

Ngina S. Chiteji and Frank P. Stafford

## **Asset Ownership Across Generations**

Report No. 00-454

### Research Report

**PSC** POPULATION STUDIES CENTER  
AT THE INSTITUTE FOR SOCIAL RESEARCH  

---

UNIVERSITY OF MICHIGAN

**The Population Studies Center** at the University of Michigan is one of the oldest population centers in the United States. Established in 1961 with a grant from the Ford Foundation, the Center has a rich history as the main workplace for an interdisciplinary community of scholars in the field of population studies. Today the Center is supported by a Population Research Center Core Grant from the National Institute of Child Health and Human Development (NICHD) as well as by the University of Michigan, the National Institute on Aging, the Hewlett Foundation, and the Mellon Foundation.

**PSC Research Reports** are prepublication working papers that report on current demographic research conducted by PSC associates and affiliates. The papers are written by the researcher(s) for timely dissemination of their findings and are often later submitted for publication in scholarly journals. The PSC Research Report Series was begun in 1981 and is organized chronologically. Copyrights are held by the authors. Readers may freely quote from, copy, and distribute this work as long as the copyright holder and PSC are properly acknowledged and the original work is not altered.



# **Asset Ownership Across Generations<sup>1</sup>**

Ngina S. Chiteji and Frank P. Stafford

August 2000

## Abstract

This paper examines cross-generational connections in asset ownership. We study the effect that parental ownership of individual assets has on their children's knowledge about assets and their portfolio choice decisions. The paper first presents a theoretical framework that develops the distinction between the intergenerational transfer of knowledge about financial assets and the direct transfer of dollars. It subsequently analyzes data from the Panel Study of Income Dynamics (PSID). Our empirical research reveals that there is intergenerational correlation in asset ownership and that parental asset-ownership affects the probability of holding a bank account and the probability of owning stock.

<sup>1</sup>We are grateful to Sandy Baum, Kerwin Charles, Sheldon Danziger, Pamela Davis-Kean, Dan Hamermesh, Erik Hurst, Ming-Ching Luoh, Joseph Lupton, Hiromi Ono, and participants of the Economic Behavior Program seminar series at the University of Michigan for helpful comments. Additionally, special thanks is owed specifically to Erik Hurst and Ming-Ching Luoh for their assistance as we were constructing our dataset. We also thank Margaux Matter for her research assistance. Finally, Chiteji wishes to acknowledge the financial support of a Ford Foundation grant in Poverty, the Underclass, and Public Policy. This research also was sponsored in part by Citicorp Credit Services and the Alfred P. Sloan Foundation Center for the Ethnography of Everyday Life. All views and mistakes are the sole responsibility of the authors.

"Give a man a fish and you feed him for a day; teach a man to fish, & you feed him for the rest of his life."

## I. Introduction

Intergenerational transfers are widely recognized as having an effect on the wealth holdings of the receiving offspring. Less emphasized in the literature are the different *forms* of transfers and the role of financial knowledge from the family. What is the relevance of knowledge for wealth holding? In a world of perfect information, individuals are presumed to know the range of investment options in the economy and asset-ownership involves deciding where to place one's savings given an income stream, a desired spending path, and the characteristics of the different saving instruments. In practice, however, the information needed to make these choices is neither costless nor evenly distributed.<sup>1</sup>

In this paper we explore the distinction between intergenerational transfers of knowledge about financial assets and direct dollar transfers from parents to children. Transfers such as bequests of assets have been estimated to account for anywhere from 15% to 46% of household wealth (Kotlikoff and Summers, 1981; Kopczuk and Lupton, 2000). Additionally, the importance of inter vivos transfers, such as those facilitating human capital accumulation and downpayment assistance with home purchases, also has been investigated (Cox 1990, for example). Here we examine parents' ability to affect their children's wealth outcomes by imparting critical information about asset-ownership to the next generation. This possibility has not been readily explored in literature on wealth, yet the intergenerational transfer of knowledge has some inherent differences from asset transfers.

For example, if each partner in a marriage receives an inheritance the effect on their family wealth is likely to be additive. In contrast, when considering the information that the two partners may have acquired while growing up, one spouse may believe equities a necessary part of a portfolio while the other spouse 'wouldn't touch the stuff.' The net result on their family choice may be very unclear. Certainly, just as for differences in religious or cultural background, we would expect the result to be other than simple addition. We find that variants of the generational models of attributes used in biology serve as a good framework for organizing one's thinking about asset knowledge transfer across generations. After reviewing these models briefly, we apply the approach to the asset choices across generations in the Panel Study of Income Dynamics (PSID), 1984 and 1994.<sup>2</sup>

Interest in intergenerational knowledge transfer is accentuated by findings of race differences in wealth holdings, and in the understanding that there appears to be some relationship between intergenerational transfers and inequality. For example, recent empirical research has found race differences in both overall levels of wealth and in the *form* of financial asset holdings, more specifically (Blau and Graham, 1991; Oliver and Shapiro, 1995; Hurst, Luoh and Stafford, 1998; and Wolff, 1998), in entry into the stock market during the peak periods of 1984-1994 (Hurst, Luoh, and Stafford, 1998), and in the consequent growth of wealth holdings

---

<sup>1</sup> Research on information imperfections in financial markets typically focuses on problems related to screening borrowers (Stiglitz and Weiss, 1981; and Jaffee and Stiglitz, 1990, for example). Information barriers can be present at the funds mobilization stage also, so as to prevent potential investors from seeking out particular investments on their own accord.

<sup>2</sup> The PSID is sponsored by the National Science Foundation (grant number 9515005), and other Federal Agencies. The wealth data have been collected in 1984, 1989, and 1994, under a grant from the National Institute on Aging.

over time (Lupton and Stafford, 2000).<sup>3</sup> Other research has established some connection between intergenerational transfers and the observed racial inequality in the distribution of aggregate wealth (Blau and Graham, 1991; and Menchik and Jianakoplos, 1997).

These results echo the findings from research on educational outcomes, earnings capacity, and home ownership. There, differences in intergenerational transfers across groups—particularly transfers such as human capital investment in children and funds provided as start-up financing for housing investment—have been linked to differences in outcomes in the recipient generation (Loury, 1981; Oliver and Shapiro, 1997; and Charles and Hurst, 2000). In these studies, too, the role of information versus direct resource transfers has not received much attention. In our work we attempt to see whether there is a knowledge effect beyond direct transfers, via gifts or bequests.

Places that early knowledge may be acquired include the media and formal schooling, both of which may supplant (or supplement) lessons learned within the family. Research in the social sciences has shown the family to be an important locus for gathering information about a variety of life activities. Parents have been shown to be an influential source of information as they teach children about behavior, values, language, employment prospects, and violence, (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985; Oliver and Shapiro, 1995; Wilson, 1995; Eccles, et al, 1997; and Lundberg and Pollak, 1998). Parents also “socialize” children to hold certain expectations and preferences (Easterlin, 1980; Henretta, 1984; and Bisin and Verdier, 1998).

It is reasonable to posit that financial behavior and other ownership patterns (housing for example) can be shaped by the family. Whether an individual has been exposed to specific assets by his or her parents will affect asset choice, through the development or cultivation of asset-specific knowledge that is relevant to the ownership decision. The expectation is that children of parents who hold a particular asset, say stock, would be more likely to hold stock themselves (compared to children of non-stock owners). This is because they are likely to have experienced ‘learning-by-observing’ within the family. Studies of human capital acquisition and labor market participation have found intergenerational correlation in educational levels and in occupational outcomes (Solon, 1992; and Lam, 1999). Yet the reason for the generational carry over – direct financial (or time) resources versus knowledge or values supporting education as a goal - has not been widely investigated by researchers.

This paper finds that there are ownership differences arising from family-based exposure to assets. In establishing this theoretical and empirical connection the work supports the hypothesis that intergenerational influences appear to explain some of the differences in asset ownership between African-American and other families.<sup>4</sup> Section II presents our theoretical framework, developing the distinction between transfer of knowledge about assets and the transfer of assets per se. Section III discusses the data, and section IV presents the empirical findings. The conclusion (Section V) includes a discussion of the different policy implications that stem from the intergenerational transfer of knowledge framework and the classic bequest models.

---

<sup>3</sup>Preliminary data from the 1999 PSID show a stall-out in the growth of wealth holdings of African-American families in the United States (Lupton and Stafford, 2000).

<sup>4</sup> At present, the authors are aware of only one other paper examining parents’ and children’s asset-ownership. Henretta (1984) exclusively examines home ownership using data from the PSID, and finds an empirical connection between the home ownership of parents and children. However, Henretta (1984) attributes this connection to children’s striving to “emulate” their parents, and does not explore the possibility that children may acquire information that is critical for asset choice as a result of being exposed to specific assets by their parents, nor does it address inequality and differences in home-ownership by race in either the parent or child generations.

## II The Theoretical Framework

Overlapping generations models, with “families” represented as one parent with one child, and where transfers of money, inputs to education, or other *quantities* transferred from parent to child have been used effectively in certain settings (Loury, 1981 for example). When contemplating the transfer of asset ownership ‘traits’, models depicting family formation in each generation as well as the transmission process from one generation to the next are more appropriate (Bisin and Verdier, 1998 for example). In this section we present a simple model of the intergenerational transmission of asset ownership via knowledge, which bears a close resemblance to models used in biology.<sup>5</sup> Inheritance of a given trait may be subject to threshold effects and one trait commonly displaces another.

### A. A deterministic model of intergenerational transmission<sup>6</sup>

Consider a simple overlapping generations model in which each individual lives for two periods: childhood and adulthood. Also consider an individual asset of type “j”. For initial conditions, let  $\pi_{Mt}$  represent the fraction of males who grew up in families that held this particular asset during time t, where  $\pi_{Mt}$  is restricted to lie on the domain [0,1]. Define  $\pi_{Ft}$  similarly for females. The expression  $(1 - \pi_{Mt})$  then represents the fraction of males who were not exposed to the asset during childhood, and  $(1 - \pi_{Ft})$  represents the fraction of females who were not exposed to this asset during their time t childhoods. The variables  $\pi_{it}$  and  $(1 - \pi_{it})$  can be viewed as describing individuals’ family background in terms of the dichotomous ‘trait’, ownership of a specific asset. They characterize adult males’ and adult females’ exposure to assets during youth.

Males and females then go on to form marriages in time t+1, once they have reached adulthood. Marriages in t+1 will take the form of one of four types, and the share of each family type in the total population of marriages is represented by  $T_i$ . Type 1 marriages represent unions formed between two spouses whose parents exposed them to assets during their childhood. Type 2 represent marriages between men who were exposed to assets during childhood and women who were not exposed. A Type 3 marriage is a marriage between a man who was not and a woman who was exposed to asset-holding by their parents, and a Type 4 marriage is a marriage between two spouses, neither of whom had parents who grew up in time t families holding assets.

Though it is reasonable to assume that families with at least one spouse desiring to hold assets will take steps toward asset-ownership, we choose to avoid the complicated issue of how couples will negotiate their individual “demands” given their family backgrounds. Instead, exogenous probabilities-- $p_1$ ,  $p_2$ ,  $p_3$  and  $p_4$ --are defined as follows:

- (1)  $p_1$  represents the probability that a marriage between an exposed man and an exposed woman results in asset ownership,
- (2)  $p_2$  represents the probability that a type two marriage results in asset-ownership,
- (3)  $p_3$  represents the probability of asset ownership in a of type three marriage, and
- (4)  $p_4$  denotes the probability that a type four family opts for asset-ownership.

---

<sup>5</sup>Other economic models focus on the transmission of traits such as the propensity to be violent from parent to child (Lundberg and Pollak, 1998), and on human capital investment (Loury, 1981, for example). Oettinger (1998) finds that family-based information provided by siblings affects teens’ decisions regarding sexual activity, and he discovers a trade-off between intra-family information and extra-family information in the teen pregnancy context. As far as we know, ours is the first paper to examine intergenerational transmission of financial asset-ownership, however.

