A New Test of Borrowing Constraints for Education

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Abstract

We discuss a simple model in which parents and children make investments in the children's education, investments for other purposes, and parents can transfer cash to their children. We show that for an identifiable set of parent-child pairs, parents will *rationally* under-invest in their child's education. For these parent-child pairs, additional financial aid will increase educational attainment. The model highlights an important feature of higher education finance, the "expected family contribution" (EFC) that is based on income, assets, and other factors. The EFC is neither legally guaranteed nor universally offered: Our model identifies the set of families that are disproportionately likely to not provide their full EFC. Using a common proxy for financial aid, we show, in data from the Health and Retirement Study, that financial aid increases the educational attainment of children whose families are disproportionately likely to under-invest in education. Financial aid has no effect on the educational attainment of children in other families. The theory and empirical evidence identifies a set of children who face quantitatively important borrowing constraints for higher education.

There has been long-standing interest in whether U.S. students have access to sufficient resources to support efficient human capital investment (see, for example, Becker, 1967). But despite a large literature, no paper on borrowing constraints for higher education focuses on the family's role in financing college, particularly through their expected family contribution (EFC). The EFC is the difference between a child's cost of attending college and what the federal financial aid formulas determine is the family's "adjusted available income" for college. The EFC, however, is neither legally guaranteed nor universally offered. Children whose parents for one reason or another refuse or are unable to make their EFC may face financial constraints in attending college.[1]

It is difficult to study directly the EFC and how it affects educational attainment. There are few datasets that have detailed information on parental income, assets, and the demographic factors that are required by the Free Application for Federal Student Aid (FAFSA), along with the contributions parents actually make for college. Moreover, the EFC is determined, in part, by the college that children attend. Consequently, the EFC is endogenous to the outcomes, namely college entry or years of completed education, that are of typical interest to researchers. Even if an arguably exogenous EFC measure could be computed, borrowing constraints may have their most important effects on the decision of whether or not a child goes to college. For a child who ends up not going to college, the parent will clearly not provide college expenses. So the counterfactual – what the parent would have contributed had the child gone to college – is unobserved. This unobserved counterfactual is a major obstacle to the direct examination of the

[1] Diane, posting on 1/11/2005 to the Becker-Posner Blog, writes, "Currently if you are under 25 and not in graduate school you are considered dependent on your parents' income and have to include their income on you FAFSA which will count against you when figuring your expected family contribution. For those of us who did not receive any financial support from parents other than cosigning loans this is a real kick in the ass. Not only is my family lower middle class and unable to contribute to my education, but the government will tell me that they expected them to contribute and will punish me by lowering my available loan total" (http://www.becker-posner-blog.com/archives/2005/01/governments_rol.html).

effect of parents' education transfers on educational attainment.

In this paper we introduce a new approach to studying borrowing constraints and higher education. Our starting point is the observation that parents and children are distinct decision-makers.[2] Specifically, in our model we assume parents face complete credit markets and they care about their own consumption and about the well-being of their adult child. We assume a child cannot borrow against future earnings and they care only about their own consumption (and not their parent's). We show the child's education may be suboptimal due to borrowing constraints. The parent may be poor relative to the child or care too little about the utility of their child to provide financial help for college, since parents cannot access the returns to their child's education.[3] Alternatively parents and children may disagree about the optimal investment in education because of the possibility that the child will end up relying too heavily on the parent.

There are two regions in the equilibrium of our model. One region is distinguished by the presence of post-schooling cash transfers (and parents are relatively wealthy, or altruistic, or the child's ability is relatively modest). Here children achieve the efficient level of investment in education, so the return to education equals the financial market rate of return. There are strategic concerns, however, so the parent "ties" (by making an education-specific transfer) a portion of their intergenerational transfers. The other region is distinguished by no post-schooling cash transfers (and parents are relatively poor, or egoistic, or the child is relatively able). In this portion of the equilibrium, there will be underinvestment in the child's education, so the return to additional human capital investment will exceed the financial market rate of return. It is precisely this group of parents that will *rationally* not meet their EFC. Parents will tolerate this inefficiency because they have no way to write a binding contract to ensure that

[2] There is considerable evidence that key implications of the unitary model of intergenerational relationships are not supported in data (see, for example, Altonji, Hayashi, and Kotlikoff, 1992).
[3] McGarry and Schoeni (1995) and McGarry (1998) document low rates of transfers from children to older parents.

some portion of the child's future earnings will be repaid in return for supporting their child's education.

Financial aid will have sharply different effects on parent-child pairs in the two regions of the model's equilibrium. For parents who make post-college transfers, additional financial aid should have no effect on educational attainment, because parents will already make the efficient level of investment in their child's education. But children of parents who do not make post-college transfers under-invest in education, due in part to their inability to borrow against future earnings. For these children, increases in financial aid will increase educational attainment.

For expositional clarity, our model abstracts away from important considerations both in parent-child relations and in higher education finance. Among the most important is the fact that a child's post-college earnings are uncertain, which may affect post-college transfers, and the fact that some children finance college by working while in school or by extending the amount of time they attend college. We extend the model to address these concerns in Appendix 2 and show that the central intuition still holds: financial aid should be more likely to affect the educational attainment of children whose parents do not make post-college transfers than children whose parents do make post-college transfers.

Examining the empirical implications of the model requires data on three things: parent-child pairs; financial aid, and intergenerational transfers, ideally for a substantial period following college, so we can separate parent-child pairs into those parents who do and those who do not make post-college transfers. No dataset has all three features. The Health and Retirement Study (HRS) comes close, with good data on parent-child pairs and intergenerational transfers over a long period. The HRS also offers a good proxy for financial aid. The dollar amount of financial aid will depend on the overlap of a child's college years with those of his or her

siblings. As a result, we rely on the birth spacing of siblings as a proxy for variation in students' federal aid.

As implied by our analytic model, we find a positive and statistically significant relationship between educational attainment and sibling overlap when no post-schooling cash transfers are reported, and no significant relationship when positive transfers are reported. Our empirical models include family-specific fixed and random effects specifications and the results are consistent across several specification checks motivated by institutional features of financial aid. The magnitude of the association implies a difference in educational attainment of nearly one semester between children with zero and four years of sibling overlap in college ages. Our results suggest that borrowing constraints for higher education are important for children in families where parents are unwilling or are unable to meet their expected family contribution.

I. A model of intergenerational transfers

The starting point for our model is the small theoretical literature on collective family schooling decisions.[4] In order to generate an equilibrium that distinguishes between transfers for education and cash transfers and the timing of these, there must be scope for disagreement between parents and children over children's investments. Repeated transfer opportunities can generate a threat of strategic over-reliance of a child on an altruistic parent. In this case parents may prefer more education for the child due to the threat of over-reliance, but may also prefer less education for the child given that the parent cannot access the returns from the child's

[4] When studies of borrowing constraints for education include analytic models, they invariably assume that families make unitary college decisions based on parents' resources and children's ability. Two interesting papers that do not examine borrowing constraints but do investigate behavioral consequences of parental transfers to school-age children are Sauer (2003) and Perozek (2005). Sauer examines the effects of parental transfers during law school on borrowing and work while in school and post-school earnings for a sample of University of Michigan law school graduates. Perozek characterizes altruistic transfer rules in a dynamic setting and empirically explores the education investments of a parent and multiple children using the HRS.

education.[5]

a. The Economic Environment

Consider a two-period model where parents have altruistic concern for their children's utility. We assume that parents and children make independent, non-cooperative decisions. In particular, the parent moves first, choosing her consumption and physical capital investment, along with the dollar amounts of a cash transfer to the child and a tied transfer for college education. The child sees these choices and then decides how much to consume, invest in schooling, and save. In the second period, the parent again consumes and chooses a cash gift to the child; the child's only action is to consume the gift and the returns to his various investments. While the parent has full access to credit, we assume that the child cannot borrow against his future income.[6]

Define *a* as the total parent and child investment in physical capital, and define *e* as their total investment in the child's postsecondary education. Assume that the rate of return on physical capital is constant at *R* and the return to total human capital investment *e* is *h(e)* such that $h'(\cdot) > 0,\ h''(\cdot) < 0$ and $h'(0) > R$. The child can receive financial aid τ, which augments family human capital investments (we assume that $h'(\tau) \geq R$). Hence $e = e^p + e^k + \tau$.

The parent, *p*, and child, *k*, have utilities of consumption in the two periods given by

$$U^k(c_1^k, c_2^k) = u(c_1^k) + \beta u(c_2^k) \text{ and}$$
$$U^p(c_1^p, c_2^p, c_1^k, c_2^k) = u(c_1^p) + \beta u(c_2^p) + \alpha\left(u(c_1^k) + \beta u(c_2^k)\right),$$

[5] The Samaritan's Dilemma, evident here in the possibility of the child's over-reliance on the parent, was first described by Buchanan (1975), and results on the Samaritan's Dilemma in Lindbeck and Weibull (1988), Bergstrom (1989), and particularly Bruce and Waldman (1990) have also shaped our approach. Bruce and Waldman (1991) are the first to connect the Samaritan's Dilemma to the motive for tied transfers. Pollak (1988) uses preferences for education to motivate parents' investments, and observes that distinctions among transfer forms must rely on a disagreement between parents and children and that effective tied transfers cannot function as collateral or be resold.
[6] As discussed in Brown *et al.* (2006), both assumptions – non-cooperative behavior and children have more limited ability to borrow than parents– are necessary to obtain empirical predictions on the timing and magnitude of transfers.

where c_t^j represents the period *t* consumption of agent *j*, α expresses the parent's degree of purely altruistic concern for the child's welfare, and β is the rate at which each agent discounts future utility. Single period utility of consumption for each agent, $u(\cdot)$, is such that $u'(\cdot) > 0,\ u''(\cdot) < 0$ and $u'(0) = +\infty$.

The parent acts as a Stackleberg leader, moving first in period 1, choosing c_1^p, a^p (assets), e^p and first period transfer to the child g_1, subject to constraints $c_1^p + a^p + e^p + g_1 \le x^p$, $g_1 \ge 0$ and $e^p \ge 0$.[7] As a result of the one-sided altruism and non-cooperative interaction between the parent and the child, the parent is unable to draw resources from the child through a negative transfer or through negative investment in the child's education. The non-negativity of cash transfers in the second period will play a crucial role in determining equilibrium investments.

