers on Economic Activity*, Spring 2010: 129–176.

Rosen, S. (1981). "The Economics of Superstars." *American Economic Review*, 77(5): 845–858.

——— (1982). "Authority, Control, and the Distribution of Earnings." *Bell Journal of Economics*, 13(2): 311–323.

Sattinger, M. (1979). "Differential Rents and the Distribution of Earnings." *Oxford Economic Papers*, 31(1): 60–71.

Solon, G. (1992). "Intergenerational Income Mobility in the United States." *American Economic Review*, 82(3): 393–408.

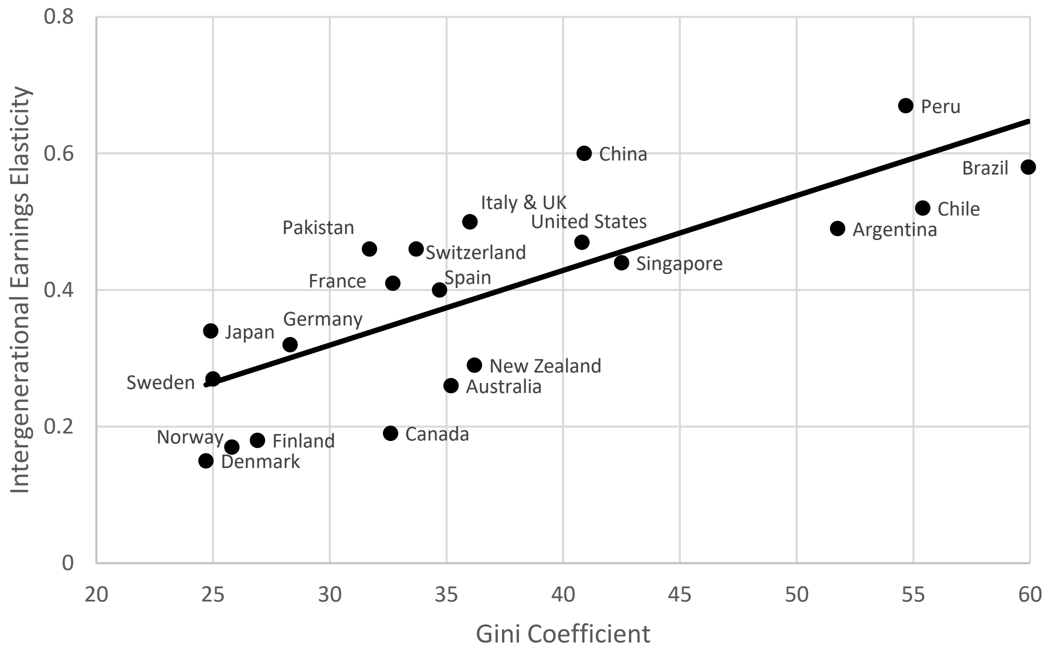
——— (1999). "Intergenerational Mobility in the Labor Market," (pp. 1761–1800) in D. Card and O. C. Ashenfelter (eds.), *Handbook of Labor Economics, Vol. 3A*. Amsterdam: Elsevier.

——— (2004). "A Model of Intergenerational Mobility Variation over Time and Place," (pp. 38–47) in M. Corak (ed.), *Generational Income Mobility in North America and Europe.* Cambridge, UK: Cambridge University Press.

——— , and C.-I. Lee (2009). "Trends in Intergenerational Income Mobility." *Review of Economics and Statistics*, 91(4): 766–772.

Stigler, G. J., and G. S. Becker (1977). "De Gustibus Non Est Disputandum." *American Economic Review*, 67(2): 76–90.