<sup>6</sup> The model presented here is similar to the model developed in Lundberg and Pollak (1998), and draws heavily on the work of Cavalli-Sforza and Feldman (1981), and Boyd and Richerson (1985).

The following assumptions govern the probability values:

- (1)  $p_4 < p_i$ , for  $i \leq 4$ , reflecting an increased probability of asset ownership attributable to having been exposed to assets as a child,
- (2)  $p_1 > p_2$ ,  $p_3 > p_4$ , so that the probability of ownership rises based on the number of spouses with childhood exposure to asset-ownership,
- (3)  $p_2 > p_3$ , to reflect possible male bias in family financial decisionmaking,<sup>7</sup>
- (4)  $0 \leq p_i \leq 1$  for all  $p_i$ .

Given these probabilities, the fraction of marriages or homes in which assets are owned in  $t+1$  can be represented by the following sum:

$$(1) \quad \sum_{i=1}^4 p_i T_i$$

And, provided that fertility rates are constant across family types, the variable,  $\pi_{t+1}$ , also will represent the fraction of children in generation  $t+1$  who are exposed to asset  $j$ .<sup>8</sup>

Denoting the expression in equation (1) above as  $\pi_{t+1}$ , one can obtain an expression for the fraction of families owning assets in a given time period that links ownership among families to the characteristics of the adults forming them, i.e., to their exposure or lack of exposure during childhood, and ultimately to family asset ownership rates in the previous period. This expression is obtained by substituting for the frequencies of each marriage type in the population. If women and men choose partners at random, the frequency of each type of marriage in the population of marriages is given as,

$$(2) \quad T_1 = \pi_{M_t} \pi_{F_t}; \quad T_2 = \pi_{M_t} (1 - \pi_{F_t}); \quad T_3 = (1 - \pi_{M_t}) \pi_{F_t}; \quad T_4 = (1 - \pi_{M_t}) (1 - \pi_{F_t}),$$

where  $\sum T_i = 1$ .

Equation (2) above indicates that individuals may have a range of experiences in terms of the types of family backgrounds, and in the likelihood of having exposure to the asset “ $j$ ” accordingly. While the standard one-parent/one-child models that often are used to analyze intergenerational transfers offer no consideration of spousal matching, as evident in equations (2) and (1), our simple framework incorporates the effect of the family formation process on exposure rates and ultimate asset-ownership in the economy.

Under assortative mating, the frequencies associated with the different marriage types also will depend upon the fraction of the population that chooses partners like them.<sup>9</sup> Because the case of random mating can be shown to be a simple sub-case of the model with assortative mating, our analysis proceeds by developing a generalized model for assortative mating.<sup>10</sup>

<sup>7</sup> More generally, intra-family bargaining power over assets could be set in a larger model of intra-family resource allocation.

<sup>8</sup> With random births, one-half of these children will be male and one-half female; hence,  $\pi_{t+1}$  not only gives the fraction of time  $t+1$  marriages or homes in which assets are held, it also gives the fraction of males (or females) who are exposed to assets while growing up during time  $t+1$ .

<sup>9</sup> Assortative mating allows for the possibility that individuals choose marriage partners based on similarity of characteristics--the characteristic of interest being exposure to assets during childhood or commonality of childhood experience.

<sup>10</sup> Results for the simpler model with random mating are contained in an appendix that is available from the authors.



### Determination of the equilibrium rate of asset-ownership in the economy

Following Lundberg and Pollak (1998) and Cavalli-Sforza and Feldman (1981), assortative mating is conceptualized as a case in which the population contains a fraction that mates at random and a complementary fraction that mates assortatively. Let  $\gamma$  represent the fraction of the population that mates assortatively;  $(1-\gamma)$  is the fraction of the population that mates at random. As noted by Lundberg and Pollak (1998), it is subsequently possible to think of the marriage market as being comprised of three submarkets--two "pure" submarkets in which individuals form homogamous unions, and one "combined" submarket where individuals choose partners at random. Consequently, we view  $\gamma$  as a market assignment parameter. It indicates that  $\gamma$  of all marriages involving exposed individuals and non-exposed individuals (separately) are required to be with exposed individuals and non-exposed individuals (respectively).

The result is that  $(1-\gamma)\pi_t^2$  is the fraction of type one marriages that materialize at random in generation  $t$  (i.e., marriages between two exposed individuals), while  $\gamma\pi_t$  is the fraction of type one marriage pairings that come about due to obligate assortative mating. Similarly,  $(1-\gamma)(1-\pi_t)^2$  is the fraction of type four marriages that come about at random in generation  $t$ , while  $\gamma(1-\pi_t)$  is the fraction of type four marriages that occur due to obligate assortative mating.

Substituting for the  $T_1$  and simplifying gives the following expression for  $\pi_{t+1}$ :<sup>11</sup>

$$(3) \quad \begin{aligned} \pi_{t+1} = & (1 - \gamma)[(p_1 + p_4) - (p_2 + p_3)] \pi_t^2 \\ & + \gamma[(p_1 + p_4) - (p_2 + p_3)] \pi_t + [p_2 + p_3 - 2p_4] \pi_t + p_4 \end{aligned}$$

When  $\gamma = 0$ , we have an expression for  $\pi_{t+1}$  under random mating. With perfect assortative mating ( $\gamma = 1$ ), asset-ownership is a weighted average of  $p_1$  and  $p_4$ .

The long-run equilibrium value for  $\pi$  is given by the solution to the following equation,

$$(4) \quad \begin{aligned} G(\pi) = & (1 - \gamma)[(p_1 + p_4) - (p_2 + p_3)] \pi^2 + \gamma[(p_1 + p_4) - (p_2 + p_3)] \pi \\ & + [(p_2 + p_3 - 2p_4) - 1] \pi + p_4 \end{aligned}$$

where  $G(\pi) = 0$  ensures a steady-state. Because the sign of the coefficient on the squared term is ambiguous, the graph of  $G(\cdot)$  may be concave or convex. Figure A-1 (appendix) illustrates these two possible shapes. Graphing equation (4) reveals that there is a unique interior solution for  $\pi^{ss}$  on the permissible domain  $[0,1]$ .<sup>12</sup>

<sup>11</sup> More detailed derivations are provided in the appendix.

<sup>12</sup>This is true regardless of whether the function is concave or convex, because it crosses the horizontal axis only once in either case. The properties of  $G(\cdot)$  and its derivatives and the boundaries of the domain guarantee a unique equilibrium: Taking derivatives reveals that the function is twice-differentiable and that the second derivative can be signed as either forever positive or forever negative for all  $\pi$  values. Inspecting the function reveals that it begins at the point  $(0, p_4)$ , a positive value, and ends at the point  $(1, p_1 - 1)$ , a negative value. The existence of an equilibrium is guaranteed by continuity and the intermediate value theorem; and, the single crossing between  $\pi = (0,1)$  implies that there is a unique interior long-run equilibrium. Under the more restrictive case of random mating, this analysis is not altered substantially. The  $G(\cdot)$  function has the same beginning and endpoints and the same single crossing property. Only the width of the  $G$ -function changes, altering the value of the steady-state solution, not the process determining it. Random mating is discussed in greater detail in an appendix available from the authors.

Noteworthy in such models is the lack of easy generalizations. Specifically, it is not possible to make definitive statements about either the local stability of the equilibrium or the speed of transition to steady-state without prior information about parameter values. We relegate the specific mathematical details governing the determination of an expression for the steady state solution, its stability, and the speed of transition to steady-state to the appendix, and we restrict ourselves to a discussion of three interesting special cases here in the main text.

### Special cases of interest

Case 1: When the probability of asset-ownership among families with two parents who were not exposed to assets during childhood is zero (i.e.,  $p_4 = 0$ ), two possibilities emerge in terms of the long-run equilibrium at which the economy will eventually settle. The economy either obtains an equilibrium in which there is zero asset-ownership, or a steady-state value between zero and one. In this special case,

$$(5) \quad G(\pi) = [1 - \gamma][p_1 - (p_2 + p_3)]\pi^2 + \gamma[p_1 - (p_2 + p_3)]\pi + (p_2 + p_3 - 1)\pi,$$

and  $G(\cdot) = 0$  at  $\pi=0$  and  $G(\cdot) = p_1 - 1$  at  $\pi=1$ . Taking derivatives and defining  $A = [p_1 - (p_2 + p_3)]$ , one can see that when “A” is positive, and the G-function therefore is convex,  $\Delta\pi$  is everywhere negative on the domain.<sup>13</sup> Hence, the economy always converges toward a long-run equilibrium in which the rate of asset ownership is zero. When  $A < 0$ , the G-function is concave and an equilibrium of zero asset-ownership or an interior solution may obtain. It is not possible to tell a priori which will occur.<sup>14</sup>

Case 2: When the probability of asset-ownership among families with two parents who were both exposed to assets during childhood is unity (i.e.,  $p_1 = 1$ ), the equation in (4) reduces to,

$$(6) \quad G(\pi) = (1 - \gamma)[1 + p_4 - (p_2 + p_3)]\pi^2 + \gamma[1 + p_4 - (p_2 + p_3)]\pi + [p_2 + p_3 - 2p_4]\pi + p_4.$$

In this special case, there are two possible outcomes for the economy (depending partly on whether G is concave or convex). The economy either converges toward an equilibrium of complete asset-ownership, or it settles at an interior equilibrium.

Case 3: When each of the above conditions holds simultaneously (i.e.,  $p_1=1$  and  $p_4=0$ ), we have,

$$(7) \quad G(\pi) = (1 - \gamma)[1 - (p_2 + p_3)]\pi^2 + \gamma[1 - (p_2 + p_3)]\pi + [p_2 + p_3 - 1]\pi.$$

---

<sup>13</sup> This can be seen by recalling that the G-function represents  $\pi_{t+1} - \pi_t$  (or the change in  $\pi$ ), and then by adding and subtracting  $p_1\pi$  to the third term of the G-function, and then rewriting the function as  $(1-\gamma)A(\pi^2 - \pi) + (p_1 - 1)\pi$ . Additionally, note that  $G' = 2(1-\gamma)[p_1 - (p_2 + p_3)]\pi + \gamma[p_1 - (p_2 + p_3)] + (p_2 + p_3 - 1)$ , and  $G'' = 2[1 - \gamma][p_1 - (p_2 + p_3)]$ . Finally, recall that by definition  $(1-\gamma) \geq 0$ .

<sup>14</sup> Illustrations of the possibilities for long run equilibrium in this and subsequent special cases are provided in the appendix.

The boundary points of this function are such that  $G = 0$  at  $\pi=0$ , and  $G = 0$  at  $\pi=1$ . Additionally, at  $\pi = 1/2$ ,  $G' = 0$ .<sup>15</sup> Defining the coefficient on the squared term in (7) as “B,” so that  $B \equiv [1-(p_2 + p_3)]$ ; in cases in which  $B > 0$ ,  $\pi$  is falling and the economy converges toward a zero rate of asset-ownership. With  $B < 0$ ,  $\pi$  is rising and the economy converges toward a long-run equilibrium of complete asset-ownership.<sup>16</sup>

### Concluding remarks about intergenerational transmission

When allowing the possibility that some children will “inherit” the traits of their parents, a connection between asset ownership rates across the generations emerges. The intergenerational transmission model presented in this section illustrates the link between asset-ownership among parents and asset-ownership by children. Aside from clarifying the effect that parental asset-ownership has on asset-ownership rates economy-wide, the model addresses factors promoting wider (and narrower) ownership throughout the generations. It reveals that even in a simple model convergence toward complete asset-ownership is not guaranteed.

The stylized model has properties appropriate to the analysis of the intergenerational transfer of knowledge capital that are missing from the more standard one-parent/one-child intergenerational transfers of financial capital/bequest models. It highlights family formation and the way that parents’ having different backgrounds can affect the transfer of information. Of course, beyond the transmission process stylized in this section there are more traditional economic factors operating. For example, if returns to some assets are sufficiently attractive, and if there is information about this, we could expect universal ownership of some assets. Such a situation could be formalized as high  $p_i$  regardless of family background type. We now turn to consideration of the specific manner in which information acquired from parents affects the asset ownership decision.