The child takes the parent's choices of c_1^p, a^p and e^p as given, choosing c_1^k, a^k and e^k subject to constraints $c_1^k + a^k + e^k \le g_1$, $e^k \ge 0$ and $a^k \ge 0$. In the second period, the parent determines consumption c_2^p and the amount of the second period cash transfer to the child, g_2, subject to constraints $c_2^p + g_2 \le Ra^p$ and $g_2 \ge 0$. The child consumes his total resources, so that $c_2^k = Ra^k + h(e^p + e^k + \tau) + g_2$.

b. Period 2

The parent's problem in the second period is

$$\max_{g_2 \ge 0} \left\{ u(Ra^p - g_2) + \alpha u(Ra^k + h(e^p + e^k + \tau) + g_2) \right\},$$

[7] Our assumptions imply that $g_1 \ge 0$ does not bind at the parent's optimum; $e^p \ge 0$, however, may bind. Key results in this paper hold even when the child has an endowment that can support first period consumption (Brown *et al*., 2006).

and the optimal transfer, given the second period resources of the parent and child, is

$$g_2(Ra^p, Ra^k + h(e^p + e^k + \tau)) = \begin{cases} g_2 \text{ such that } u'(Ra^p - g_2) = \alpha u'(Ra^k + h(e^p + e^k + \tau) + g_2) \\ \qquad \text{where } u'(Ra^p) < \alpha u'(Ra^k + h(e^p + e^k + \tau)), \\ 0 \quad \text{otherwise.} \end{cases} \tag{1}$$

When the transfer that equates second period marginal utilities across generations is positive, the parent achieves his/her preferred allocation of the family's total final-stage resources.[8] The parent's altruism toward the child implies that the final transfer decreases with the child's assets and earnings, no matter what choices preceded them, so second period transfers, when made, are compensatory. The key point of equation (1) for our purposes, however, is that when the parent's marginal utility from consuming everything in period 2 exceeds the marginal utility they would get from the first dollar of cash transfers, the parent will not make second period transfers. Whether or not second period cash transfers are made distinguishes the two segments of the equilibrium.

c. Period 1: Child

In the first period, the child determines his or her own consumption, saving, and educational investment given the $(g_1,\ a^p,\ e^p)$ chosen by the parent. The child's problem is

$$\begin{aligned} &\max_{c_1^k, c_2^k, e^k \geq 0, a^k \geq 0} \left\{ u(c_1^k) + \beta u(c_2^k) \right\} \\ &s.t.\ \ c_1^k + e^k + a^k \leq g_1, \\ &\qquad c_2^k = Ra^k + h(e^p + e^k + \tau) + g_2(Ra^p, Ra^k + h(e^p + e^k + \tau)) \text{ and} \\ &\qquad g_2(Ra^p, Ra^k + h(e^p + e^k + \tau)) \text{ as in (1).} \end{aligned}$$

The function $g_2(Ra^p,\ Ra^k + h(e^p + e^k + \tau))$ is continuous but non-differentiable where $\alpha u'(Ra^k + h(e^p + e^k + \tau)) = u'(Ra^p)$.

[8] This surprisingly robust prediction is the focus of the theory and empirical analysis in Altonji, Hayashi and Kotlikoff (1997).

The first order conditions for the child's problem make it clear that whenever $g_2 > 0$, the child would like to over-consume in the first period in order to achieve consumption path $\{c_1^k, c_2^k\}$ such that

$$u'(c_1^k) = \beta \max\left\{R, h'(e^p + e^k + \tau)\right\}\left(1 + \frac{\partial g_2}{\partial(Ra^k + h(e^p + e^k + \tau))}\right)u'(c_2^k) \quad (2)^9$$

This will be possible only if there exists an $e^k \geq 0$ and $a^k \geq 0$ that satisfy (2), given the parent's choices. As we show in the appendix, the parent can choose g_1, e^p and a^p such that $e^k \geq 0$ and $a^k \geq 0$ bind, thus mitigating the strategic concerns (and equation (2) ends up not holding in the $g_2 > 0$ case).

d. Period 1: Parent

In period 1, the parent chooses c_1^p, g_1, e^p and a^p to maximize his or her utility, subject to $c_1^p + a^p + e^p + g_1 \leq x^p$, $g_1 \geq 0$ and $e^p \geq 0$. We note three features of the model in proposition 1.[10]

Proposition 1*: (i)* Equilibrium consumption levels $\{c_1^p, c_2^p, c_1^k, c_2^k\}$ are unique. *(ii)* If $g_2 > 0$ in any equilibrium, then $h'(e^p + e^k + \tau) = R$ and the equilibrium transfers (e_p, g_2, g_1) are unique. *(iii)* If $g_2 \geq 0$ binds in any equilibrium, then $h'(e^p + e^k + \tau) > R$ – there is inefficient investment in education – and the equilibrium transfers need not be unique, since only the sum, $g_1 + e^p$, is determined.

The solution partitions the parameter space into two regions. In one region $g_2 > 0$ and $h'(e^p + e^k + \tau) = R$. The parent's c_1^p, g_1, e^p and a^p meet conditions

$$\begin{aligned} &u'(c_1^p) = \alpha u'(c_1^k),\ u'(c_1^p) = \beta R u'(c_2^p),\ h'(e^p + \tau) = R, \text{ and } u'(c_2^p) = \alpha u'(c_2^k), \\ &\text{where } c_1^p = x^p - g_1 - e^p - a^p,\ c_1^k = g_1,\ c_2^p = Ra^p - g_2, \text{ and } c_2^k = h(e^p + \tau) + g_2 \end{aligned} \quad (3)$$

[9] Recall the partial derivative $\frac{\partial g_2}{\partial(Ra^k + h(e^p + e^k + \tau))}$ is negative since second period transfers are compensatory.

[10] Proofs of both propositions are given in Appendix 1.

The solution will be in this region when parents are relatively wealthy and altruistic, and the child's return to human capital investment falls relatively quickly to the real interest rate.

In the $g_2 > 0$ equilibrium strategic concerns arise so the parent bears all responsibility for the investment in the child's education. The child realizes that the parent will be in the interior of the transfer region in the second period. Hence, given the opportunity, the child over-consumes in the first period, as shown in equation (2). The parent takes this into account and makes a cash gift of only what she prefers for the child to consume in the first period. The parent ties all additional first period transfers to education, exhausting the region of educational investment that yields a return at or above the real interest rate. To summarize, we find that families in the $g_2 > 0$ equilibrium face strategic concerns, and yet make efficient educational investments and hence they relieve the child's educational borrowing constraint.

The other region of the parameter space occurs where conditions (3) can be met only with $g_2 < 0$. In this case, $g_2 = 0$ and $h'(e^p + e^k + \tau) > R$.[11] The equilibrium is described by

$$\begin{aligned} &u'(c_1^p) = \alpha u'(c_1^k),\ u'(c_1^p) = \beta R u'(c_2^p),\ \ h'(e^p + e^k + \tau) > R,\ u'(c_2^p) > \alpha u'(c_2^k), \\ &\text{and } u'(c_1^k) = \beta h'(e^p + e^k + \tau) u'(c_2^k), \text{where } c_1^p = x^p - g_1 - e^p - a^p, \\ &c_1^k = g_1,\ c_2^p = Ra^p, \text{ and } c_2^k = h(e^p + e^k + \tau). \end{aligned} \tag{4}$$

The absence of a second period transfer means that the child has no incentive to behave strategically. As a result, the parent and child agree on the intertemporal condition to be met by the child's consumption: $u'(c_1^k) = \beta h'(e^p + e^k + \tau) u'(c_2^k)$.

While parents and the child agree on the intertemporal condition, the $g_2 = 0$ equilibrium is inefficient. The post-schooling consumption that the parent prefers to allocate to the child is less

[11] A knife's-edge case exists where $g_2 = 0$, though $g_2 \geq 0$ does not bind, and at the same time $h'(e^p + e^k + \tau) = R$. But given incomes, altruism and other model parameters, this case has no consequence for our empirical work.

than the earnings produced by the efficient human capital investment. In other words, conditions (4) imply $c_2^k < h(e^*)$, where $e^* = h'^{-1}(R)$. Since parents cannot reclaim the return to e^p invested in the child's education, they invest in human capital to support the child's second period consumption but physical capital to support their own. This leads parents to tolerate the $h'(e^p + e^k + \tau) > R$ wedge in the investment returns, despite their unbounded access to credit. Families in the $g_2 = 0$ equilibrium face no strategic concerns, yet are led by an intergenerational borrowing constraint to invest inefficiently in their children's human capital.

It is this group of $g_2 = 0$ families, where parents are relatively poor, or egoistic, or a child's return to human capital investment falls relatively slowly with additional education, who rationally may choose to not meet their expected family contribution, as determined by the federal rules determining financial aid for higher education.

The next proposition shows financial aid will have very different effects on the educational attainment of children in the $g_2 > 0$ and in the $g_2 = 0$ groups.

Proposition 2: *(i)* When $g_2 > 0$, $\frac{\partial(e^p + e^k)}{\partial \tau} = -1$; financial aid does not influence total educational attainment. *(ii)* When $g_2 \geq 0$ binds, $\frac{\partial(e^p + e^k)}{\partial \tau} > -1$; financial aid does influence total educational attainment.

Propositions 1 and 2 formalize our new strategy to examine borrowing constraints for education. With data on parent-child pairs, g_2, and financial aid, we can examine the correlation between children's years of schooling and financial aid, conditioning on child characteristics, using two separate subsamples. The first is one in which parents make a post-schooling transfer ($g_2 > 0$), and the second is one in which they do not ($g_2 = 0$). Our model implies that financial aid will have no effect on the educational attainment of children in the first ($g_2 > 0$) sample, and

a positive effect on the educational attainment of children in the other sample. We discuss our HRS-based work implementing this strategy below.

e. An Economic Environment with Greater Realism

A skeptic might argue that that our simple model abstracts away from too many important features of reality. To address this concern, we examine the robustness of our analytic results in Appendix 2 where we develop a model that incorporates three additional features relevant to our problem. First, in our simple model the sample is cleanly split by g_2, second period cash transfers. If income is uncertain, of course, post-college transfers will be affected by income shocks that parents and children receive after the child is out of college, so our sample-splitting strategy will not be sharp. Hence, in the Appendix 2 model we allow for shocks to earnings. Second, credit card promotions on college campuses are commonplace, so we allow the child to borrow at a higher rate than the parent. Third, many children work while in college. Consequently, in the appendix we incorporate a standard production function where time and expenditures are complementary in producing human capital. This allows us to model a child's decision to work while in college.[12] The model does not have an analytic solution, so we solve it using numerical methods.

For a broad range of utility and human capital production function parameters, the appendix model confirms the simple model's central intuition: families who do not pass on post-college gifts to their children are more likely to under-invest in their children's education. Children of parents who make post-college gifts are likely to have received transfers that allow them to reach their efficient level of education. Parents who have the option to make an education transfer and

[12] Work while in college is the mechanism children use to relieve borrowing constraints in Keane and Wolpin (2001), for example. They differ from our approach by assuming all children face the same tuition. In contrast, we assume that there are colleges of varying costs and consequently low income families with high ability children will choose to attend less expensive colleges and go to school for fewer years (since time and expenditures are complements), if they are borrowing constrained.

choose not to are foregoing a high rate of return investment opportunity. Since parents are at a point in their lifecycle where they do not face borrowing constraints, the decision to under-invest cannot be rationalized if parents have sufficient resources to make cash gifts later on. For reasonable parameters of the income process, the intuition from the simple model holds probabilistically, but the g_2 sample split is no longer sharp.