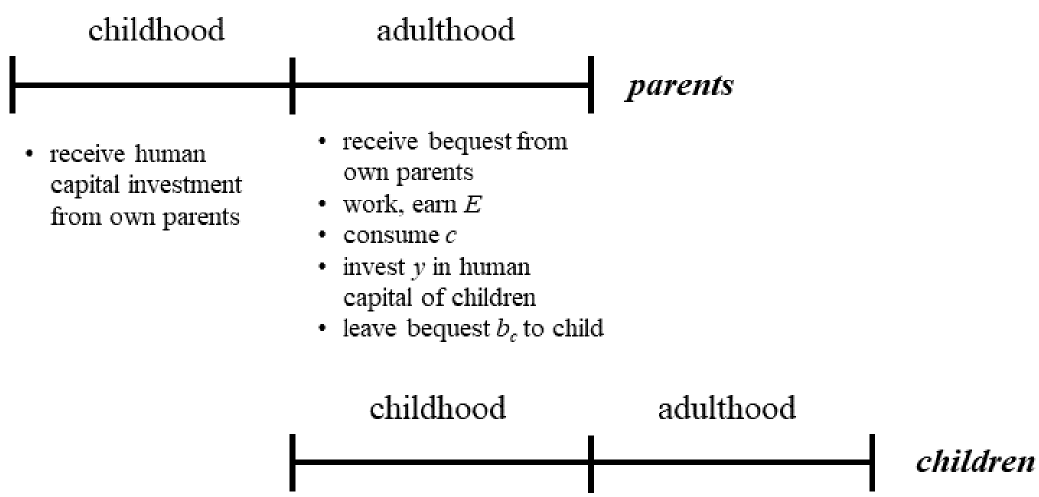
Figure 1: The Great Gatsby Curve



Notes: Figure shows the relationship between inequality, as measured by the Gini coefficient on the *x* -axis, and intergenerational persistentce, as measured by the intergenerational earnings elasticity on the *y* -axis. Higher values indicate more inequality and more persistence, respectively.

Sources: Based on Corak (2013).

Figure 2: Timing



Notes: Figure shows the timing of actions in our model.

Figure 3: Intergenerational Dynamics in Linear Models

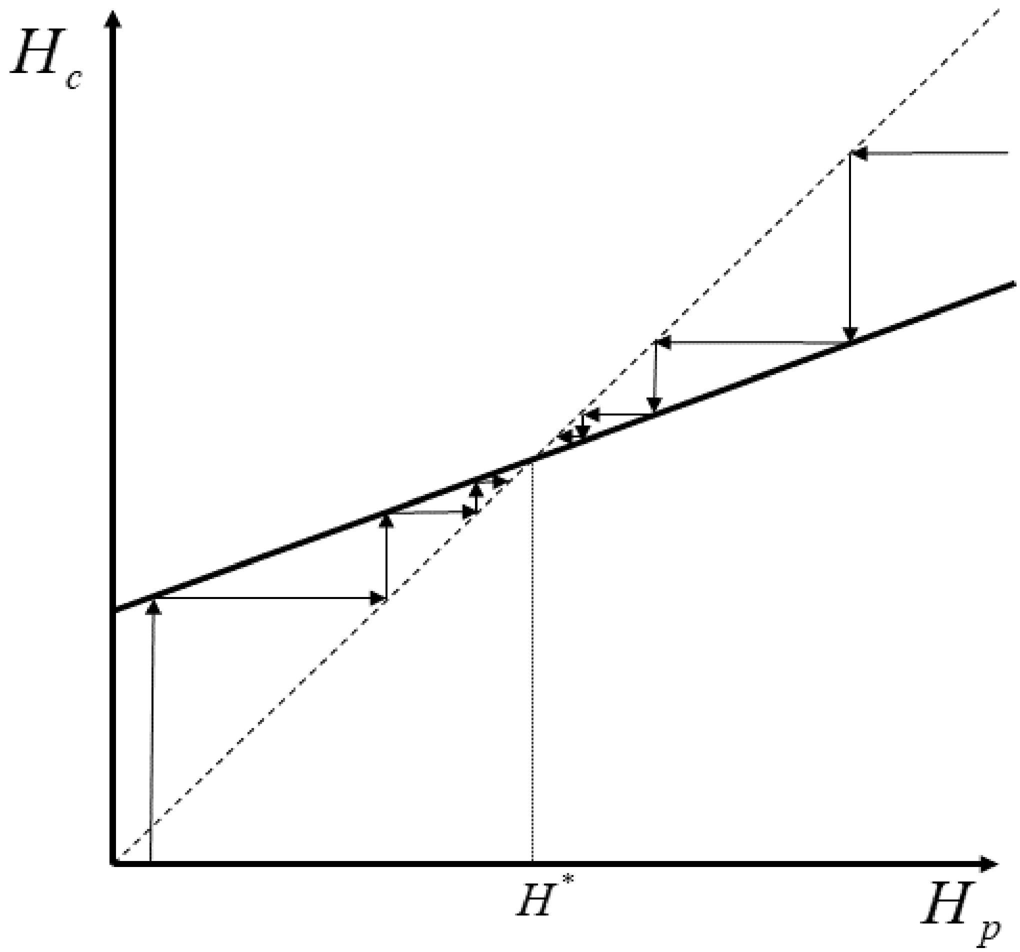


Figure 4: Intergenerational Dynamics in Our Model