#### *B. The Relevance of Knowledge Gained at Home*

Our theoretical framework began by viewing the family as a critical locus for the transmission of traits. We now demonstrate the manner in which knowledge about assets is relevant for the accumulation of assets.

The ownership decision is represented as:

$$(8) \quad A_j = A_j(k_c, Z)$$

where  $Z$  represents the set of traditional income, returns, risk, market information, and other resource factors that affect the decision to hold or forego a particular asset of type “j,” ( $A_j = 0,1$ ), and  $k_c$  represents the stock of knowledge capital (or asset-specific information) that an individual has. The process of accumulating asset-specific knowledge is presumed to behave according to the following equation:

---

<sup>15</sup>This can be seen by noting the following expression for  $G'$

$$G' = 2[1 - \gamma][1 - (p_2 + p_3)]\pi - (1 - \gamma)[1 - (p_2 + p_3)].$$

<sup>16</sup>This can be seen by noting that  $G < 0$  when  $B > 0$  and  $G > 0$  everywhere when  $B < 0$  (as  $G \equiv \pi_{t+1} - \pi_t$ ).

$$(9) \quad k_c = a_i P_i + E_i - \delta k_c$$

where  $a_i$  is the age-specific capacity to learn about the nature or desirability of a particular asset at age  $i$  given parental inputs to this learning,  $P_i$ , and  $E_i$  represents external sources of knowledge, such as market information provided by financial institutions or the news media, and  $\delta$  allows for possible depreciation of the knowledge capital stock. The presence of  $P_i$  reflects the fact that parents' ownership of an asset is a key aspect of the parent-based, social learning process.

The theoretical framework presented in this section suggests some critical differences between the intergenerational transfer of financial capital and the intergenerational transmission of knowledge. With bequests there is a dollar for dollar effect associated with transfers, a constant returns property. Every dollar transferred from one generation to the next augments the receiving family's position by a dollar (and every dollar rise in the amount of parents' holdings potentially represents a dollar increase in bequeathable wealth). With information, there is something in either the realm of decreasing returns, or via family formation of 'opposites,' a displacement property. The intergenerational transfer of information about assets therefore is distinct from the intergenerational transfer of financial capital.

### III. Sample Construction

Data from the 1994 wave of the Panel Study of Income Dynamics (PSID), a nationally representative, longitudinal survey that collects data on economic, financial, and socio-demographic information about U.S. families, were used to construct a dataset of parents and their adult children. This resulted in a subset of all PSID families -- 1,993 young adult families -- for whom we could match data on one set of parents' asset holdings (taken from the 1984 wealth supplement).<sup>17</sup> (Further details about the construction of the dataset are contained in the appendix.<sup>18</sup>)

Selected characteristics of our weighted sample of young households include: total household wealth (as defined in Hurst, Luoh and Stafford, 1998) that ranges from \$(-)108,974 and \$7,623,948 in 1994 (measured in 1996 dollars), with average wealth holdings of \$89,696 per household.<sup>19</sup> Restricting the analysis to financial assets, the families in our sample hold anywhere from \$0 to \$1,060,116 and have mean financial wealth of \$27,351. For bank account and stock balances, mean holdings are about \$8,311 and \$9,233, respectively, with 76.2% of the sample having at least one bank account and 30.5% owning stock. These balances are lower than national balances reported elsewhere; however, the differences should be attributable largely to the fact

---

<sup>17</sup> Sponsored by the National Science Foundation, the National Institute on Aging, and other Federal agencies, the PSID follows a family line and for this reason only provides parental background for one spouse in each of these families.

<sup>18</sup> Information about the PSID is available at the survey's website: <http://www.umich.edu/~psid/> in the "documentation" section (under "computer assisted documentation") for the 1994 questionnaire or in the "supplemental file documentation" section for the wealth and active savings variables.

<sup>19</sup> All figures are for household wealth including home equity measured in 1994 (in 1996 dollars). The 1994 PSID shows an overall range of \$(-)681,352 to \$11,198,927. Median wealth in our sample of young families is \$16,452 in 1996 dollars. For discussion of the household net worth measures contained in the PSID see Hurst, Luoh, and Stafford (1998).

that our sample focuses on younger households in the population, while, nationally, greater wealth holding occurs among older, pre-retirement and retirement households.<sup>20</sup>

The households in our sample range from age 25 to 53, with a mean age of 33 for the household heads. The mean level of education for household heads in our sample is 13.3 years of schooling, indicating that on average our young families are not only high school educated, but possess some post-secondary schooling. Mean long-term average family income is \$39,597, while in 1994 the average for all families in the PSID was \$49,255.<sup>21</sup> On average, there is one child per household. Of the weighted sample households, 14.8% are African-American. The majority of households in the sample are headed by males (77.1%), but the sample is almost evenly split between married and unmarried households (51.6% married and 48.4% unmarried). For data on the "financial family background" of this young family sample: A large percentage of the sample had parents who owned bank accounts in 1984. Eighty percent of households were in this category. Additionally, 32.6% of the sample had parents who held stock.

Descriptive data indicate an intergenerational correlation in asset-ownership. Table 1 presents data comparing bank account and stock ownership rates for two different generations of families using data from the PSID. The data reveal that, regardless of race, young adults whose parents held bank accounts were more likely to hold bank accounts than young adults whose parents did not own a bank account. A similar result holds for stocks; almost twice as many young adults whose parents held stocks went on to own stocks as the proportion of young adults whose parents did not own this particular financial asset. The Pearson correlation coefficient between parents' and children's asset-ownership is 0.28 for bank accounts and 0.20 for stocks.<sup>22</sup>

Beyond differences in parental asset-ownership among young families, there are also differences in asset ownership by race. Non-black families are more than twice as likely to hold a bank account as African-American families, and the rate of stock ownership for African Americans is only about one-third of the rate of stock ownership for non-black families (Table 2). In addition to the gap in participation rates in financial markets, African-American families possess lower bank balances and lower stock balances than other families, on average. Table 3 indicates that there are also race differences in parental ownership of financial assets. The percentage of African-American households whose parents owned bank accounts was about half the percentage of non-black households whose parents owned bank accounts (42.7% compared to 86.5%). Similarly, for stocks, fewer young African-American families had parents who owned stock (16.2% compared to 35.5%).

Table 1. Young Families' Asset Ownership, 1994—by Parents' Ownership Status<sup>23</sup>

---

<sup>20</sup>In its analysis of PSID data, Hurst, Luoh and Stafford (1998) reports mean bank account balances of \$20,217 in 1994 (1996 dollars) with 77.8% of the population holding accounts. It reports \$29,768 for the national average for stock balances and 34.5% as the percentage of the overall population holding stocks, and also notes that households that are 55 and older account for 65.2% of all stock holdings (i.e., dollar amounts) and 61.2% of all bank balances, so it is not surprising that the mean for our sample is much lower than these national averages.

<sup>21</sup>Based on a five year average of income from 1987-1991.

<sup>22</sup>For income, Behrman and Taubman (1990) finds an intergenerational correlation of 0.26.

	<i>Percentage of young families owning bank accounts or stocks</i>	<i>Mean holdings</i>	<i>Mean holdings conditional on holding</i>
<b>Bank account ownership</b>			
Young families whose parents held bank accounts (N=1205)	82.2%	\$9,249 (559.4)	\$11,252 (717.6)
Young families whose parents did not hold accounts (N=585)	52.37%	\$4,546 (844.7)	\$8,680 (1721.2)
<b>Stock ownership</b>			
Young families whose parents owned stock (N=397)	43.79%	\$12,210 (1826.9)	\$27,883 (3829.5)
Young families whose parents did not own stock (N=1392)	24.07%	\$7,792 (1257.1)	\$32,365 (5599.8)

Table 2. Asset Ownership among Young Adult Families, 1994—by Race<sup>1</sup>

<i>Asset</i>	<i>Proportion holding accounts</i>	<i>Average balances held</i>	<i>Average balances conditional upon holding</i>
<b>Bank account ownership</b>			
African-American Households (N=651)	34.78%	\$2,648 (448.9)	\$7,612 (1166.4)
Other Households (N=1138)	83.46%	\$9,296 (642.1)	\$11,138 (751.0)
<b>Stock ownership</b>			
African-American Households (N=651)	10.55%	\$1,733 (297.6)	\$16,424 (2,291.5)
Other Households (N=1138)	33.98%	\$10,538 (1400.9)	\$31,014 (3927.9)

Table 3. Race Differences in Parental Asset Ownership among Young Adult Families, 1994  
--Percentage of Families Whose Parents Held Bank Accounts or Stock Balances

<i>Asset</i>	<i>Yes</i>	<i>No</i>
<b>Parental account ownership</b>		
African-American Households	42.7	57.3
Other Households	86.5	13.5
<b>Parental stock ownership</b>		
African-American Households	16.2	83.8
Other Households	35.5	64.5

<sup>23</sup> Means and percentage holdings for Tables 1-3 are weighted using 1994 PSID weights. All dollar values are in 1996 dollars.

#### IV. Empirical Ownership Patterns Across Generations

##### A. Cross-generational asset-ownership

Probit regression analysis is used to explore the relationship between asset-ownership and parental asset-ownership in the presence of other variables that affect the decision to hold a bank account and stock. The decision to hold a specific financial asset is taken to be dependent upon a variety of economic and socio-demographic variables, including those gauging the availability of resources and variables related to tastes, along with parental asset-ownership. The hypothesized relationship between these exogenous variables and financial asset ownership propensity ( $F_i$ ) is,

$$(10) F_i = f(\text{age}, \text{age}^2, \text{income}, \text{education}, \text{number of children}, \text{marital status}, \text{gender}, \text{race}, \text{parental ownership})$$

Age and age-squared are included in the asset choice equation because of their relevance for saving behavior as stipulated by the life-cycle hypothesis. Income represents resources available to devote to saving (with income measured as average labor income over a five year period in this analysis). The number of children in the family is included as a family size measure that further strengthens our ability to measure available resources. Marital status is included as a socio-demographic “taste” variable because of empirical evidence elsewhere indicating that marriage has a positive effect on asset accumulation. Race and gender are added because these variables have been found to be empirically connected to asset accumulation, presumably either because of discrimination or cultural factors shaping preferences. Education (years of formal schooling) is hypothesized to be another variable that influences asset accumulation because it represents a human capital measure and due to the expectation that greater education may correspond to more information about financial services generally, and possibly about the family’s investment options more specifically.<sup>24</sup> Each of these six variables is standard in the literature analyzing wealth accumulation (e.g. Menchik and Jianakoplos, 1997; and Blau and Graham, 1991).<sup>25</sup>

$$(11) y^* = \alpha_0 + \alpha_1 \text{Age} + \alpha_2 \text{Age}^2 + \alpha_3 G + \alpha_4 M + \alpha_5 I + \alpha_6 E + \alpha_7 R + \alpha_8 P + \alpha_9 B + \varepsilon,$$

We estimate a variant of (10) for each asset using probit regressions. The reduced form equation is,

where  $y=1$  if  $y^* > 0$ ;  $y=0$  otherwise; and  $y$  denotes observed values of the dependent variable while  $y^*$  represents an unobservable, which determines whether the asset in question is obtained (in which case we observe  $y=1$ ) or whether it is foregone (in which case we observe  $y=0$ ). Age represents the age of the household head, G represents gender, M represents marital status, I represents income, E represents education, R represents race, P represents parental ownership of the asset under investigation. B represents bequests, and it is added to limit the possibility that asset-ownership by parents and their young adult children are connected by the simple effect of receiving assets from one’s parents. Our interest is to disentangle this direct effect from that of transferring asset specific knowledge.