In the appendix model, children of parents who do not make education transfers can borrow, work while in college, or even postpone college. Still, their optimal schooling is less than the efficient level. The reason is that each of these "make do" options are costly. This is obviously true for borrowing at an interest rate that exceeds the financial market rate of return. Working while in college helps relieve borrowing constraints, but takes time away from human capital acquisition as well as leisure.[13] In short, we find that a constrained child who receives no help from his or her parents will, at the margin, consume less, work a little more while in college, and choose to go to a lower cost college for fewer years than would an otherwise identical child with more generous parents. Thus, the additional model features we examine mitigate the importance of borrowing constraints, but they do not eliminate their importance.

II. The effects of financial aid on education in intergenerationally constrained and unconstrained families

The Health and Retirement Study (HRS) has good information on parent-child pairs and post-college transfers. It is a national panel study with an initial sample (in 1992) of 12,652 persons and 7,607 households. It oversamples blacks, Hispanics, and residents of Florida. The baseline 1992 study consisted of in-home, face-to-face interviews with the 1931-1941 birth cohort and their spouses, if married. Follow-up interviews were given by telephone in 1994, 1996, 1998, 2000, 2002 and 2004. Other cohorts, born before 1923 (Asset and Health Dynamics

[13] Stinebrickner and Stinebrickner (2003) provide evidence on costs of working while in college.

of the Oldest Old), between 1923 and 1930 (Children of the Depression), and between 1942 and 1947 (War Babies), were added to the main HRS cohort in 1998.[14] We use data from all these cohorts as long as needed information is available.

Some supplemental analyses in this paper (and more in our 2007 paper draft) use data from the NLSY-97, a national panel survey of 8,984 youths who were born between 1980 and 1984, first fielded in 1997. The NLSY-97 cannot be used as our central data source because it does not yet have suitable data on post-college transfers.[15]

a. Measuring post-college cash transfers

In waves 3 through 7 of the HRS respondents are asked the following question about cash transfers exceeding $500 in the last 24 months.[16] The specific wording in 2000 (Wave 5) reads:

> "Including help with education but not shared housing or shared food (or any deed to a house), in the last 2 years did [the Respondent or Spouse] give financial help totaling $500 or more to any of their children or grandchildren?"

Those answering "yes" were then asked how much. We aggregate transfers reported by parents over the period 1998-2004 (Waves 4 through 7) for our first measure of post-college cash transfers, g_2.[17] There are three reasons for using this measure. First, starting in 1998 (wave 4) the HRS is a representative sample of all households born before 1948, so it is natural to start with this wave. Second, even if we were willing to ignore data from the new cohorts added to

[14] A 1948 to 1953 cohort (Early Baby Boomers) was added in 2004, but because we do not have information on this group in earlier waves, we do not include them in our study.

[15] The earlier NLSY-79 is not ideal because the latest measure of g_2 in that survey was elicited when children were 21 to 28 years old. The ideal measure for identifying parents with active post-schooling financial linkages gathers information over a long post-college period. Moreover, the age distribution of the sampling frame is such that there are too few siblings to estimate models with family fixed effects. The value of conditioning on time-invariant family-specific factors is discussed below.

[16] Wave 1 asks about transfers exceeding $500 in the last 12 months and wave 2 asks about transfers exceeding $100 in the last 12 months.

[17] Recall that the purpose of g_2 is to separate the sample into intergenerationally constrained and unconstrained parent-child pairs. The fact that the primary transfer question includes grandchildren is not ideal, given that the model we write down considers only two generations. But we think parents making cash gifts to grandchildren are likely to have relieved educational borrowing constraints for their children, so we do not view the inclusion of grandchildren in the transfers question to be an important limitation of the study.

the HRS in 1998, it is not clear how to aggregate over the first three waves due to differences in the way the transfers question was worded in each wave. Third, problems with missing responses increase with the number of waves we use.

We would prefer, however, to use a measure of significant post-college transfers over a longer time period in the estimation. While no long-term retrospective question on major cash transfers to children is available in any of the HRS core surveys, Wave 2 of the HRS, fielded in 1994, does include a topical module on parent-child transfers. The Wave 2 survey (in Module 7) asked 827 HRS respondents in 427 households:

> "Other than contributions toward education expenses, have you ever given substantial gifts to your grown children?"

Those who answer "yes" are asked the total amount of these gifts. This is arguably the exact question we require to distinguish families with relatively wealthy or altruistic parents who have active post-schooling financial linkages from those with relatively poor or egoistic parents who likely have no post-schooling financial linkages. The drawback to this question is that it was asked only of a small subsample. Thus we report estimates using both the shorter window of cash transfers observed for the full HRS sample and this longer transfer window observed only for Wave 2, Module 7 respondents. Responses to this question are available for 334 of the 9,471 families for whom we have complete demographic and education information on multiple siblings aged 24 and older. These families include 1,262 children.[18]

b. A proxy for financial aid

The U.S. Higher Education Act of 1965 authorized grants and subsidized loans for students pursuing post-secondary, graduate, and professional education. The Higher Education Act was reauthorized every 4 years between 1968 and 1980, and every 6 years thereafter. The 1992

[18] Appendix Table 1 gives more detail on the construction of the full HRS sample and the module sample that we use for our analyses.

reauthorization came with several major reforms. Before 1992, parents' EFC was calculated according to separate formulas for Pell Grants (the Pell Grant Index) and subsidized loans (the Congressional Methodology). After 1992 a common Federal Methodology was used.[19]

It would be difficult to trace and aggregate all of the historical details of U.S. financial aid policy over the relevant period for our sample children, and impossible to uncover parental asset and income information relevant to financial aid formulas at the potential date of college entry for each sample child. One consistent feature of the aid formulas, however, allows us to infer a major component of within-family aid variation from family structure alone. Both before and after the 1992 reform, the EFC has been independent of the number of children a parent had in college in a given year. Once the family's "Adjusted Available Income" is determined based on income and assets, the EFC comes from dividing it by the number of children in college in the relevant academic year. This means there are large discontinuities in financial aid as a function of number of siblings in college.

Define *COA* as the cost of attending college for a given student, including tuition and fees, room and board, books and travel expenses. The objective of federal aid, in cooperation with most U.S. colleges, is to provide grants and loans that cover the cost of attendance after the individual student's expected family contribution is removed, *COA – (AAI/# children in college)*. This implies that for a lone student for whom *COA* > *AAI*, the amount of college costs not covered by aid is decreased by *AAI/2* dollars when another sibling attended college in the same year. Depending on the size of the expected family contribution, this formula may create large swings in individual siblings' costs of college as family members age through the education process and may be responsible for large differences in the costs of educating siblings within the

[19] Helpful discussions of federal financial aid policy can be found in NCES (2004), Kane (1998, 2006), Kim (1999), Monks (2004), and Wu (2006).

same family.

We use the variation in college financial aid due to children's birth spacing to proxy for unobserved aid levels.[20] The median year in which children in our HRS sample reach the age of 18 is 1977, with most being college age in the 1970s, 80s, and early 90s. The landmark 1965 reforms in higher education finance occurred *after* the vast majority of children in our sample were born, so decisions about birth spacing were very unlikely to be affected by financial aid considerations.

A natural question to ask is whether sibling overlap is significantly, positively correlated with financial aid. We cannot examine the relationship between sibling overlap and financial aid using the HRS because it does not include information on financial aid. But we can examine the relationship using the NLSY-97. To do this we regress the financial aid a student received in his or her first term of college on a set of covariates, including parental income, parental income squared, net worth, net worth squared, AFQT, AFQT squared, a constant, and a measure of sibling overlap. We measure a point-in-time sibling overlap variable as the number of siblings who are college age (ages 18 through 21) at the time financial aid is being measured for the child in question.[21] The sibling overlap variable does not require the sibling to be in college at the time, since this information is not available in the HRS.[22] The coefficient of the overlap variable given in Appendix Table 2 is $358 and it is significant at the 5 percent level.[23] This result, along

[20] Our use of child birth spacing is similar to the approaches taken by Kim (1999) and Monks (2004) to estimate the savings effects of the asset tax implicit in the federal financial aid formula.

[21] We used the household and non-household rosters to construct information on respondents' siblings (so that we could get siblings living both in and out of the respondent's home). Siblings are defined to be biological, half, step, adoptive, or foster siblings. Our measure of financial aid includes the dollar amount of any grants, scholarships, loans, work study, or other kinds of government/institutional aid a respondent received during his/her first term of post-secondary schooling.

[22] Another reason the overlap proxy relies on potential and not actual overlap in college attendance is because realized overlap or a siblings' realized college attendance while the child is 18-21 would be mechanically related to our outcome variable of interest, educational attainment.

[23] The mean financial aid for all NLSY-97 college students is slightly under $3,000.

with evidence from Liu and van der Klaauw (2007), adds to our confidence that the financial aid proxy used in the HRS analyses does, in fact, capture financial aid differences within and across families.

Given that parental resources affect financial aid, families might want to declare their children's financial independence. The standards for independence, however, are strict. In order to declare independence a student must *(i)* reach age 24 by January of the academic year, or *(ii)* enroll in a graduate program, or *(iii)* be married, or *(iv)* have a dependent child or other dependents, or *(v)* be an orphan or ward of the court, or *(vi)* be a veteran of the U.S. Armed Forces (IFAP 2006). Thus a child under age 24, whose parents decide not to make the expected family contribution, will need to cut back their schooling, work while in college, stretch out the time they are in college, or find some other way to adapt. As discussed earlier, all these adaptations lower the net returns to schooling so, as argued in Appendix 2, the implications of the model still hold.

c. Estimation samples and covariates

Our sample selection criteria include the requirement that we observe parents' household income and net worth and complete information on the education, date of birth, and relationship to the family of each child reported by the HRS respondent. We also require that children included in the estimation have at least one sibling. Finally, we include only children aged 24 or older (in 2000) in our estimation sample. The intention of this restriction is to allow the sample children time to complete their schooling, and to consider only cash transfers that take place following completion of the children's' schooling.[24] This leaves us with a sample of 34,593 children from 9,471 HRS families.

Our empirical models include child variables that allow us to condition on factors that may

[24] The qualitative results are similar if we require sample children to be aged 30 or older in 2000.

influence the schooling attained by a young adult student, particularly relative to his or her siblings. These include the child's age in 2000, the child's gender, indicators for whether the child is an oldest or youngest child, and a cumulative measure of sibling-years of overlap for a college-age child. Specifically, the child's sibling-years of overlap is the sum of the number of siblings the child had between the ages of 18 and 21 while he or she was 18, plus the number of siblings aged 18-21 while he or she was 19, and so on, until the child is age 21.[25]

Table 1 gives descriptive information for these variables for both the full HRS analysis sample and for the Wave 2, Module 7 respondents. Forty-nine percent of core sample children have parents who made positive cash transfers to them or to a sibling between 1998 and 2004, and 37 percent of the children of module respondents have parents who ever made substantial non-educational transfers to their adult children.[26] These variables allow us to split samples based on post-schooling transfers as suggested by the analytic model. Roughly half of each sample is female. The median child age in 2000 is 41 for both samples. Birth order indicators tell us that 29 (26) percent of core (module) sample children are oldest siblings, 26 (24) percent youngest, and 45 (50) percent are middle siblings. We exclude any variables that were likely determined after the completion of the child's schooling, such as marital status or earnings in 2000.