##### B. Ownership Equations

Marginal effects, which depict the effects of a one unit change in any of the explanatory variables on the probability of asset ownership, for the probit models are reported in Tables 4 and 5. Because the main hypothesis being tested is whether the effect of parental asset-ownership on a young family’s decision to hold financial assets remains net of income and other relevant factors, the coefficient on the parental asset-ownership term is of foremost interest. Attention also is given to the effect that the inclusion of the exposure variables has on the race effect

---

<sup>24</sup>Presumably this would reflect a greater awareness of available saving devices and money management strategies more generally. It also might be attributable to a greater likelihood of having financiers in one’s networks (among one’s circle of friends or colleagues, for example).

<sup>25</sup>Later in this section, we present the results from a specification that also includes wealth as a regressor, and the results of additional tests which we conducted to check the robustness of our results.

typically found in the empirical literature on wealth inequality. Importantly, we attempt to discern whether there are variables that interact with parental asset ownership, in order to determine factors that may offset a lack of learning about specific assets within the home.

As shown in Column 1 of Table 4, for bank account ownership the standard result that income, education, age, marital status, and the number of children in the household each affect the probability of asset-ownership is confirmed, with all signs in the expected direction. The results also indicate that African-American households are much less likely to own an account even when variables reflecting economic fundamentals, such as income and education, are controlled for. Column 2 (model II) indicates that having parents who owned a bank account also affects the likelihood of owning a bank account. The inclusion of this variable reduces the effect that race has on the probability of owning this financial asset only modestly, however. Parental account ownership raises the probability of owning a bank account by about 6 percent on average, and the effect of race declines by about 3 percent when the parental account ownership variable is included.

Parallel results hold for stock ownership. Table 5 reports these results. Families with higher income, more education, a spouse, and fewer children are more likely to own stocks. This can be seen in model I of Column 1, which reports the results from the standard probit regression. The regressions also indicate that parental stock ownership affects the likelihood of owning stock: families whose parents own stock are more likely to be stock owners themselves even when the influences of other economic and demographic variables is taken into account. In fact, parental stock ownership raises the probability of owning an account by almost 10 percent (Column II, Model II). As was the case in the bank account ownership model, adding the parental ownership variable only slightly reduces the effect of race. This can be seen by comparing the estimated marginal effects in models I and II.

These family background results offer a mixed message. The race effects decline after the inclusion of the parental asset-ownership measures. This suggests that a portion of the race effect found elsewhere in the literature may actually represent the effect of a lack of exposure to financial assets, although the importance of parental asset-ownership for explaining observed race differences does not appear to be very large. Nonetheless, our general finding that parental asset-ownership affects adult children's probability of asset-ownership suggests that parents' inability to expose children to financial assets has important consequences for future generations. Parents who have not been able to introduce their children to assets may have children who are "disadvantaged" compared to others when it comes to participation in specific asset markets. As set out in our theoretical approach this "trait," lack of ownership for a share of the population, can persist across the generations.

The generational "trait" approach does not address differences arising from exogenous shifts in knowledge from other sources. This appears to matter. The inclusion of interaction terms indicates that educational attainment can offset the importance of parental asset-ownership in the case of stock ownership.<sup>26</sup> Column 3 of Table 5 (model III) reveals that the education interaction term has a negative sign, implying that rising educational opportunities can attenuate the influence of limited financial learning in a young adult's family of origin.<sup>27</sup>

Having established that the parental ownership effect initially found in simple correlations persists even after controlling for economic and socio-demographic variables that affect asset-ownership, and that the effect is numerically interesting, we examine the effects at the median. The nonlinearity of the probit model implies that the effects of any regressor are not constant across all levels of the independent variables. While it is standard to report

---

<sup>26</sup>The results for models including income interaction terms were not as promising from a policy standpoint. In both the stock ownership models and the bank account ownership regressions, the average labor income-parental stock ownership interaction term had the expected negative sign; however, it was not statistically significant in either case. (These results are not reported, but are available from the authors.)

<sup>27</sup>Results for each of these models with additional controls added for parental wealth, parent's education, and parental income are available from the authors upon request. For stock ownership, our results were completely robust to the inclusion of these additional regressors; parental stock ownership remains statistically significant as do race and the education interaction term. Furthermore, a Wald test fails to reject the null hypothesis when testing for the joint significance of the three variables. An additional restriction of the sample to families 40 years of age and under finds parental stock ownership still critical for determining the probability of stock ownership among young families, with the size of the marginal effect remaining in the 10% range that was found in the models for the full sample. For bank accounts, whether the statistical significance of the parental account ownership term is retained depends upon whether the outliers of the wealth distribution are excluded from the regressions (significance remains when they are not dropped).



effects of the independent variable evaluated at the mean, as was done earlier, we compute median effects as well, as a check on robustness of our result. Table 5 contains these results.<sup>28</sup>

The size of the marginal effects for parental asset ownership assessed at the median values of the explanatory variables are similar to those computed at the mean. For bank accounts the difference between the marginal effect of parental account ownership at the mean compared to the median is a 6 percent increase in the probability of account ownership compared to a 4 percent increase. For stock ownership, the effects of parental asset ownership are even closer -- 9.7 percent compared to 10.3 percent as the increase in the probability of stock ownership that is associated with having parents who owned stock. For the model with the education interaction term (model III in Table 5), the effects for race, parental stock ownership, and the interaction between education and parents' stock-holding are nearly indistinguishable when comparing the results for regressions at the mean and regressions evaluating the marginal effects at the median.

### C. Two-stage estimation results -- stock ownership and wealth

How robust are the results to endogenizing wealth? To study this we embed the stock ownership equation in a simultaneous equation model. The logic of including wealth as a regressor in the stock equation hinges primarily on the notion that stock market participation may be constrained by minimum investment requirements.<sup>29</sup> Additionally, adding wealth as a regressor can be viewed as an exploration into the possibility that there are costs of diversifying the portfolio at low levels of wealth, potentially related to concerns about the additional risks that equities may pose. Suppose it is true that there are significant barriers to stock market entry that are tied to a family's overall wealth position. Then a regression for stock ownership that does not include a measure of the overall volume of savings that an individual has available to invest or allocate across different assets would be misspecified. If stock ownership is dependent upon the amount of savings that an individual has to work with, the earlier regressions will have omitted an important determinant of stock ownership by not including wealth, leading to inconsistent parameter estimates.

Correcting for this problem turns out not to be a simple process because of the endogeneity of wealth. This is additionally compounded by the rapid growth in the stock market value witnessed in recent years. That wealth levels are strongly influenced by stock ownership necessitates a system of simultaneous equations. Because the relevant simultaneous system of equations (shown below) includes an equation for a discrete variable, a variant of the Nelson-Olson estimator is used to estimate the model (Amemiya, 1979; and Maddala, 1997).

Our simultaneous system begins with the following theoretical relationships:

(12)  $S = S(\text{wealth, gender, marital status, income, education, race, parental stock ownership, bequests})$

(13)  $W = W(\text{stock ownership, age, age}^2, \text{ number of children, gender, marital status, income, education, race}),$

where  $S$  represents stock ownership (a dichotomous measure) and  $W$  represents wealth levels. To identify the stock equation, age, age-squared, and number of children are dropped in this regression analysis. The inclusion of gender, marital status, income, education and race in the equation for stock ownership follows the logic laid out in the earlier discussion of regressors.

$$(14) \quad S = \alpha_0 + \alpha_8 W + \alpha_1 G + \alpha_2 M + \alpha_3 I + \alpha_4 E + \alpha_5 R + \alpha_6 P + \alpha_7 B + \epsilon_s$$

Rewriting (12) and (13), the structural equations are,

---

<sup>28</sup> Results from regressions at the 25th percentile and the 75th percentile are available from the authors upon request.

<sup>29</sup> See Blau and Graham (1991:325) for example. We do not explore the issue of minimum investment requirements with bank accounts because we find the theoretical case for including wealth there to be unconvincing: the transactions services that bank accounts provide renders an argument that they are an "elite" asset unconvincing and legislative initiatives have been implemented in recent years to make low cost accounts available.

$$(15) \quad W = \beta_0 + \beta_9 S + \beta_1 A + \beta_2 A^2 + \beta_3 G + \beta_4 C + \beta_5 M + \beta_6 I + \beta_7 E + \beta_8 R + \varepsilon_w$$

In the Nelson-Olson two-stage estimation framework, reduced forms are first estimated for each of the dependent variables. These reduced form equations are then used to obtain predicted values for the dependent variables, and each predicted value is substituted into the structural equation for the other dependent variable.<sup>30</sup> In reporting our results, we present both the usual standard error estimates, and the standard errors from the corrected variance-covariance matrix based on Maddala (1997).

Wealth is generally not statistically significant in determining stock ownership. (See table 7.) More precisely, when we run the basic model (minus age terms and number of children), and models with an education or an income interaction term, no evidence is found to support the hypothesis that stock ownership is contingent upon being wealthy, and parental stock-ownership continues to have an effect.<sup>31</sup>

### C. *The relationship between stock balances and parental stock ownership*

As a final step and as an additional analysis of parental asset ownership and stock market participation by their children, we examine levels of stock holdings to determine whether parental stock ownership has an effect on the balances held by young adult families. The reduced form equation estimated is,

$$(16) \quad S^B = \lambda_0 + \lambda_1 A + \lambda_2 A^2 + \lambda_3 G + \lambda_4 M + \lambda_5 I + \lambda_6 E + \lambda_7 R + \lambda_8 P + \lambda_9 B + \varepsilon_{SB}$$

where  $S^B$  denotes stock balances, and other terms are as defined earlier.

The results from this single equation stock balances equation estimated using a tobit regression are presented in Table 8. The table offers no evidence to suggest that parental stock ownership affects the *size* of families' stock holdings. The theoretical analysis laid out in section I establishes a relationship between the asset-specific information that different generations have, which should have a threshold effect on entering certain asset markets. It does not suggest that childhood informational exposure should influence the value of the portfolio.

### D. *Potential measurement error issues due to the nature of the PSID data*

The intergenerational model presented in section II suggests that the family financial background of both the husband and wife (in terms of exposure to specific assets by parents) influences the probability that a young family will go on to hold a specific asset such as stocks. This means the theoretical model calls for two parental exposure measures. Despite its attractiveness as the only nationally representative longitudinal dataset that contains financial information on parents, the PSID allows us to measure only one set of parents' asset ownership. Absence of information on backgrounds for both sides of a marriage limits the ability to model alternative bargaining or influence models as they lead to family portfolio choice. This can also be thought of as giving rise to omitted variable or errors-in-variables bias in an empirical implementation of such models. As an errors-in-variable problem, for example, under less than perfect assortative mating, the inability to obtain information for both spouses can be thought of as a potential cause of measurement error, which would lead to attenuation bias (making the estimated effect of parental asset-ownership smaller than the true effect). The extent to which such measurement error is present in practice depends on the degree of assortative mating that exists in the general population. If there is perfect assortative mating ( $\gamma=1$  in the theoretical model of section II), individuals always marry someone similar, meaning that our measure of parental account ownership will capture the background exposure experience of the young adult family perfectly. This is because despite the fact that we only can obtain such background information

---

<sup>30</sup>A critical issue that emerges for estimation purposes is how to estimate the wealth equation so as to be able to obtain predicted values that can be plugged into the structural form of the stock equation, which is then estimated by maximum likelihood. Because the Nelson-Olson estimation procedure requires that we estimate a reduced form equation for wealth in the first stage, the answer to this question is inextricably tied to the choice of a wealth measure. The wealth measures that we employ are continuous, uncensored, variables therefore ordinary least squares is used.

<sup>31</sup>This is true even with the inclusion of parental education, income, and wealth as additional controls, and with minor changes to the specification.

for one spouse in the PSID, perfect assortative mating will assure that what we observe for one spouse is true of the other (whose parental ownership status we cannot observe directly).

When mating is less than perfectly assortative, however, the observed values of unity for parental asset ownership actually may correspond to a range of family types:  $T_1 - T_3$  (with associated probabilities  $p_1 - p_3$ ). An observed value of zero for parental asset ownership actually may indicate any one of three different family types: the case in which neither spouse had exposure ( $T_4$  with associated probability  $p_4$ ), or the two intermediate cases in which either the head or spouse had parents who owned assets but were non-PSID sample members. In this case no information on them is available--their asset ownership does not get captured by PSID data.

Educational correlations between spouses and similarities in terms of other attributes suggests a tendency for individuals to marry those who are similar. For example, Kremer (1997) presents correlation estimates of 0.620 for spousal education. More generally, several studies in sociology indicate that people choose partners who are similar to them in terms of other characteristics, such as religion and educational attainment (Mare, 1991, for example). If these serve as a guide as to the correlation between spouses on

asset ownership background, measurement error may not be too problematic in our case. Ideally, this discussion of potential measurement error problems will spur future efforts to collect financial background data on both sides of the family tree, so that the suspicion that one does not miss much by only including one set of parents' asset-ownership information can be tested.

## V. Conclusion

Several economic studies have focused on intergenerational links when examining outcomes such as the propensity to be violent, educational levels, and earnings. Our analysis reveals that there are intergenerational correlations in asset-ownership too, and it suggests that exposure to assets by parents may be an important source of information about individual assets. Allowing for the possibility that some learning about assets occurs within the home creates a link between asset-ownership rates from one generation and the next, and it makes the overall ownership rate in the economy dependent upon the balance of family backgrounds in the general population. In our empirical research we find evidence to suggest the presence of an effect of parental asset-ownership on the decisions made by children during adulthood.

This parental learning effect is not a mere transfer of assets effect (and thus the empirical evidence supports the contention that the parental ownership effect is distinct from the intergenerational transfer of financial capital). Neither does parental asset ownership appear to be picking up other potential sources of parent-child correlation, such as correlations in affluence or parents and children both being highly educated. Instead, the cross-generational effect that we find appears to capture something more fundamental about the environment that children were raised in--plausibly, the information made available to them about specific assets. This parent-based effect is robust to the inclusion of wealth as a regressor and to other changes in the specification of the model. Consistent with a knowledge transmission model, we do not find an effect of parental asset-ownership for value of stock, conditional on holding. The key effect of parents' asset-holding appears to be in increasing children's awareness of specific assets, not in influencing the volume of holdings.

A policy implication emerging from our findings is that a lack of parental stock ownership is partially offset by increased education. This suggests that increased educational levels may help eliminate some of the current differences that are observed in stock market participation rates across different sub-groups of the U.S. population. From an empirical standpoint, this highlights a difference between the standard, intergenerational transfer of financial capital model (or bequest model), and our intergenerational transfer of knowledge analysis. The first model would lead one to expect a positive relationship between education and the intergenerational transmission term, as bigger bequests would allow for greater human capital acquisition by recipients. Our results also suggest a role for public information. Bank accounts, being traditionally held by a wider set of families, are found to be less likely to have ownership depend on either parental holdings or one's own education. This suggests three competing informational sources: parents, own private knowledge, and publicly available knowledge.

Our theoretical analysis also suggests that ideally one needs parental ownership measures on both sides of the family tree and information about intrafamily bargaining to examine the intergenerational links thoroughly, unless assortative mating is sufficiently prominent. The degree to which couples match up based on asset-ownership background is an empirical question, and future research would benefit greatly from access to financial data covering both sets of parents. This could support research on intrafamily bargaining over asset allocation in conjunction with differential background knowledge of each side of the family. At present, we are aware of no dataset which contains such information; we therefore settle for results that may be subject to attenuation bias,

implying the effects that we find can be viewed as possibly providing only a lower bound on the size of the true effect of parental asset-ownership. The strong initial evidence of an intergenerational effect upon asset-ownership that is provided here for stocks and bank accounts begs the question of whether similar effects are present for other assets. Future research should investigate the relevance of knowledge for home ownership across generations, since home owning represents an important share of African-American wealth. As another type of financial behavior likely to depend on learning from parents, is there a connection between pensions and job choice of parents and their children?

Table 4. Probit Regressions Predicting Bank Account Ownership, 1994

<i>Variable</i>	<i>Standard probit regression:</i>		<i>Marginal effects</i>
	<i>Marginal effects</i>		<i>at the median</i>
	Model I	Model II	Model II
Age of head	0.050 (1.97)	0.046 (1.83)	0.032 (1.83)
Age squared	-0.001 (-2.11)	-7.09 x 10 <sup>-4</sup> (-1.96)	-4.86 x 10 <sup>-4</sup> (-1.96)
Average labor income	0.046 (6.23)	0.044 (5.97)	0.030 (5.97)
Education	0.030 (4.51)	0.027 (4.04)	0.019 (4.04)
Number of children	-0.041 (-3.58)	-0.039 (-3.28)	-0.267 (-3.28)
Male head	-0.060 (-1.61)	-0.060 (-1.60)	-0.038 (-1.60)
Marital status	0.148 (4.14)	0.144 (4.14)	0.134 (4.14)
African-American head	-0.331 (-7.36)	-0.300 (-6.85)	-0.262 (-6.85)
Parental account ownership		0.061 (1.65)	0.045 (1.65)
Bequest		0.102 (1.49)	0.063 (1.49)
Pseudo R-square	.260	.265	.265
Chi-square value	n.a.	299.00 (p = 0.00)	299.00 (p=0.00)
Mean of dependent variable	.7603	.7603	
Predicted probability		.8240	
Number of observations	1700	1700	1700

Notes: (1) All regressions include a constant. (2) Marginal effects refer to the change in the probability of ownership from a one unit change in the independent variable. (Test-statistic is in parenthesis.) (3) Regressions with the parental account ownership term are estimated using Stata's clustering procedure; the chi-square test is the most appropriate test of the power of the regression for these models (p value indicated in parenthesis). (4) Predicted probabilities reported are those computed at the regression's mean. (5) Average labor income is the 5 year (pre-tax) average between 1987 and 1991, measured in \$10,000 denominations. (6) Estimation is based on a weighted sample (using the 1994 PSID weights) and includes households with 1994 wealth between -\$100,000 and \$4,000,000 only.

Table 5. Probit Regressions Predicting Stock ownership, 1994

<i>Variable</i>	<i>Standard probit regression</i>			<i>Marginal effects at the median</i>	
	<i>Marginal effects</i>			<i>Model II</i>	<i>Model III</i>
	<i>Model I</i>	<i>Model II</i>	<i>Model III</i>		
Age of head	0.048 (1.57)	0.041 (1.42)	0.0378 (1.33)	0.041 (1.42)	0.038 (1.33)
Age squared	-0.001 (-1.55)	-5.80 x 10 <sup>-4</sup> (-1.42)	-5.35 x 10 <sup>-4</sup> (-1.33)	-5.89 x 10 <sup>-4</sup> (-1.42)	-5.41 x 10 <sup>-4</sup> (-1.33)
Average labor income	0.048 (7.02)	0.045 (6.07)	0.045 (6.01)	0.046 (6.07)	0.045 (6.01)
Education	0.049 (6.42)	0.047 (5.92)	0.058 (6.12)	0.048 (5.92)	0.057 (6.12)
Number of children	-0.024 (-1.82)	-0.021 (-1.60)	-0.020 (-1.52)	-0.022 (-1.60)	-0.021 (-1.52)
Male head	0.026 (0.48)	0.023 (0.42)	0.026 (0.48)	0.023 (0.42)	0.026 (0.48)
Marital status	0.089 (2.11)	0.091 (2.09)	0.090 (2.07)	0.085 (2.09)	0.083 (2.07)
African-American head	-0.103 (-1.96)	-0.090 (-1.86)	-0.087 (-1.81)	-0.089 (-1.86)	-0.085 (-1.81)
Parental stock ownership		0.097 (2.85)	0.542 (2.24)	0.103 (2.85)	0.533 (2.24)
Bequest		0.091 (1.44)	0.091 (1.47)	0.092 (1.44)	0.092 (1.47)
Education*parental stock			-0.028 (-1.80)		-0.028 (-1.80)
Pseudo R-square	.177	.186	.189	.186	.189
Chi-Square statistic*	n.a.	208.99	215.86	208.99	215.86
Mean of dependent variable	.3049	.3049	.3049		
Predicted probability		.2665	.2630		
Number of observations	1700	1700	1700	1700	1700

Notes: (1) All regressions include a constant. (2) Marginal effects refer to the change in the probability of ownership from a one unit change in the independent variable. (Test statistic in parenthesis.) (3) Average labor income is the 5 year (pre-tax) average between 1987 and 1991, measured in 10,000 denominations. (4) Estimation is based on a weighted sample (using the PSID 1994 weights) and includes households with 1994 wealth between -\$100,000 and \$4,000,000 only. (5) All Chi-square statistics produce a p value equal to 0.00. (6) We also ran separate models by race. For white families, marital status, education, income, parental ownership, and bequests were statistically significant; while for black families, the age terms, education, income and bequests were found to be statistically significant, but parental ownership was not. While results from a Chow test suggest the two models are distinct, due to the small sample size in conjunction with the small stock ownership rates for black families and the measurement error issues, these results cannot be taken as being definitive. Splitting the sample by race produces about 600 families for the regression for black households, but only 66 of these households hold stock.

Table 6. Characteristics of families at the different quartiles, 1994

VARIABLE	25TH PERCENTILE	MEDIAN	75TH PERCENTILE
Age of head	29	32	37
Number of children	0	1	2
Race	White	White	White
Gender of head	Male	Male	Male
Marital status	Unmarried	Married	Married
Education	High school degree	13 years of schooling	College educated
Average labor income	\$20,000	\$34,000	\$52,000
Bequest	None	None	None

Table 7. Probability of Stock Ownership, 1994: Two-Stage Estimates

<i>Variable</i>	<i>Model II</i>			<i>Model III</i>				
	<i>Marginal effect</i>	<i>Test-statistic</i>	<i>Standard error</i>	<i>Amemiya corrected standard error</i>	<i>Marginal effect</i>	<i>Test-statistic</i>	<i>Standard error</i>	<i>Amemiya corrected standard error</i>
Predicted wealth	-0.003	-0.411	0.006	0.019	-0.002	-0.353	0.006	0.019
African American	-0.098	-2.038	0.045	0.158	-0.095	-1.983	0.045	0.158
Male head	0.037	0.650	0.055	0.174	0.038	0.683	0.055	0.175
Marital status	0.075	1.73	0.042	0.131	0.074	1.726	0.042	0.132
Education	0.050	6.250	0.008	0.024	0.060	6.210	0.010	0.030
Average labor income	0.048	3.182	0.013	0.038	0.047	3.744	0.013	0.038
Parental stock ownership	0.105	3.072	0.035	0.101	0.490	2.093	0.220	0.677
Bequest	0.121	1.633	0.078	0.207	0.119	1.650	0.077	0.204
Education*parental stock ownership					-0.026	-1.628	0.016	0.050
N=1694								
Chi-square	206.80				212.62			
Associated p-value	0.00				0.00			

Notes: (1) All regressions include a constant, use the 1994 PSID weights, and include households with 1994 wealth between -\$100,000 and \$4,000,000. (2) The inclusion of additional controls for parental wealth, parents' income, and parental education does not substantially alter the results; parental stock ownership remains statistically significant, and the size of its estimated marginal effect remains similar.

Table 8. Regression Explaining Stock Balances (in \$10,000)--Tobit Regression Results

<i>Variable</i>	Basic model w/ Race	+ Parental account ownership	+Education interaction term
	<i>Coefficient</i>	<i>Coefficient</i>	<i>Coefficient</i>
Age of head	1.304 (0.725)	1.203 (0.683)	1.143 (0.673)
Age squared	-0.017 (0.010)	-0.016 (0.010)	-0.015 (0.010)
Number of children	-0.514 (0.293)	-0.410 (0.286)	-0.383 (0.291)
African American	-2.877 (1.492)	-2.641 (1.363)	-2.567 (1.341)
Male head of household	1.406 (1.220)	1.480 (1.275)	1.517 (1.289)
Marital Status	1.580 (1.049)	1.400 (1.010)	1.380 (1.008)
Education	1.073 (0.274)	1.052 (0.282)	1.313 (0.377)
Average labor income	0.961 (0.181)	0.905 (0.170)	0.901 (0.170)
Parental stock ownership		1.038 (0.665)	9.710 (4.941)
Bequest		3.611 (2.589)	3.654 (2.600)
Education*parental stock ownership			-0.618 (0.359)
Sigma	8.48	8.43	8.43
N=1694			
Chi-square (Wald test)	36.71	52.11	52.19
(associated probability value)	0.000	0.00	0.00

Notes: (1) Tobit regressions of stock holdings in 1994 (in \$10,000). (2) All regressions include a constant and use the 1994 PSID weights. (3) Standard errors in parentheses. (4) Average labor income is the 5 year (pre-tax) average of labor income between 1987 and 1991, and is measured in \$10,000.. (5) Estimation includes households with 1994 wealth between -\$100,000 and \$4,000,000. (6) The addition of additional controls for parental wealth, parental income and parental education does not substantially alter the results.