The dependent variable in our primary empirical specification is the child's education. Core sample children have attained a mean of 13.8 and a median of 13.0 years of schooling (it is 13.3 and 12.0 in the module sample). The large sample and broad range of ages give us a standard

[25] Triplets, for example, each have eight sibling-years of overlap in college ages. A child with two siblings who are three and six years younger, respectively, has one sibling-year of overlap in college ages. The middle child in this family has two years of overlap, and the youngest child has one.

[26] Readers might expect that the fraction of the sample *ever* giving cash gifts would exceed the fraction of the sample giving cash gifts between 1998 and 2004. Three factors make the 49 and 37 percent responses not comparable. First, the Wave 2, Module 7 question refers to "substantial" gifts while the other question asks specifically about gifts exceeding $500. Second, the Wave 2, Module 7 question is asked of a much narrower cohort of households. Third, the core sample question includes gifts to grandchildren exceeding $500.

deviation of 6.88 years of schooling, despite the top-coding of schooling years to 17 for graduate and professional education.[27] The primary independent variable of interest is years of overlap with siblings. Its mean and median are 2.34 and 2.00 in the core sample and 2.63 and 2.00 in the module sample. There is substantial variation in sibling-years of overlap in both samples, with a standard deviation for this variable of roughly 2.1 years in each.

III. The empirical model, results, and robustness

Many factors likely influence the difference in schooling between two arbitrarily chosen, unrelated students. Among other issues, parents may differ in their attitudes toward education and the investments they make in their children. Heritable components of academic aptitude that the students received from their parents might also differ. We would have a difficult time controlling adequately for these between-family differences using the HRS data. To account for time-invariant, within family characteristics, our empirical model includes a family-specific effect:

$$e_{is} = \omega_i + X_{is}\beta + \gamma o_{is} + \varepsilon_{is}, \qquad (5)$$

where families are indexed by i = 1,…,N and siblings in family i by $s = 1,...,S_i$.[28] In this expression e_{is} represents the education of sibling s in family i, X_{is} is a vector of exogenous characteristics of sibling s in family i, and o_{is} represents the number of years of overlap in college ages that sibling s in family i shares with his or her siblings. The family fixed effect ω_i represents the unobservable contribution to educational attainment shared by the children of family i.

The main coefficient of interest is γ, the effect of the overlap variable (which proxies for

[27] The youngest children in the sample are 24. The oldest 1.8 percent of children have reached retirement age.
[28] The number of siblings varies from 2 to 11 across families, creating an unbalanced panel.

financial aid) on children's total schooling. Recall that our model suggests that γ will be positive and significant for children whose parents make no subsequent gifts ($g_2 = 0$), but γ will be insignificant for children whose parents do make subsequent gifts to children ($g_2 > 0$). With fixed effects, of course, γ is identified by comparing the educational attainment of children within the same family. For example, in a three child family in which the first child is born three years before the second child and five years before the third child, we are asking whether the closely spaced younger siblings obtain more schooling than the older sibling. To the extent that family background characteristics are identical among siblings, the family fixed effect estimates hold them constant.

Table 2 reports estimates for the gift and no-gift subsamples using the full HRS sample and the special question asked of Wave 2, Module 7 respondents. We find a coefficient on overlap of 0.105 in the no-gift, full HRS sample, which is significantly different from zero at the one percent level. The corresponding coefficient in the gift, full HRS sample is 0.034. The estimate is not significantly different from zero at standard confidence levels. A similar pattern emerges in the results using the Wave 2, Module 7 sample. The coefficient on overlap in the no-gift sample is 0.094 and differs significantly from zero at the one percent level. The coefficient on overlap in the gift sample is -0.050 and is insignificant.[29]

Other coefficients in Table 2 reflect the correlations between children's demographic characteristics at the time of schooling decisions and their educational attainment. Brothers get less schooling than their sisters on average, and this effect is significant at the five percent level in two of the samples. The implied difference in schooling between brothers and sisters on

[29] In simultaneous estimation of all group-specific coefficients for the gift and no gift samples, F-tests reject the null hypotheses that the gift and no gift overlap coefficients are the same for the full and module samples at the ten and six percent levels, respectively.

average is a third of a year or less. Controlling for birth order, older siblings get significantly less schooling than younger ones in both no-gift samples; one year more of age is associated with 5 hundredths of a year of school in the two samples. Oldest children receive more education than their middle-child siblings on average, though the estimated coefficient on the oldest child indicator is significantly different from zero for only one of the four samples. There is no clear pattern in the level of schooling of youngest children relative to those of middle children.

Before describing our robustness checks, we briefly mention two less far-reaching specification and sampling alternatives.[30] First, we recognize the coefficient estimates on gender, age, and youngest and oldest child indicators vary across samples in magnitude and significance. Specifications where we exclude all within-family covariates except the family effect and the overlap measure also yield a positive and highly significant overlap coefficient for the no gift group and a small, insignificant overlap coefficient for the gift group. So the key result in Table 2 is not sensitive to the inclusion of covariates. It also does not depend on whether or not step-children are included in the sample. Several authors have noted that parent-child behavior and outcomes can differ for stepchildren relative to biological children of either parent.[31] We repeated the central estimation shown in Table 2 using only never married parents and parents who were still married to their first spouses in 2000 in an effort to drop step families. The results for the parameters of interest were very similar.

b. Estimation issues and sensitivity analyses with the HRS sample

In the remainder of this section we describe six sampling or robustness checks that increase our confidence that we are interpreting the empirical results sensibly. While we elaborate on each in greater detail below, we can roughly break the discussion into a) who is being affected –

[30] Any result not shown in the paper is available from the authors on request.
[31] See, for example, Light and McGarry (2004), Brown (2006), and Pezzin, Pollak, and Schone (2006).

here we make sure the affected groups are, in fact, children who could plausibly be affected by financial aid; and b) is it something else – here we try to rule out spurious explanations for the results.

1. Who is being affected? The distributional effects of financial aid policy

There are nonlinearities in the financial aid system that we do not account for in the equation (5) empirical model. In particular, the children of very wealthy parents should expect no federal financial aid whether or not they have siblings in college (also see Monks, 2004). Similarly, federal aid formulas provide approximately full support to the children of very poor parents, and therefore educational achievement should be unrelated to sibling overlap. Thus, even in the no-gift subsample, we would expect years of schooling to be unresponsive to sibling overlap for children in low-income families, because they receive full financial aid, and for children in high wealth families, because there will be no differences in schooling costs across children (within a family) due to financial aid considerations.

We do not know the parent's financial circumstance at the time their children were in school. So, to address the concern about non-linearities, we repeat the initial estimation, but this time estimate separate overlap coefficients for each parental net worth tercile. If the findings in Table 2 are indeed driven by financial aid effects, and not some other feature of birth spacing, then overlap should not matter for any tercile of the gift sample and it should be strongest for the middle tercile of the no-gift sample.

Estimates are given in Table 3 using the full HRS sample and a sample based on the special question asked of Wave 2, Module 7 respondents. The estimated overlap coefficients are small and not significantly different from zero for each of the net worth terciles of both gift samples. In the no gift samples, we find small, insignificant overlap coefficients for the poorest and

wealthiest terciles. However, the significant (at conventional level) point estimates on sibling overlap are 0.189 for the middle tercile of the full HRS sample and 0.197 for the much smaller special module sample. F-tests reject the null hypotheses that the middle tercile coefficient is equal to the high and low tercile coefficients at the five and ten percent levels, respectively in the full sample (but only rejects the equality of the middle and high coefficients in the smaller module sample).

Though we have no way of knowing whether the net worth tercile categorization appropriately reflects the parental income and wealth regions where financial aid is either complete or zero, we nevertheless expect that the aid received by middle wealth children varied most in response to sibling years of overlap. The evidence that the effect of sibling overlap on educational attainment occurs for middle wealth families in two samples is encouraging, given the structure of financial aid policy.

2. Who is being affected? Historical changes in financial aid policy

Financial aid to middle and higher income families increased substantially in 1978 as a result of the Middle Income Student Assistance Act (MISAA). Before the MISAA, the Pell Grant and Guaranteed Student Loan (GSL) family income caps were $15,000 and $25,000, respectively. The U.S. median household income in 1978 was $15,064. The MISAA extended both types of aid to children of families with higher incomes, and was followed by a tripling in the number of GSL program loans over 3 academic years.[32]

With more aid available for middle-income children as a consequence of the MISAA, we expect the main beneficial effects on attendance to occur for those children who now have greater access to aid, but whose parents, for one reason or another, were not fully committed to paying for college. In the context of the Table 3 empirical specification, we expect the

[32] Detail on the short-run effects of this and other aid reforms can be found in Baum (1986).

interaction of overlap and the middle wealth tercile to be larger (while still positive and significant) following the MISAA than before enactment of the MISAA. We further expect the MISAA to have no beneficial effects on attendance for the $g_2 > 0$ subsample (though parents presumably benefit from inframarginal subsidies).

We split the sample into a pre-reform subsample that includes only students who reached age 18 in 1978 or before, prior to the bill passage and expansion in aid. The post-reform subsample includes only students who reached age 18 in 1979 or later, after the aid expansion. Estimates for the Table 3 empirical model, pre- and post-reform, are given in Table 4.

As expected, the coefficient for the overlap by middle wealth tercile interaction is precisely estimated and larger – nearly twice the size – in the post-reform subsample as in the pre-reform subsample. Hence the expansion of aid to families above the median income following the MISAA is accompanied by a shift in the estimated association between the aid proxy and attainment of children in middle wealth families.[33]

As in the previous specification, the overlap by high-wealth interaction is insignificant in both groups both pre- and post-reform. In addition, five of six coefficients in the $g_2 > 0$ subsample are insignificant, as expected. We find two unexpected results in Table 4, both occurring for the pre-reform sample for the overlap-by-lowest-wealth-tercile coefficients. The positive, significant coefficient for the low-wealth, pre-reform subsample might suggest that aid was scarce even for low-wealth (and income) children, so having a closely spaced sibling enhanced the ability to finance college relative to observationally similar children without a closely spaced sibling. But this explanation is hard to reconcile with a *negative* significant coefficient for closely spaced siblings in families who made post-college gifts.

[33] The coefficients also reflect the fact discussed by Kane (2006) and Belley and Lochner (2007) and others that the real cost of college has risen sharply while federal financial aid has not kept pace.

3. Who is being affected? The attainment margin should be related to college

Many children in our samples were born in the late 1940s and 1950s. A high school degree for this cohort was less common than it is today. Our preferred interpretation of our results would clearly be wrong if the margin through which education increases for closely-spaced children in the no-gift sample is that they were more likely to get to 11th grade rather than 10th grade. Put differently, college financial aid should have its primary influence on *college* enrollment and attainment.