Table A-1. Selected Characteristics of the Households in Our Sample, 1994

<i>Variable</i>	<i>Mean or Proportion</i>
<b>Socio-economic and Demographic</b>	
Age	33.00 (0.126)
Age squared	1118 (8.753)
Average number of children in home	1.044 (0.028)
Education	13.3 (0.053)
Permanent income	\$39,597 (836.97)
Percent African-American	14.8%
Percent male	77.1%
Percent married	51.6%
<b>Wealth attributes</b>	
Bank account balances	\$8,311 (486.9)
Percent owning bank accounts	76.2
Account balances conditional on holding	\$10,900 (660.7)
Stock holdings	\$9,233 (1,035.4)
Percent owning stock	30.5
Stock balances conditional on holding	\$30,267 (3,569.7)
Financial assets	\$27,351 (1,763.4)
Total wealth holdings	\$89,696 (9,649)
<b>Family background—Parental asset ownership</b>	
Percent whose parents owned bank accounts	80.0
Percent whose parents owned stock	32.6

Notes: Standard errors in parentheses. All data are weighted using the 1994 PSID weights. All dollar figures are in 1996 dollars

**Graphs Appendix**  
7/12/2000

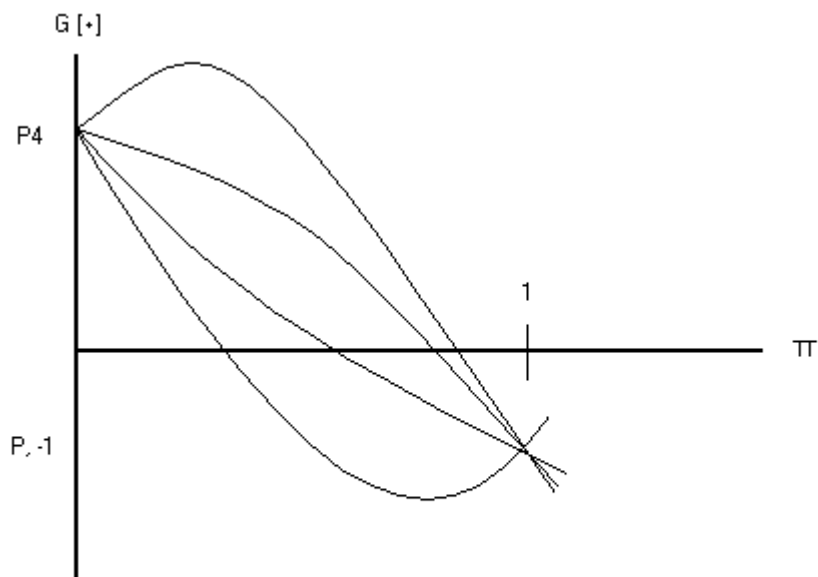


Figure 1. Possible shapes of the G-function  
(Assortative or Random mating)

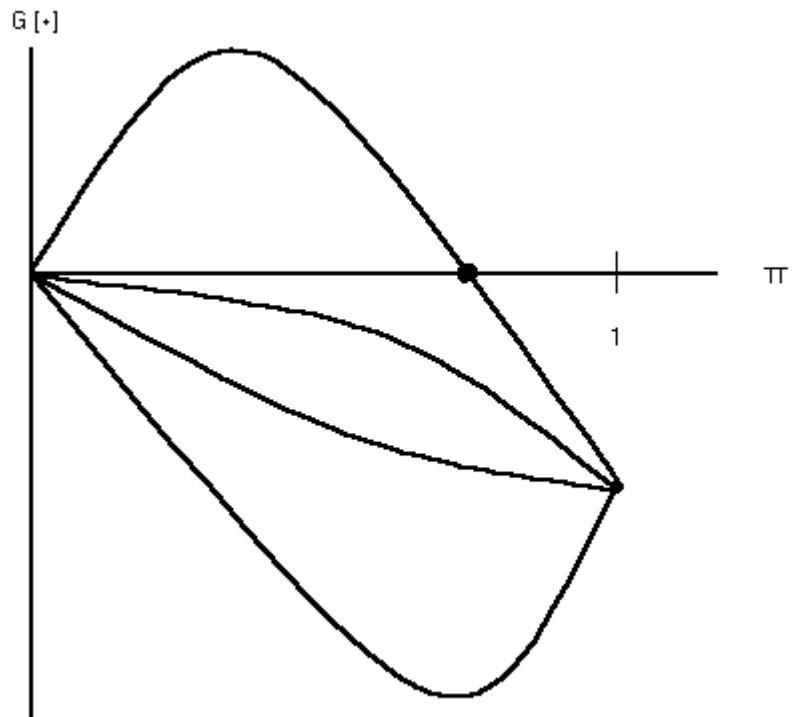


Figure 2. Determination of steady-state equilibrium  
 Possible shapes for G-function under the special case of  $p_4=0$   
 Assortative mating

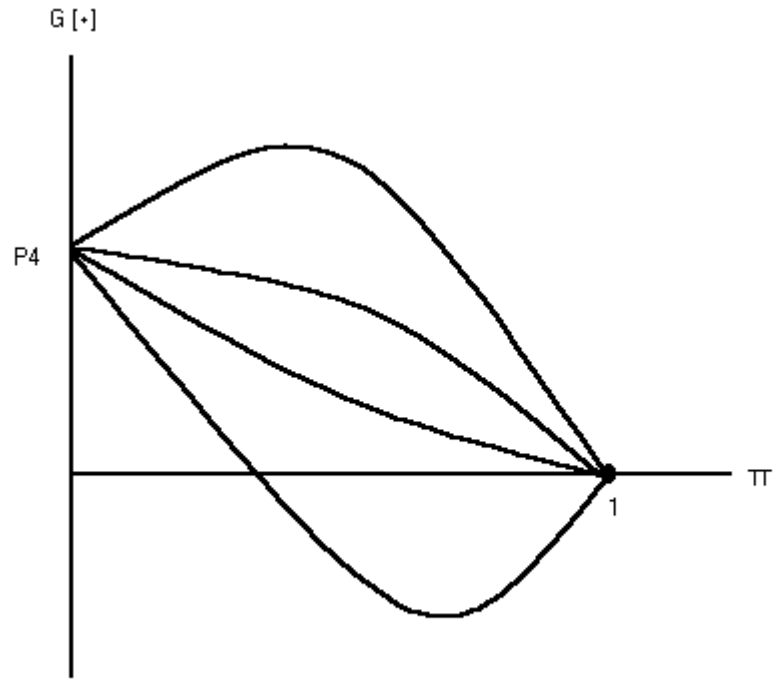


Figure 3. Determination of steady-state equilibrium  
 Possibilities for shape of G-function under special case of  $p1=1$   
 Assortative mating

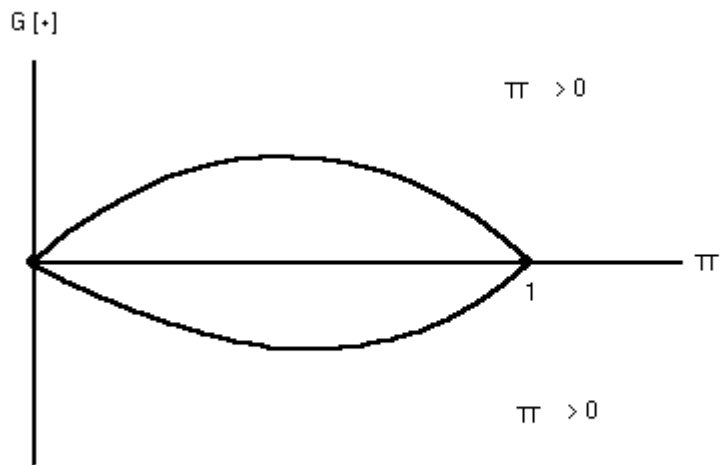


Figure 4. Determination of steady-state equilibrium  
 Possible shapes of the G-function under special case of  $p_4=0$  and  $p_1=1$   
 Assortative mating

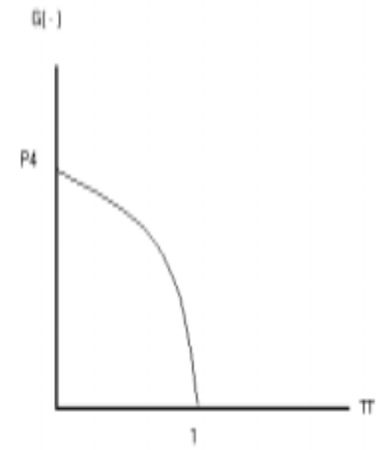
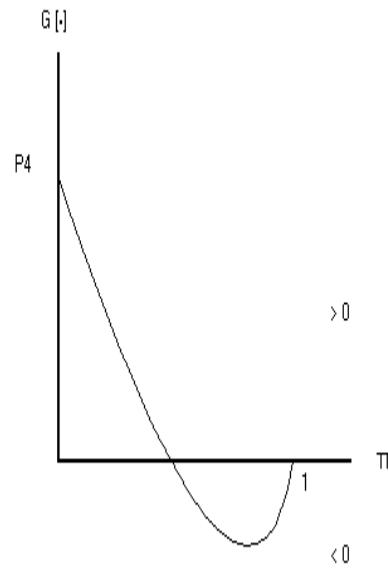
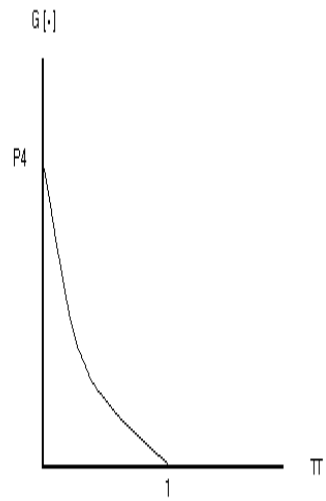


Figure 5. Determination of steady-state equilibrium  
Possible shapes of the G-function for special case of  $p_1=1$   
Under Random mating

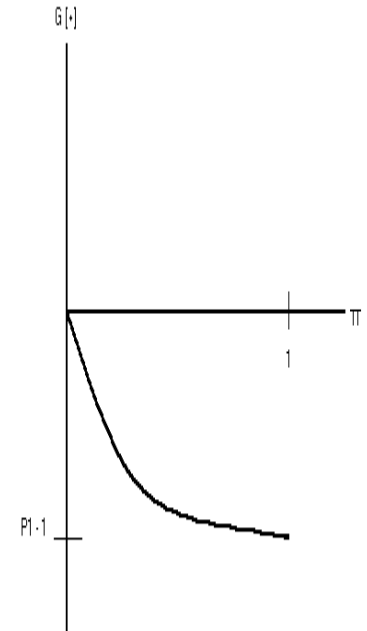
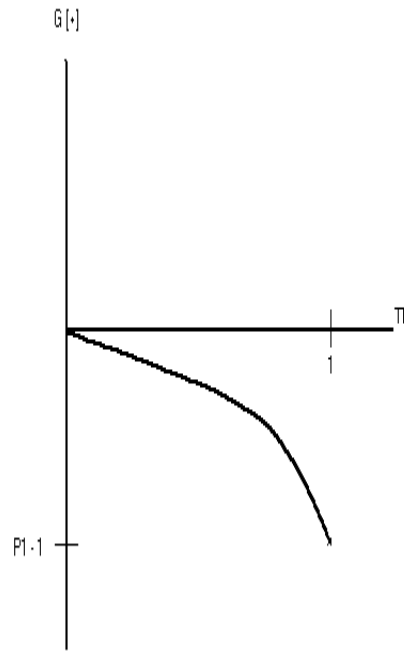
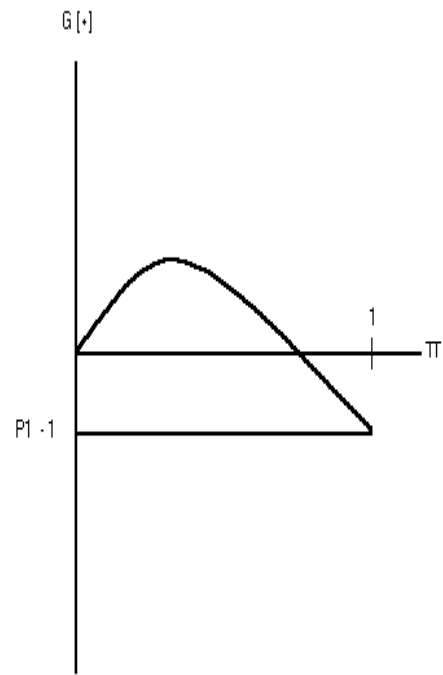


Figure 6. Determination of steady-state equilibrium  
Possible shapes of the G-function for the special case of  $p_4=0$   
Under Random mating

## Mathematical Appendices

### Appendix—A1 The $\pi_{t+1}$ function (For Assortative Mating Model)

#### Derivation of $\pi_{t+1}$ equation

We begin with the following expression, derived from substituting the probabilities of each marriage type into equation (1):

$$(A.1) \quad \pi_{t+1} = p_1 \gamma \pi_t + p_4 \gamma (1 - \pi_t) + (1 - \gamma) [p_1 \pi_t^2 + p_2 \pi_t (1 - \pi_t) + p_3 (1 - \pi_t) \pi_t + p_4 (1 - \pi_t)^2].$$

The first two terms reflect marriages originating in the pure market. The third expression, pre-multiplied by  $(1-\gamma)$ , represents marriages coming out of the mixed marriage market.

Combining like terms in order to represent the above as a quadratic equation,

$$(A.2) \quad \pi_{t+1} = (1 - \gamma) [(p_1 + p_4) - (p_2 + p_3)] \pi_t^2 + [\gamma (p_1 - p_4) + (1 - \gamma) (p_2 + p_3 - 2 p_4)] \pi_t + (1 - \gamma) p_4 + \gamma p_4$$

$$= (1 - \gamma) [(p_1 + p_4) - (p_2 + p_3)] \pi_t^2 + \gamma [(p_1 + p_4) - (p_2 + p_3)] \pi_t + [p_2 + p_3 - 2 p_4] \pi_t + p_4$$

Noting that  $\pi_{t+1} = p_4$  when  $\pi_t = 0$ , and  $\pi_{t+1} = p_1$  when  $\pi_t = 1$ , we are able to identify the endpoints of a graph of the above equation on the domain  $\pi = [0,1]$ . Because  $p_1 > p_4$ , the graph is necessarily upward sloping. However, because one cannot immediately sign the coefficient on the quadratic term, the graph of the  $\pi_{t+1}$  equation may be concave or convex on our domain.

Taking derivatives,

$$(A.3) \quad \pi'_{t+1} = 2(1 - \gamma) [(p_1 + p_4) - (p_2 + p_3)] \pi + \gamma [(p_1 + p_4) - (p_2 + p_3)] + (p_2 + p_3 - 2 p_4)$$

and

$$\pi''_{t+1} = 2(1 - \gamma) [(p_1 + p_4) - (p_2 + p_3)]$$



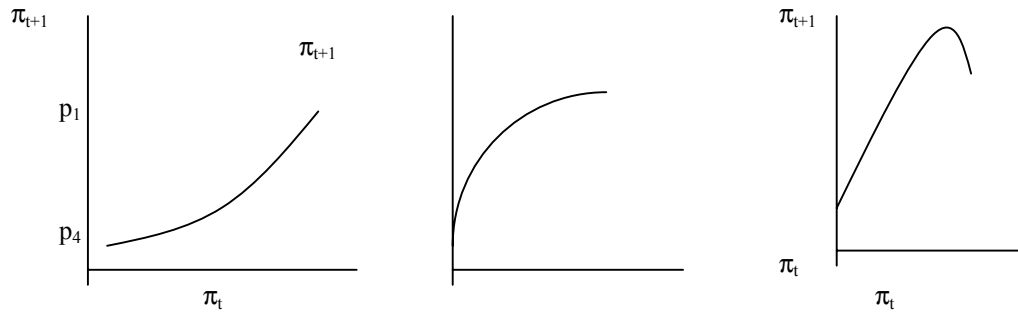
Defining  $A = [(p_1 + p_4) - (p_2 + p_3)]$ , and  $(p_2 + p_3 - 2p_4)$  as “C,” it is apparent that  $\pi'_{t+1}$  is positive if  $A > 0$ .<sup>32</sup> If  $A < 0$ , the first derivative cannot be signed without additional information about parameter values. The second derivative always takes the sign of  $A$ .

The  $\pi_{t+1}$  function obtains a max (or min) at,

$$\pi^* = \frac{[2p_4 - (p_2 + p_3)] + \gamma[(p_2 + p_3) - (p_1 + p_4)]}{2(1 - \gamma)[(p_1 + p_4) - (p_2 + p_3)]} \quad (\text{A.4})$$

$$= \frac{-[\gamma A + C]}{2(1 - \gamma)A}$$

which is clearly negative if  $A > 0$ , placing the minimum to the left of the endpoints  $(0, p_4)$  and  $(1, p_1)$  in the case of a convex function. However, if  $A < 0$ , the location of the turning point relative to the endpoints is indeterminable without further information on parameter values. We therefore get three possibilities for the shape of the  $\pi_{t+1}$  function. These are illustrated below.



<sup>32</sup> The term  $(p_2 + p_3 - 2p_4) > 0$  always following the assumption that  $p_2 > p_3 > p_4$  laid out earlier in the model.



## Appendix—A2 Steady State and Stability Conditions (For Assortative Mating Model)

### The steady state value of $\pi$

From the equation for  $\pi_{t+1}$ , we obtain an equation that can be used to determine the steady state value,  $\pi^{ss}$ :

$$(A.5) \quad G(\pi) = (1 - \gamma)A\pi^2 + \gamma A\pi + [p_2 + p_3 - 2p_4 - 1]\pi + p_4$$

When  $G(\cdot) = 0$ , the economy is in steady state. The above equation represents a non-linear, first order difference equation. Graphing the equation reveals that there is a unique interior solution for  $\pi^{ss}$  on the permissible domain  $[0,1]$ . Upon inspection it is clear that  $G(\cdot)$  is positive when  $\pi = 0$ , and that  $G(\cdot)$  is negative when  $\pi=1$  (taking on a value of  $p_1-1$ ). It also is evident that  $G(\cdot)$  is twice differentiable, and that  $G'$  is either always rising or always falling (never switching signs):

$$(A.6) \quad G' = 2(1 - \gamma)A\pi + \gamma A + (p_2 + p_3 - 2p_4 - 1)$$

and

$$(A.7) \quad G'' = 2(1 - \gamma)A$$

The first derivative cannot be signed without specific information about individual parameter values. The second derivative is positive for  $A > 0$ , and negative when  $A < 0$ . In conjunction with the intermediate value theorem, these facts about the derivative allow us to determine that  $G(\cdot)$  crosses the horizontal axis only once on our domain. The possible shapes that  $G(\cdot)$  may take on are depicted below.

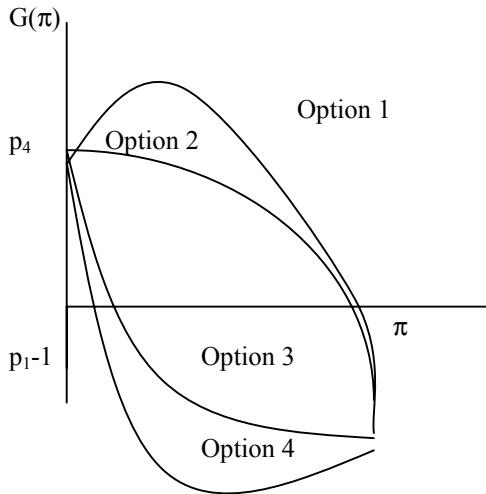


Figure XXX (above) depicts four possible shapes because it is not possible to tell whether  $G'$  has an extremum at a positive or a negative value of  $\pi$  (meaning one cannot tell whether this occurs on the domain). This obtains because

$G' = 0$  when,

$$(A.8) \quad \pi = [(2p_4 + 1) - (p_2 + p_3) - \gamma A] / [2(1 - \gamma)A],$$

and  $\pi|_{G=0}$  cannot be signed without without knowledge about the specific values that gamma and the individual  $p_i$  take on.

### Stability of the long run equilibrium

Following Roughgarden (1979) and Chiang (1984) it is possible to state the conditions under which the economy converges to equilibrium, and the conditions under which the convergence is oscillatory or monotonic. The slope of the G function provides this information.

Recall from equation (A.6) that  $G'$  is given as follows,

$$G' = 2(1 - \gamma)A\pi + \gamma A + C.$$

Applying the quadratic formula to equation (1) and substituting the resulting expression for  $\pi^{ss}$  yields,

$$(A.9) \quad G' = \pm \sqrt{(\gamma A + C)^2 - 4(1 - \gamma)Ap_4}$$

where, once again,  $C \equiv (p_2 + p_3 - 2p_4 - 1)$  and  $A \equiv [(p_1 + p_4) - (p_2 + p_3)]$ . As noted in Roughgarden (1979), the expression for  $G'$  can be used to check the stability of the equilibrium: When  $0 < (\sqrt{\quad})^2 < 4$ , the equilibrium is stable; and, additionally, if  $(\sqrt{\quad})^2 > 1$ , the convergence is oscillatory, while if  $(\sqrt{\quad})^2 < 1$ , the convergence is monotonic.

Alternatively, one can use the following rules laid out in Cavalli-Sforza and Feldman (1981) after taking the general expression for  $\pi^{ss}$  derived from the quadratic formula:

$$(A.10) \quad \pi^{ss} = [-(\gamma A + C) \pm \sqrt{(\gamma A + C)^2 - 4(1 - \gamma)Ap_4}] / [2(1 - \gamma)A]$$

Only one root will present a real number solution that lies between zero and one (the negative of the square root term). The general conditions governing the local stability of the equilibrium are as follows:<sup>33</sup>

1. If  $[p_2 + p_3 - 2p_4] < 1$  then  $\pi^{ss} \geq 0$ , while  $\pi^{ss} \leq 1$  always.
2. If  $[\text{sqr}t(\cdot)]^2 < 4$ , then  $\pi_t$  converges to  $\pi^{ss}$  and the equilibrium is stable.
3. If  $[\text{sqr}t(\cdot)]^2 < 1$ , the convergence is monotonic.
4. If  $1 < [\text{sqr}t(\cdot)]^2 < 4$ , the convergence is oscillatory.
5. If  $[\text{sqr}t(\cdot)]^2 > 4$ , there is no stable equilibrium. Instead, the economy eventually reaches a two-point cycle such that it switches back and forth between two different values.

---

<sup>33</sup>These are as found in Cavalli-Sforza and Feldman (1981), and they can be derived easily using basic insights about the derivative of the original  $\pi_{t+1}$  function, as listed in Chiang (1984) and Roughgarden (1979, pp. 577+) for example. See the appendix for derivations for the first four conditions in the context of our model. Graphically, it is clear that we can establish that  $\pi_{t+1}$  is increasing over the domain  $\pi = [0,1]$ , but it is not possible to tell whether its slope is greater than one or less than one. (Hence, graphs are no help in determining whether the equilibrium necessarily will be stable.)