When we exclude high school dropouts, we get similar results for the association between overlap and educational attainment, with the exception that the positive, significant overlap coefficient in the no-gift sample is substantially larger.[34] As in Kling (2001), we find that the response to our schooling cost measure is greatest at the college entry margin.

4: Is it something else? Random effects

Our family fixed effect estimates have the potential drawback that siblings in two-child families have identical years of overlap, so the central overlap coefficient is identified only from families with three or more children. Even the most casual observation will confirm that cross-family differences are enormously important in explaining educational attainment. Random effects specifications allow us to identify the overlap coefficient using families with two or more children, at the cost of assuming that family effects are independent of the regressors.

The random effect estimates from the full HRS sample are presented in Table 5. The results are consistent with the fixed effect results in Table 2. The overlap coefficient is 0.071 and significant in the "no gift" sample, and 0.034 and insignificant in the "gift" sample. Like others, we find that parental education is strongly correlated with educational achievement in both

[34] Moreover, overlap is insignificant in the $g_2 > 0$ and $g_2 = 0$ samples if both are restricted to those children with high school or less education.

subsamples.[35]

5: Is it something else? Ability and birth spacing

We do not have an ability measure in the HRS. This is one of the reasons why a within-family (fixed effect) specification is useful, since it accounts for time-invariant, family-specific ability differences that might arise from the home environment. Nevertheless, there are obviously ability differences between children within a family. If closely spaced children have significantly different ability than children with greater birth spacing, our HRS-based estimates might be biased. For this bias to explain most or all of the results, it must be the case that the ability levels of closely spaced children exceed the ability levels of children spaced apart in families where there are no post-schooling transfers (constrained families, or families with $g_2 = 0$), and this ability differential with birth spacing does not occur in unconstrained ($g_2 > 0$) families. If families with closely spaced kids are resource-constrained over their life-cycle, either in the time or the money they are able to allocate to closely-spaced siblings, it seems unlikely the constrained subset have higher ability children relative to others, at least in an economically important magnitude.

We can shed a little further light on this potential explanation using data from the NLSY-97: in particular, we look at whether sibling overlap is correlated with AFQT. In Appendix Table 3 we show the result of regressing AFQT on sibling overlap and covariates that we expect to be correlated with AFQT, including mother's education, parental income, parental income squared, indicator variables for the number of siblings, female, black, Hispanic, broken home, living in an urban area, and living in the South. Sibling overlap is significantly correlated with AFQT, but the relationship is negative, and the empirical magnitude is -0.51, while the standard deviation of

[35] Parental education is measured for the HRS family respondent. Most but not all family respondents are mothers. We chose to do this in order to retain families in which only the mother or only the father is represented in the HRS.

AFQT is 29.2 in the sample. Hence, we find it implausible that unobserved ability accounts for the empirical patterns we document in the HRS data.

6: Is it something else? The role of altruism

Underlying family characteristics – parental resources, the shape of the human capital production function, and altruism – will determine the region of the parent-child equilibrium. One unusual feature of the HRS is that it includes, for a small subsample, self-reported measures of parents' financial generosity toward their children. Wave 5 of the HRS from 2000 contains an Economic Altruism Module where parents were asked

> "Suppose that [your child/one of your children] had only half/three-quarters/one-third as much income per person to live on as you do. Would you be willing to give your child 5% of your own family income per month, to help out until things changed – which might be several years?"

Our analytic model shows that post-college giving will be more common among parents with higher α values. If the responses to the special HRS module question are informative about α, we expect financial aid to have a smaller effect on the educational attainment of children with high-α parents than those with low-α parents.

914 parents (with 3,292 children) responded to this question and have complete information on other covariates included in our empirical model. Only 3 percent of children had parents who said they would give at 1/3 but not above. So we pool the 1/3 respondents with those who indicate that they would not give 5 percent of their income under any of the scenarios.

We estimate the empirical model given in (5), modified so that

$$e_{is} = \omega_i + X_{is}\beta + \sum_{j=1}^{3} \gamma_j m_j o_{is} + \varepsilon_{is}, \qquad (6)$$

where indicators m_1 = 1 if the parent gives under no circumstances or only when the child's income is 1/3 of hers (12 percent of the sample), m_2 = 1 if the parent gives when the child's

income is ½ of hers but not when it is ¾ (26 percent of the sample), and $m_3 = 1$ if the parent gives when the child's income is ¾ of hers (62 percent of the sample).

The estimates are presented in Table 6. The overlap coefficient is insignificant (with a t-statistic below one) for the most altruistic families: those who will give 5 percent of their income when their child's person-adjusted income is ¾ of theirs. The overlap coefficient is large, positive and highly significant for each of the less generous parent categories. F-tests fail to reject the null hypothesis that $\gamma_1 = \gamma_2$ but strongly reject the null that $\gamma_1 = \gamma_2 = \gamma_3$. To the extent that high self-reported generosity is predictive of the giving equilibrium, these results also align with the model and our previous results in that financial aid is inframarginal for children of the most altruistic parents but that it matters for the children of other parents.

7. Summing up

We develop an analytic model that tells us precisely how to approach the data to examine whether borrowing constraints affect education decisions. The key issue is whether parents meet their expected family contribution. Children whose parents do not will have a harder time financing college than will other children. Issues may arise with any single specification we examine. But we have not been able to come up with a coherent alternative explanation to borrowing constraints for the empirical patterns we have documented. Specifically, close birth spacing is a strong predictor of college financial aid. Among the children of a parent who makes no post-schooling transfers, siblings with closer birth dates complete more education than their siblings with more isolated birth dates. Birth spacing does not matter for families making post-college transfers. The effects only appear for middle-wealth families who would be expected to not receive complete financial aid or no financial aid. The effects are larger during periods when more financial aid is available. Similar results arise when the sample is split based on an

experimental proxy for parental altruism: Birth spacing has no effect on educational attainment of children with the most altruistic parents while spacing is significant for children with less altruistic parents. We think the evidence, taken together, supports the implications of the model where strategic concerns result in some parents investing less than the efficient level in their children's education.

Kane (2006) surveys the extensive literature documenting the fact that college attendance is responsive to changes in financial aid. To a certain extent this is the expected response to "price effects," namely, that financial aid makes education less expensive, so more of it is purchased. In the notation of our framework, recall that the marginal condition dictating the optimal choice of education is given by $h'(e)=R$. If prices are all that matters, financial aid makes e cheaper, whether through loans or grants, and hence it must rise in equilibrium. Why do our results not simply reflect the fact that education decisions respond to price? There are two reasons.

First, most loans come with a cap on borrowing. Suppose for example that the optimal investment is around $15,000 for a child. Federal loans will rarely subsidize this entire amount. If a smaller amount is borrowed at a lower interest rate, the marginal condition remains unaffected. So long as the parent or the child is contributing at least a dollar to the child's education, the marginal dollar is subject to the market interest rate and not the lower, subsidized rate. Since almost all of our families contribute a positive amount to their children's education, this increases our confidence that the loans are infra-marginal for the families that are intergenerationally unconstrained to begin with.

Second, our results are quite specific: we see that closely spaced children in families in the middle wealth tercile get more education than their siblings spaced farther apart, but only in families that make post-college transfers. Families in the $g_2 > 0$ sample also receive greater

financial aid when their children are closely spaced. Yet there is no evidence that closely spaced siblings in these families get more education than their siblings spaced further apart, either in aggregate or in any wealth tercile. Finding effects in the $g_2 = 0$ sample but no significant effects in the $g_2 > 0$ sample is consistent with the implications resulting from our analytic framework. If price effects are driving the empirical patterns in the data, it is not clear why they would be present in only one of the six distinct wealth tercile groups that we examine.

IV. Conclusions

A student's federal assistance for college is determined based on their parents' presumed ability to pay, and standards for financial independence from parents are stringent. Parents are under no legal obligation to meet their expected contribution as specified in federal financial aid formulas. If parents refuse to pay, children may face financial constraints in attending college. According to their parents, a third of all children in the Health and Retirement Study who got some post-secondary education did so without their parents' financial assistance. This fact is not solely a consequence of need-based financial aid differences. A quarter of children whose parents held $200,000-$400,000 in net worth in 2000 attended college without parental support, as did 16 percent of those whose parents' net worth exceeded $400,000. The scope for some students having financial difficulty in attending college appears quantitatively important.

Given this fact, we present a theory of efficient human capital investment, focusing on the roles of parent and child decisions and financial aid. The theory implies that financial aid increases the educational attainment of intergenerationally constrained children who receive no post-schooling gifts from their parents, but financial aid does not matter to the attainment of intergenerationally unconstrained children. These effects each rely on an asymmetry in the access of parents and their college-aged children to credit.

Estimates using data from the HRS support the model's predictions. Based on an idiosyncrasy in the dependence of U.S. financial aid on the number of children a parent has in college, we use years of overlap with college-age siblings as a proxy for financial aid. We find the educational attainment of children whose parents are not observed to make post-schooling cash gifts is affected by financial aid. The educational attainment of children whose parents do make gifts is not affected by financial aid. These results, along with a series of specification and robustness tests, suggest that parents can relieve educational borrowing constraints for their children, but that they do not always choose to do so. The results further indicate that parents and children make distinct choices regarding children's schooling, and that these choices may well be consequential for financial aid policy.

To provide some perspective on magnitudes of our results, the coefficient on overlap for the no gift group drawn from the full HRS sample in Table 2, for example, indicates that a college student with no siblings in college (during all four years) attains almost one semester less schooling than a student who has one sibling in college for each of the four years, all else equal. If we assume that first term aid behaves similarly to aid in other college terms, and that a degree is earned by NLSY-97 cohort students in 8 semesters (or 15 quarters), then the NLSY-97 Appendix Table 2 estimates imply that the child with one sibling in school in each term can expect, on average, $2,864-$5,370 more financial aid than the only child over the course of a bachelor's degree. Put differently, that amount of financial aid would result in nearly one semester more educational attainment, assuming that the relationship of aid to birth spacing is similar for NLSY-97 children and children of HRS respondents.

A large, insightful prior literature documents empirical relationships that authors interpret as being consistent with educational borrowing constraints (see, for example, Manski and Wise,

1983; Hauser, 1993; Kane, 1994; Card, 1999; Kane and Rouse, 1999; Ellwood and Kane, 2000; Keane and Wolpin, 2001; Rothstein and Rouse, 2007; and, at least in data from the National Longitudinal Survey of Youth, 1997 cohort, Belley and Lochner, 2007). The same can be said for the papers that argue that U.S. educational credit markets are nearly complete by Cameron and Heckman (1998, 2001), Shea (2000), Carneiro and Heckman (2002), Cameron and Taber (2004), and Stinebrickner and Stinebrickner (2008).[36]

Our paper does not resolve this tension in the literature. But by modeling explicitly how the interactions between parents and children may rationally lead to credit constraints for college, it offers a new perspective on the nature of credit constraints. Our framework also suggests that research strategies that attempt to investigate the importance of credit constraints by examining the income gradient of college attendance or of educational attainment will be difficult to interpret.

In our model, holding all else equal, educational attainment will vary *inversely* with parental resources for those intergenerationally constrained families where parents contribute nothing to their children's education. The explanation comes directly from financial aid rules. As parents' resources increase, the expected family contribution (EFC) increases. If children have parents who refuse or are unable to meet the EFC, the larger the unmet EFC, the more difficulty the child will have in financing college. For low-income families who get full financial aid, educational attainment will be non-decreasing with parental resources. Of course other factors, some likely unobserved, may lead to a positive correlation between parental income and educational attainment. The relationship between parental income and their children's educational attainment will be difficult to interpret in empirical studies that mix families willing to meet and

[36] Carneiro and Heckman (2002) find that up to 8 percent of the relevant U.S. population may be short-run credit constrained.

unwilling to meet their expected family contribution

Our results provide evidence that the inability to borrow against future earnings affects the educational attainment of a set of children living in families where parents, for one reason or another, are unwilling or unable to meet their expected family contribution. Increases in financial aid for these children would increase educational attainment. At the same time, greater financial aid would likely reduce contributions made by families currently meeting (or exceeding) their expected family contribution. So policy-makers will need to grapple with this tradeoff – providing marginal subsidies for borrowing constrained students against infra-marginal subsidies to families willing to support their children's educational goals. Our evidence suggests that financial aid increases can increase educational attainment, though clearly at a cost that exceeds a perfectly targeted policy.

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Appendix A: Proofs

Constraints $a^k \geq 0$ and $e^k \geq 0$ both bind for the child if the parent chooses e^p, a^p and g_1 such that

$$u'(g_1) \geq \beta \max\left\{R, h'(e^p+\tau)\right\}\left(1+\frac{\partial g_2}{\partial(h(e^p+\tau))}\right)u'(h(e^p+\tau)+g_2(Ra^p, h(e^p+\tau))). \qquad (7)$$

Lemma 1: If $g_2 > 0$ in equilibrium, then it must be the case that $a^k = 0$.

The intuition behind lemma 1 is that, since both the parent and the child earn return *R* on physical capital investment, the parent who anticipates a positive second period gift will always prefer to save for the child. A formal proof of lemma 1 is available from the authors.

Lemma 2: In the first period, the parent can do no better than to choose (g_1, a^p, e^p) to maximize $\left\{u(c_1^p)+\beta u(c_2^p)+\alpha\left(u(g_1)+\beta u(c_2^k)\right)\right\}$ subject to $c_1^p + a^p + e^p + g_1 = x^p$, $c_2^p = Ra^p - g_2(Ra^p, h(e^p))$, $c_2^k = h(e^p) + g_2(Ra^p, h(e^p))$, $g_2(Ra^p, h(e^p))$ as in (1), and $e^k \geq 0$ and $a^k \geq 0$ binding for the child.

Assume an equilibrium consisting of

$$(e^p, a^p, g_1, e^k, a^k, g_2(Ra^p, Ra^k + h(e^p + e^k + \tau)))$$

where $e^k + a^k > 0$, and associated consumption levels

$$\{c_1^p, c_2^p, c_1^k, c_2^k\} = \{x^p - g_1 - e^p - a^p, Ra^p - g_2(Ra^p, Ra^k + h(e^p + e^k + \tau)),$$
$$g_1 - e^k - a^k, Ra^k + h(e^p + e^k + \tau) + g_2(Ra^p, Ra^k + h(e^p + e^k + \tau))\}.$$

We find that the parent can replicate the consumption paths of any such equilibrium by deviating from the equilibrium in period 1 to choose first period transfer $\tilde{g}_1 = g_1 - a^k - e^k$, savings $\tilde{a}^p = a^p + a^k$ and human capital investment $\tilde{e}^p = e^p + e^k$. In the deviation, constraints $e^k \geq 0$ and $a^k \geq 0$ bind for the child. This implies that the parent can replicate any feasible consumption path by choosing (g_1, a^p, e^p) in the first period such that $e^k \geq 0$ and $a^k \geq 0$ bind. Therefore the parent can do no better than to choose her most preferred period 1 (g_1, a^p, e^p) subject to $e^k \geq 0$ and $a^k \geq 0$ binding for the child. A formal proof of lemma 2 is available from the authors.

Proof of Proposition 1:

Proof Given Lemma 2, consider the parent's solution to

$$\max_{g_1, a^p, e^p} \left\{u(c_1^p)+\beta u(c_2^p)+\alpha\left(u(g_1)+\beta u(c_2^k)\right)\right\}$$

$$\text{s.t.} \quad c_1^p + a^p + e^p + g_1 = x^p,\ c_2^p = Ra^p - g_2(Ra^p, h(e^p+\tau)), \qquad (8)$$

$$c_2^k = h(e^p+\tau) + g_2(Ra^p, h(e^p+\tau)),\ g_2(Ra^p, h(e^p+\tau)) \text{ as in (1),}$$

and $e^k \geq 0$ and $a^k \geq 0$ binding for the child.

Recall that the requirement that condition (7) holds is equivalent to the requirement that $e^k \geq 0$ and $a^k \geq 0$ bind. Suppose that the parent is permitted to choose g_2 such that $u'(Ra^p - g_2) = \alpha u'(h(e^p + \tau) + g_2)$, even if this implies $g_2 < 0$. Without imposing (7), the parent's choice of (g_1, a^p, e^p) meets conditions

$$\begin{aligned} &u'(c_1^p) = \alpha u'(g_1),\ u'(c_1^p) = \beta R u'(c_2^p),\ h'(e^p + \tau) = R,\ u'(c_2^p) = \alpha u'(c_2^k), \\ &\text{where } c_1^p = x^p - g_1 - e^p - a^p,\ c_2^p = Ra^p - g_2,\ \text{and } c_2^k = h(e^p + \tau) + g_2. \end{aligned} \tag{9}$$

Conditions (9) imply $u'(c_1^k) = \beta R u'(c_2^k)$. In transfer expression (1), $\dfrac{\partial g_2}{\partial(h(e^p + \tau))} \leq 0$. Given $h'(e^p + \tau) = R$ in (9), it must be the case that

$$\begin{aligned} &u'(g_1) = \beta R u'(c_2^k) \\ &\Rightarrow u'(g_1) \geq \beta \max\{h'(e^p + \tau), R\}\left(1 + \frac{\partial g_2}{\partial(h(e^p + \tau))}\right) u'(c_2^k) \end{aligned}$$

and therefore (7) is satisfied at the parent's preferred feasible (g_1, a^p, e^p). Conditions (9) are met by a unique set of consumption levels $\{c_1^p, c_2^p, c_1^k = g_1, c_2^k\}$. If conditions (9) can be met with $g_2 \geq 0$, then these consumption levels result from the parent's optimal actions given her resource constraints and the choices available to the child.

However, it is possible that conditions (9) cannot be met with $g_2 \geq 0$. Where $g_2 \geq 0$ binds for the parent, the solution to (8) is such that

$$\begin{aligned} &u'(c_1^p) = \alpha u'(g_1),\ u'(c_1^p) = \beta R u'(c_2^p),\ \ h'(e^p + \tau) > R,\ u'(c_2^p) > \alpha u'(c_2^k), \\ &u'(g_1) = \beta h'(e^p + \tau) u'(c_2^k), \\ &\text{where } c_1^p = x^p - g_1 - e^p - a^p,\ c_2^p = Ra^p, \text{ and } c_2^k = h(e^p + \tau). \end{aligned} \tag{10}$$

Note that $h'(e^p + \tau) > R$, $u'(g_1) = \beta h'(e^p + \tau) u'(c_2^k)$, and $\dfrac{\partial g_2}{\partial(h(e^p + \tau))} \leq 0$ together imply

$$\begin{aligned} u'(g_1) &= \beta h'(e^p + \tau) u'(c_2^k) \\ &\geq \beta \max\{h'(e^p + \tau), R\}\left(1 + \frac{\partial g_2}{\partial(h(e^p + \tau))}\right) u'(c_2^k), \end{aligned}$$

so that again (7) need not be imposed. Like conditions (9), conditions (10) are satisfied by a unique set of consumption levels $\{c_1^p, c_2^p, c_1^k = g_1, c_2^k\}$. In either case, Lemma 2 implies that the parent's lifetime welfare at this consumption vector, $u(c_1^p) + \beta u(c_2^p) + \alpha\left(u(c_1^k) + \beta u(c_2^k)\right)$, represents the maximum equilibrium welfare available to the parent given the resource constraints and the child's available choices. The uniqueness of the consumption levels that solve (8) implies that no other set of feasible consumption levels yields higher welfare for the parent, and therefore $\{c_1^p, c_2^p, c_1^k, c_2^k\}$ represents the family's unique equilibrium consumption, completing the proof of *(i)*.

We know, based on (9) and (10), that $\{c_1^p, c_2^p, c_1^k, c_2^k\}$ can be generated by only one set of parental choices $\{g_1, a^p, e^p, g_2\}$ at which $e^k \geq 0$ and $a^k \geq 0$ bind. It may still be the case, however, that this same consumption path can be supported by different transfers and investments where e^k and a^k take positive values. Define $\left\{c_1^p(0), c_2^p(0), c_1^k(0), c_2^k(0),\ g_1(0), a^p(0), e^p(0), g_2(0)\right\}$ as the values of $\left\{c_1^p, c_2^p, c_1^k, c_2^k, g_1, a^p, e^p, g_2\right\}$ in the only equilibrium in which $e^k + a^k = 0$. The parent transfers to the child through $g_1(0)$, $e^p(0)$, and $g_2(0)$. We seek to determine whether the same consumption is supported when the parent transfers some portion of $g_2(0)$ or $e^p(0)$ through g_1, expecting the child to save for herself or invest in her own education.
When $g_2(0) > 0$, the answer is clear. The child's choices of e^k and a^k meet condition (2) where $e^k + a^k > 0$. Whenever $g_2(0) > 0$, (1), (2), and $h'(e^p) = R$ together imply $u'(c_1^k) < \beta R u'(c_2^k)$. However, among conditions (9) is the requirement that $u'(c_1^k) = \beta R u'(c_2^k)$. Thus whenever $g_2(0) > 0$, the parent and the child disagree on the child's optimal intertemporal consumption path. Allowing the child to save independently or invest in her own education will lead to consumption other than $\{c_1^p(0), c_2^p(0), c_1^k(0), c_2^k(0)\}$. Thus the $e^k + a^k = 0$ equilibrium is the only set of actions that supports the parent's preferred $\{c_1^p, c_2^p, c_1^k, c_2^k\}$. The parent chooses $\{g_1, a^p, e^p, g_2\} = \{g_1(0), a^p(0), e^p(0), g_2(0)\}$ as in (3) in this unique equilibrium, imposing $e^k + a^k = 0$ and $h'(e^p + \tau) = R$. This completes the proof of *(ii)*.