**Appendix--A3**  
**Speed of Transition to the Steady-State**  
**(For Assortative Mating Model)**

As noted in Roughgarden (1985, pp. 576-577), the recursive equation for  $\pi_{t+1}$  can be used to obtain an expression detailing the fate of solutions that begin close to the steady-state. This can be seen by representing equation (1) as a generic function,  $\pi_{t+1} = f(\pi_t)$ , and then taking a Taylor series expansion of  $f(\cdot)$  about  $\pi^{ss}$ . This exercise produces an expression relating initial deviations from the steady-state to deviations  $t$  periods later. That expression is,

$$(A.11) \quad (\pi_{t+1} - \pi^{ss}) = [\pi'_{t+1}(\pi^{ss})]^t (\pi_0 - \pi^{ss}),$$

where  $\pi'_{t+1}$  is simply the expression for the derivative of equation (1) evaluated at the steady-state solution and  $\pi_0$  represents an initial value of the rate of asset-ownership in the economy. This indicates that given an initial value of the rate of asset ownership in the population, one can compute the deviation from the steady state, and then obtain an estimate for the length of time it takes the economy to reach the steady-state (i.e.,  $t$  such that  $[\pi'_{t+1}(\cdot)]^t = 0$  so that equilibrium obtains).

More specifically, one can arrive at (A.11) through the following steps:

1. Recall that a discrete time dynamic model starts with an equation expressing  $\pi_{t+1}$  as a function of  $\pi_t$ :

$$(equ. 1) \quad \pi_{t+1} = f(\pi_t) \quad \text{is how we will represent this.}$$

2. Note that by definition of equilibrium,

$$(equ. 2) \quad \pi^{ss} = f(\pi^{ss}) \quad \text{This obtains because in the steady-state, } \pi_{t+1} = \pi_t, \text{ since both equal } \pi^{ss}.$$

3. Take a Taylor series expansion of  $f(\pi_t)$  around  $\pi^{ss}$ :

$$(A.12) \quad f(\pi_t) = f(\pi^{ss}) + f'(\pi^{ss})(\pi_t - \pi^{ss}) + f''(\pi^{ss})(\pi_t - \pi^{ss})^2 + \dots$$

This is done simply to represent the polynomial function  $f(\pi_t)$  in terms of deviations from the steady-state.

4. Use the right hand side of the Taylor series expansion to substitute into equation 1, on its right hand side:

$$(A.13) \quad \pi_{t+1} = f(\pi^{ss}) + f'(\pi^{ss})(\pi_t - \pi^{ss}) + f''(\pi^{ss})(\pi_t - \pi^{ss})^2 + \dots$$

For small deviations from the equilibrium,  $(\pi_t - \pi^{ss})^i$  where  $i > 1$  will be near zero allowing the higher order terms to be dropped.

5. Dropping higher order terms, one can write,

$$(A.14) \quad \pi_{t+1} = f(\pi^{ss}) + f'(\pi^{ss})(\pi_t - \pi^{ss})$$

6. Now recall from (equ. 2) that  $f(\pi^{ss}) = \pi^{ss}$ , and make that substitution:

$$(A.15) \quad \pi_{t+1} = \pi^{ss} + f'(\pi^{ss})(\pi_t - \pi^{ss})$$

Rewriting produces,

$$(A.16) \quad \pi_{t+1} - \pi^{ss} = f'(\pi^{ss})(\pi_t - \pi^{ss}).$$

Expressing the per-period deviation from the steady-state as  $n_t = \pi_t - \pi^{ss}$ ,  $n_{t+1} = \pi_{t+1} - \pi^{ss}$ , etc., we have,

$$(A.17) \quad n_{t+1} = f'(\pi^{ss}) n_t.$$

As noted in Roughgarden, this equation can be used to determine the fate of solutions that begin near the steady-state value  $\pi^{ss}$ . The thing to note about the equation first, however, is that it is a simple, linear, recursive equation, such that

$$n_{t+1} = f'(\pi^{ss}) n_t$$

$$n_t = f'(\pi^{ss}) n_{t-1}$$

$$n_{t-1} = f'(\pi^{ss}) n_{t-2}$$

.....

After repeated substitution (for  $n_t$ , for  $n_{t-1}$ , etc.), it becomes clear that this can be represented more generally as,

$$(A.18) \quad n_{t+1} = [f'(\pi^{ss})]^{t+1} n_{t-i},$$

with the power on the  $f'$  function coming from the distance between  $t+1$  and  $t-1$  (i.e.,  $[t+1] - [t-1]$ ).

We can represent this more simply as,

$$(A.19) \quad n_t = [f'(\pi^{ss})]^t n_0$$

and then use this expression to see what happens to solutions that originate near  $\pi^{ss}$ .<sup>34</sup>

Accordingly, one can use  $\pi'_{t+1}$  to determine the length of time it takes to reach the steady-state. Substituting the expression for the derivative  $\pi'_{t+1}$  into the above equation, it is apparent that when,

$$(A.20) \quad [\pi'_{t+1}]^t = 0$$

i.e.,

$$\{2(1-\gamma)([p_1 + p_4] - [p_2 + p_3])\pi + \gamma([p_1 + p_4] - [p_2 + p_3]) + (p_2 + p_3 - 2p_4)\}^t = 0,$$

the economy will have reached steady-state.

Substituting for  $\pi^{ss}$  from equation (A.10) into (A.19) above yields,

$$(A.21) \quad [-1 \pm \sqrt{(\gamma A + C)^2 - 4(1-\gamma)A p_4}]^t$$

for the expression to indicate how long it takes the economy to reach steady-state.

---

<sup>34</sup> In addition to using the equation to obtain estimates of the length of time that it will take to get to equilibrium given an initial deviation of  $\pi_0 - \pi^{ss}$ , the expression could be used to derive stability conditions.

## References

Amemiya, Takeshi (1979). "The Estimation of a Simultaneous-Equation Tobit Model," International Economic Review, Vol. 20(1), pp. 169-181.

Barsky, Robert, et. al., (1997), "Preference Parameters and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Study," Quarterly Journal of Economics, Vol. 112( 2), pp. 537-79.

Behrman and Taubman (1990). "The Intergenerational Correlation between Children's Adult Earnings and Their Parents' Income: Results from the Michigan Panel Survey of Income Dynamics," Review of Income and Wealth, Vol. 36(2), pp. 115-127.

Bisin, Alberto and Thierry Verdier (1998). "On the Cultural Transmission of Preferences for Social Status," Journal of Public Economics, Vol. 70(1), pp. 75-97.

Blau, Francine D. and John W. Graham (1990). "Black-White Differences in Wealth and Asset Composition." Quarterly Journal of Economics, Vol. 105(2), pp. 312-339.

Boyd, Robert and Peter J. Richerson (1985). Culture and the Evolutionary Process, Chicago: University of Chicago Press.

Cavalli-Sforza, Luigi Luca and M.W. Feldman (1981). Cultural Transmission and Evolution: A Quantitative Approach, Princeton: Princeton University Press.

Charles, Kerwin and Erik Hurst (2000). "The Transition to Home Ownership and the Black-White Wealth Gap," manuscript, Department of Economics, University of Michigan, June 2000.

Chiteji, Ngina and Frank Stafford (1998). "Portfolio Choices of Parents and Their Children as Young Adults: Asset Accumulation by African-American Families," American Economic Review Papers and Proceedings, Vol. 89(2), May, pp. 377-380.

Cox, Donald (1990). "Intergenerational Transfers and Liquidity Constraints," Quarterly Journal of Economics, Vol. 105(1), pp. 187-217.

Easterlin, Richard (1980). Birth and Fortune: The Impact of Numbers on Personal Welfare, London: Basic Books.

Eccles, J.S., A. Wigfield and U. Schiefele (1997). "Motivation" in N. Eisenberg, ed., Handbook of Child Psychology, Vol. 3, 5th edition, pp. 1017-1095, New York: Wiley.

Greene, William (1997). Econometric Analysis, Upper Saddle River, NJ: Prentice Hall, third edition.

Harvey, A. (1976). "Estimating Regression Models with Multiplicative Heteroskedasticity," Econometrica, Vol. 44(3), pp.461-465.

Henretta, John C. (1984). "Parental Status and Child's Home Ownership," American Sociological Review, Vol. 49 (February), pp. 131-140.

- Hurst, Erik, Ming Ching Luoh, and Frank Stafford (1998). "Wealth Dynamics of American Families, 1984-1994," Brookings Papers on Economic Activity 1998:I, pp. 267-337.
- Jaffee, Dwight and Joseph Stiglitz (1990). "Credit Rationing," in Friedman, Benjamin and Hahn, Frank, eds., Handbook of Monetary Economics, Vol. 2, pp. 837-888.
- Kennickell, Arthur and Martha Starr-McCluer (1997). "Household Saving and Portfolio Change: Evidence from the 1983-1989 SCF Panel," Review of Income and Wealth, 43(4), pp. 381-399.
- Kremer, Michael (1997). "How Much Does Sorting Increase Inequality?" Quarterly Journal of Economics, Vol. 112(1), pp. 115-139.
- Kotlikoff, Laurence and Lawrence Summers (1981). "The Role of Intergenerational Transfers in Aggregate Capital Accumulation," Journal of Political Economy, Vol. 89(4), pp. 706-732.
- Kopczuk, Wojciech and Joseph Lupton (2000). "To Leave or Not to Leave: An Empirical Investigation of the Distribution of Bequest Motives," manuscript, Department of Economics, University of Michigan, May 2000.
- Lam, David (1999). "Generating Extreme Inequality: Schooling, Earnings, and Intergenerational Transmission of Human Capital in South Africa and Brazil," Research Report 99-439, Population Studies Center at the Institute for Social Research, University of Michigan,
- Loury, Glenn C. (1981). "Intergenerational Transfers and the Distribution of Earnings," Econometrica, Vol. 49(4), pp. 843-867.
- Loury, Glenn C., "Why More Blacks Don't Invest," New York Times, June 6, 1998.
- Lundberg, Shelley and Robert A. Pollak (1998). "An Intergenerational Model of Domestic Violence," manuscript, Department of Economics, University of Washington and Washington University in St. Louis, December, 1998.
- Lupton, Joseph and Frank Stafford (2000). "Five Years Older: Much Richer or Deeper in Debt?" Paper presented at the Allied Social Science Meeting, Boston, MA, January 7-9, 2000.
- Maddala, G.S. (1997). Limited-Dependent and Qualitative Variables in Econometrics. Cambridge University Press.
- Mare, Robert D. (1991). "Five Decades of Educational Assortative Mating," American Sociological Review, Vol. 56(1), pp. 15-32.
- Menchik, Paul L. and Nancy Ammon Jianakoplos (1997). "Black -White Wealth Inequality: Is Inheritance the Reason?" Economic Inquiry, Vol. 35(2), pp.428-442.
- Oettinger, Gerald (1998). "The Effects of Sex Education on Teen Sexual Activity and Teen Pregnancy," manuscript, Department of Economics, University of Texas, May, 1998.
- Oliver, Melvin and Thomas Shapiro (1995). Black Wealth/White Wealth: A New Perspective on Racial Inequality, New York: Routledge.



Roughgarden, Jonathan (1979). Theory of Population Genetic and Evolutionary Ecology: An Introduction, New York: MacMillan Publishing Company.

Solon, Gary (1992). "Intergenerational Income Mobility in the United States," American Economic Review, Vol. 82(3), pp. 393-408.

Stiglitz, Joseph and Andrew Weiss (1981). "Credit Rationing in Markets with Imperfect Information," American Economic Review, Vol. 71(3), June, pp. 393-410.

Wilson, William (1997) When Work Disappears, New York: Vintage Books.

Wolff, Edward (1998). "Recent Trends in the Size Distribution of Household Wealth," Journal of Economic Perspectives, Summer, Vol. 12(3), pp. 131-150.