When $g_2(0) = 0$, however, the parent may reallocate transfers and still achieve $\{c_1^p(0), c_2^p(0), c_1^k(0), c_2^k(0)\}$. Only the reallocation of e^p to g_1 must be considered. Define $\underline{e}$ such that $u'(Ra^p(0)) = \alpha u'(h(\underline{e} + \tau))$. Suppose that the parent increases g_1 to $g_1 = g_1(0) + \varepsilon$, where $\varepsilon \in \left(0, e^p(0) - \underline{e}\right]$, while maintaining $a^p = a^p(0)$ and $g_1 + e^p = g_1(0) + e^p(0)$. Since $e^p \geq \underline{e}$, the second period transfer is still zero. Further, the child's choice of $e^k = 0$ given $\left(g_1(0), a^p(0), e^p(0)\right)$ implies that she chooses an e^k at which $e^p + e^k \leq e^p(0)$ given $\left(g_1(0) + \varepsilon, a^p(0), e^p(0) - \varepsilon\right)$. Therefore, by conditions (10), $h'(e^p + e^k + \tau) > R$ and the child's condition (2) determining her choice of e^k reduces to

$$u'(c_1^k) = \beta h'(e^p + e^k + \tau) u'(c_2^k).$$

Since the above agrees with the intertemporal condition on the child's consumption in (10), we see that the parent's reallocation of $\varepsilon \in \left(0, e^p(0) - \underline{e}\right]$ from e^p to g_1 results in the same equilibrium $\{c_1^p(0), c_2^p(0), c_1^k(0), c_2^k(0)\}$. Finally, condition (2) and the definition of $\underline{e}$ together indicate that where *p* reallocates $\varepsilon \in \left(e^p(0) - \underline{e}, e^p(0)\right]$ from e^p to g_1 the child's educational investment may or may not be such that conditions (10) hold. Therefore where $g_2(0) = 0$ there does exist a continuum of equilibria $\{g_1, a^p, e^p, a^k, e^k\} \in \left[\{g_1(0), a^p(0), e^p(0), 0, 0\},\ \{g_1(0) + e^p(0) - \underline{e}, a^p(0), \underline{e}, 0, e^p(0) - \underline{e}\}\right]$ that

support the unique equilibrium values of $\{c_1^p, c_2^p, c_1^k, c_2^k\}$, and there may exist further equilibria $\{g_1, a^p, e^p, a^k, e^k\} \in \left[\{g_1(0)+e^p(0)-\underline{e}, a^p(0), \underline{e}, 0, e^p(0)-\underline{e}\},\ \{g_1(0)+e^p(0), a^p(0), 0, 0, e^p(0)\}\right]$ that support the unique equilibrium values of $\{c_1^p, c_2^p, c_1^k, c_2^k\}$. Each possible equilibrium satisfies (10) and therefore implies $h'(e^p+e^k+\tau) > R$, completing the proof of *(iii)*.

Proof of Proposition 2*:* In the $g_2 > 0$ equilibrium,

$$h'(e^p+e^k+\tau) = R$$
$$\Rightarrow e^p+e^k = h'^{-1}(R)-\tau.$$

Since $h'^{-1}(R)$ is a fixed and exogenous level of investment, $\frac{\partial(e^p+e^k)}{\partial\tau} = -1$ and total educational investment is invariant to the child's financial aid, completing the proof of *(i)*.

The $g_2 = 0$ equilibrium requires only that $h'(e^p+e^k+\tau) > R$, and in it only $G_1 = g_1 + e^p$ is determined. Recall that $e = e^p + e^k + \tau$. Suppose $\frac{\partial(e^p+e^k)}{\partial\tau} \le -1$. Then $\frac{\partial e}{\partial\tau} \le 0$, $\frac{\partial c_2^k}{\partial\tau} = \frac{\partial h(e)}{\partial\tau} \le 0$ and $u'(c_1^k) = \beta h'(e)u'(h(e))$ from conditions (4) for the $g_2 = 0$ equilibrium implies $\frac{\partial c_1^k}{\partial\tau} \le 0$. With $u'(c_1^p) = \alpha u'(c_1^k)$ and $u'(c_1^p) = \beta R u'(c_2^p)$ from conditions (4), $\frac{\partial c_1^k}{\partial\tau} \le 0$ implies $\frac{\partial c_1^p}{\partial\tau} \le 0$ and $\frac{\partial c_2^p}{\partial\tau} \le 0$. Together these conditions imply $c_1^p + \frac{c_2^p}{R} + c_1^k + h^{-1}(c_2^k)$ is (weakly) decreasing in τ, contradicting the implication of $c_2^p = Ra^p$, $c_2^k = h(e)$ and the combined asset constraints of the problem that $c_1^p + \frac{c_2^p}{R} + c_1^k + h^{-1}(c_2^k) = x^p + \tau$. Therefore $\frac{\partial(e^p+e^k)}{\partial\tau} > -1$ in the $g_2 = 0$ equilibrium, completing the proof of *(ii)*.

Appendix B: An Economic Environment with Greater Realism

In this appendix we extend the baseline model, allowing uncertain earnings and the child to borrow at a higher interest rate than the parent, and we explicitly model the human capital production function of the child, which allows us to model a child's decision to work while in college. We show the central result from our simple model in the text holds: financial aid will have a larger effect on the educational attainment of children from families that do not make financial transfers in the second period ($g_2 = 0$ families) compared to children from families that do make second period transfers ($g_2 > 0$ families). Since we now consider a stochastic version of the model, we can no longer say that all children in the $g_2 = 0$ sample will be constrained in their human capital investment decisions. Instead, we show these children are significantly more likely to under-invest in their human capital than children in the $g_2 > 0$ sample.

We start by assuming the child faces uncertainty in future earnings. The child solves

$$\max\left\{u(c_1^k, l_1^k) + \beta\int u(c_2^k, l_2^k)d\Theta(\theta)\right\},$$

subject to

$$c_1^k + a^k + e^k = g_1 + w(1 - l_1^k - n^k),$$

and

$$c_2^k = R(a^k) + \theta w(1 - l_2^k)h(n^k, e^p + e^k + \tau) + g_2,$$

where the function R is given by

$$R(a^k) = \begin{cases} Ra^k, \text{ if } a^k \geq 0 \\ R'a^k, \text{ if } a^k < 0 \end{cases}.$$

We assume that the rate at which children can borrow R' exceeds the market rate of return R.

In the above formulation, l stands for leisure, n denotes time spent in college, w stands for the wage rate, and θ denotes uncertainty in labor earnings. While the child experiences the same rate of return to savings, R, as does the parent, the cost of borrowing against his or her own future earnings is higher and is denoted by R'. We assume that the distribution from which shocks are drawn is the same for all levels of human capital.[37]

The parent cares about the child, so the parent's decision problem is given by

$$\max\left\{v(c_1^p) + v(c_2^p) + \alpha\left[u(c_1^k, l_1^k) + \beta\int u(c_2^k, l_2^k)d\Theta(\theta)\right]\right\}$$

subject to

$$c_1^p + a^p + e^p + g_1 = x^p$$

[37] If we assumed highly educated households face less uncertainty about their future earnings, we would be more likely to find that parents who do not follow up with post-schooling gifts under-invest in their children's education.

and

$$c_2^p + g_2 = Ra^p$$

The model is now substantially more complicated than before – there are many more choice variables, and uncertainty in earnings breaks the one-for-one link between efficient investment in human capital and second period cash gifts. Hence, this economic environment needs to be solved numerically.

Parameterization

We assume that children's preferences are Cobb-Douglas between consumption and leisure, i.e. $u(c,l) = \frac{\left[c^{\eta} l^{1-\eta}\right]^{1-\theta}}{1-\theta}$ where $0 < \eta < 1$ determines the relative taste for consumption versus leisure. Cobb-Douglas preferences are widely used in the macro literature, since they are consistent with balanced growth, irrespective of the choice for θ. Moreover, this specification implies non-separability between consumption and leisure, which is consistent with some microeconomic empirical evidence (for example, Heckman, 1974). The parameter η can be identified by the share of disposable time people devote to market work. A typical value for η is $\frac{1}{3}$. Our preferences imply that the parameter θ governs both the intertemporal elasticity of substitution for consumption and the corresponding elasticity for hours worked. In particular, the intertemporal elasticity of substitution for consumption is $\frac{1}{\theta}$. A standard value for θ is 4. The coefficient of relative risk aversion is then $1-\eta+\eta\theta$. Our parameters imply a risk aversion coefficient of 2 and a Frisch labor supply elasticity of 1. We experiment with η between 0.1 and 0.5 and θ between 1 and 6. These cover the range of available estimates for the labor supply elasticity and risk aversion.

Our human capital production function is parameterized as $h(n,e) = zn^{\gamma_1}e^{\gamma_2}$. Time and goods inputs are combined with ability, z, to produce human capital. This specification follows the pioneering work of Ben Porath (1967). There are numerous papers that estimate the parameters γ_1 and γ_2. A prominent set of estimates suggest that the returns to scale in the human capital production function, $\gamma = \gamma_1 + \gamma_2$ are 0.9 or higher (see Browning, Hansen and Heckman, 1999).[38] In our baseline parameterization we assume that $\gamma = 0.9$ and $\gamma_2 = 0.3$. Finally, we assume that R equals 5 percent while R' equals 10 percent. Here, we have in mind uncollaterized loans such as credit card loans that typically come with an interest rate well above 10 percent. Higher values of R' would make our results stronger.

[38] If $\gamma_2 = 0$, expenditures do not affect human capital production

The distribution of earnings after college is the result of two underlying sources of heterogeneity. First, children are different on the basis of their ability before college. This reflects both innate differences in children as well as differences in acquired human capital before college. Second, earnings are also affected by luck shocks that the child realizes after completing college. Two moments are used to parameterize the two distributions – the distribution of schooling and the distribution of earnings. We obtain this information from the Health and Retirement Study.

Results

As we have noted several times, uncertainty breaks the tight link between the optimality (from the child's perspective) of first period education transfers and second period financial transfers. Given this, our strategy is to split the sample into those who do give gifts and those who do not and then examine whether families who do not pass on gifts are more likely to under-invest.

In the baseline specification of preferences, we find that 69 percent of families who do not pass on gifts in the second period, under-invest in college education. In contrast, only 17 percent of families who do end up with positive post-schooling cash transfers under-invest in their children's education.

It is instructive to examine the implications of two assumptions – the possibility of borrowing while in college and work while in college. If we assume that work while in college is not possible and that the child cannot borrow against future income, then fraction of households (with zero gifts) that under-invest increases to 87 percent from 69 percent. This suggests that while both these options relieve borrowing constraints, a substantial fraction of parents who do not give gifts still have children who are unable to get the efficient level of education, even when work and high-cost borrowing are available. As mentioned earlier, we also experiment with a range of parameter values, allowing η to vary between 0.1 and 0.5 and θ to vary between 1 and 6. Then the fraction of households with zero gifts that under-invests ranges from 59 percent to 91 percent depending on parameter values, and this fraction is always substantially higher than the group that does give gifts.

These results add to our confidence that the main implications of our simple model stand up to further scrutiny. This is perhaps not all that surprising since the results depend on two assumptions – parents are altruistic and human capital production is subject to diminishing returns. The assumptions (along with optimizing behavior) will lead parents to equate the marginal return to investing in education to the real financial market rate of return. Parents who get to this margin will then give post-college gifts. Parents who do not, will be significantly less likely to give post-college gifts.

Table 1: Child-Level Descriptive Statistics for the Health and Retirement Study Samples

Variable	Sample	Sample size	Mean	Median	Standard deviation
Parent made any gift to children, 1998-2004	1998-2004 Cores	34,593	0.4888	0.0000	0.50
Parent ever made major gift to child	1994 Module	1262	0.3700	0.0000	0.4988
Parent's 2000 household income	2000 Core	34,593	$42,155	$25,588	$64,439
	1994 Module	1262	$48,975	$35,000	$49,734
Parent's 2000 household net worth	2000 Core	34,593	$299,689	$111,000	$799,255
	1994 Module	1262	$309,531	$149,950	$571,914
Child years of education	2000 Core	34,593	13.80	13.00	6.875
	1994 Module	1262	13.30	12.00	2.194
Child gender (male = 1)	2000 Core	34,593	0.5004	1.0000	0.5000
	1994 Module	1262	0.4857	0.0000	0.5000
Child age in 2000	2000 Core	34,593	41.82	41.00	9.64
	1994 Module	1262	40.73	41.00	6.45
Oldest child indicator	2000 Core	34,593	0.2856	0.0000	0.4517
	1994 Module	1262	0.2647	0.0000	0.4413
Youngest child indicator	2000 Core	34,593	0.2617	0.0000	0.4395
	1994 Module	1262	0.2361	0.0000	0.4249
Years of overlap with siblings' college ages	2000 Core	34,593	2.337	2.000	2.130
	1994 Module	1262	2.631	2.000	2.141

Note: Sample children are aged 24 and older.

Table 2: Family Fixed Effect Estimates of Years of Schooling, HRS, Gift v. No Gift

	1998-2004 Gifts to Children		Transfer Module Gifts to Children	
	Gifts	No Gifts	Gifts	No Gifts
Independent variable	**Parameter (Std error)**	**Parameter (Std error)**	**Parameter (Std error)**	**Parameter (Std error)**
Child gender, male=1	-0.242***	-0.086	-0.249	-0.314**
	(0.087)	(0.088)	(0.195)	(0.134)
Child age	-0.014	-0.048***	-0.008	-0.051***
	(0.013)	(0.012)	(0.029)	(0.018)
Oldest child indicator	0.147	0.296**	0.079	0.290
	(0.117)	(0.121)	(0.258)	(0.186)
Youngest child indicator	0.119	-0.089	0.187	-0.056
	(0.124)	(0.126)	(0.265)	(0.194)
Sibling-years of overlap	0.034	0.105***	-0.050	0.094**
in college ages	(0.031)	(0.030)	(0.064)	(0.046)
Number of Children	16,892	17,701	467	795
Number of Families	4890	4581	125	209
R-squared	0.5934	0.6521	0.5713	0.5941
Adjusted R-squared	0.4276	0.5304	0.4073	0.4454

* indicates significance at the 10 percent, ** at the 5 percent, and *** at the 1 percent level.

Table 3: Family Fixed Effect Estimates of Years of Schooling, HRS

	1998-2004 Gifts to Children		Transfer Module Gifts to Children	
	Gifts	No Gifts	Gifts	No Gifts
Independent variable	**Parameter (Std error)**	**Parameter (Std error)**	**Parameter (Std error)**	**Parameter (Std error)**
Child gender, male=1	-0.241**	-0.088	-0.341	-0.379*
	(0.0878)	(0.089)	(0.0204)	(0.153)
Child age	0.014	-0.048**	-0.014	-0.067**
	(0.013)	(0.012)	(0.029)	(0.023)
Oldest child indicator	0.145	0.297*	0.094	0.331
	(0.117)	(0.121)	(0.273)	(0.216)
Youngest child indicator	0.119	-0.089	0.547	-0.274
	(0.125)	(0.127)	(0.286)	(0.224)
Sibling-years of overlap	0.020	0.070	0.048	0.071
in college ages*Tercile 1	(0.045)	(0.046)	(0.103)	(0.063)
Sibling-years of overlap	0.048	0.189**	0.060	0.197*
in college ages*Tercile 2	(0.051)	(0.047)	(0.083)	(0.082)
Sibling-years of overlap	0.040	0.046	-0.044	-0.047
in college ages*Tercile 3	(0.055)	(0.054)	(0.128)	(0.114)
Number of Children	16,824	17,609	364	582
Number of Families	4869	4557	92	150
R-squared	0.59	0.65	0.59	0.57
Adjusted R-squared	0.43	0.53	0.44	0.41

* significant at 5%; ** significant at 1%

Table 4: Family Fixed Effect Estimates of Years of Schooling, HRS, Around Reform

College Entry	Pre-reform		Post-reform	
1998-2004 Gifts to Children	Gifts	No Gifts	Gifts	No Gifts
Independent variable	Parameter (Std Error)	Parameter (Std Error)	Parameter (Std Error)	Parameter (Std Error)
Child gender, male=1	-0.0707	-0.146	-0.443**	-0.0104
	(0.113)	(0.121)	(0.142)	(0.157)
Child age	0.00553	-0.0610**	-0.00152	-0.0211
	(0.0191)	(0.0182)	(0.0296)	(0.0327)
Oldest child indicator	0.128	0.338*	0.204	0.229
	(0.145)	(0.159)	(0.201)	(0.242)
Youngest child indicator	0.0184	-0.164	0.258	0.0487
	(0.172)	(0.187)	(0.196)	(0.215)
Sibling-years of overlap	-0.231**	0.239**	0.111	-0.0145
in college ages*Tercile 1	(0.0688)	(0.0684)	(0.0656)	(0.0829)
Sibling-years of overlap	0.0710	0.143*	0.0403	0.284**
in college ages*Tercile 2	(0.0716)	(0.0670)	(0.0828)	(0.0874)
Sibling-years of overlap	-0.0296	0.0692	0.114	0.0533
in college ages*Tercile 3	(0.0745)	(0.0758)	(0.0929)	(0.0974)
Number of Children	8180	11,036	8712	6636
Number of Families	3133	3579	3416	2623
R-squared	0.7339	0.6559	0.6248	0.7327
Adjusted R-squared	0.5682	0.4903	0.3821	0.5572

* significant at 5%; ** significant at 1%

Table 5: Family Random Effect Estimates of Years of Schooling, HRS

1998-2004 Gifts to Children:	Gifts	No gifts
Independent variable	**Parameter (SE)**	**Parameter (SE)**
Sibling-years of overlap	0.03	0.07**
in college ages	(0.03)	(0.03)
Number of children	0.01	-0.26**
	(0.12)	(0.11)
Number of children squared	-0.01	0.01
	(0.01)	(0.01)
Child gender, male=1	-0.25***	-0.13
	(0.08)	(0.08)
Child age	0.02***	-0.01
	(0.01)	(0.01)
Oldest child indicator	0.12	0.12
	(0.10)	(0.11)
Youngest child indicator	0.13	0.06
	(0.11)	(0.12)
Parent's 2000 income in 100,000s	0.04	0.59
	(0.15)	(0.42)
Income squared in billions	-0.00	-0.02
	(0.00)	(0.01)
Parent's 2000 net worth in millions	0.37***	0.39
	(0.13)	(0.26)
Net worth squared in 100 billions	-2.24**	-0.98
	(0.92)	(0.76)
Black	0.44**	0.63***
	(0.20)	(0.23)
Hispanic	0.33	-0.94***
	(0.30)	(0.27)
Parent's education less than HS	-0.75***	-0.75***
	(0.18)	(0.20)
Parent some college	0.70***	0.91***
	(0.17)	(0.25)
Parent college graduate	1.27***	0.98**
	(0.22)	(0.39)
Parent post graduate education	1.72***	1.79***
	(0.23)	(0.44)
Mean family effect	13.02***	14.74***
	(0.43)	(0.50)
Total number of children	16565	17327
Number of families	4820	4488

* indicates significance at the 10 percent, ** at the 5 percent, and *** at the 1 percent level.

Table 6: Family Fixed Effect Estimates of Years of Schooling, HRS 2000 Economic Altruism Module

	Altruism Module
Independent variable	**Parameter (Std error)**
Child gender, male=1	-0.0877
	(0.203)
Child age	-0.0464
	(0.0313)
Oldest child indicator	0.581*
	(0.276)
Youngest child indicator	0.134
	(0.286)
Sibling-years of overlap in college ages*Give 3/4	0.0982
	(0.0894)
Sibling-years of overlap in college ages*Give 1/2	0.644**
	(0.109)
Sibling-years of overlap in college ages*Never give	0.398*
	(0.157)
Number of Children	3292
Number of Families	914
R-squared	0.3035
Adjusted R-squared	0.0332

* significant at 5%; ** significant at 1%

Appendix Table 1: HRS Sample Construction

Full HRS 2000 sample, with 1998-2004 gift data	
Initial number of households	13,091
Number of children of these households	40,667
Of these, children with complete age and education data	37,875
Of these, children aged 24 and over	36,353
Of these, children with complete gender and relationship data	36,351
Of these, children with at least 1 sibling	34,610
Of these, have 1998-2004 gift data	34,593
Number of families represented by remaining children	9,471

HRS Wave 2 Module 7 sample	
Initial number of module respondents	827
Number of families represented by the respondents	427
Number of children in the above families	1542
Of these, children with complete age data on all siblings	1536
Of these, children who are 24 and older	1458
Of these, children with gift data	1444
Of these, children with complete education, gender and relationshi	1362
Of these, children with at least 1 sibling	1262
Number of families represented by remaining children	334

Appendix Table 2: OLS Estimates of Financial Aid, NLSY-97

Independent variable	Parameter (Std error)
Sibling-years of overlap in first term of college	358.44**
	(179.52)
Parent's 1997 income, 1000s	-23.84***
	(6.38)
Parent's 1997 income squared, 10000s	7.14***
	(2.33)
Parent's 1997 net worth, 1000s	-2.19**
	(0.98)
Parent's 1997 net worth squared, 10000s	0.06*
	(0.03)
AFQT percentile	-28.97*
	(16.69)
AFQT percentile squared	0.63***
	(0.15)
Constant	3,152.17***
	(463.69)
Observations	2608
R-squared	0.06

* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix Table 3: OLS Estimates of AFQT percentile, NLSY-97

Independent variable	Parameter (Std error)
Sibling-years of overlap in college ages	-0.51**
	(0.22)
Mother's education <HS	-18.13***
	(1.09)
Mother HS grad	-9.51***
	(0.86)
Parent's 1997 income, 1000s	0.24***
	(0.02)
Parent's 1997 income squared, 10000s	-0.07***
	(0.01)
Zero siblings	3.62**
	(1.49)
One sibling	1.88**
	(0.94)
Three siblings	-0.16
	(1.12)
Four siblings	-2.06
	(1.44)
Five or more siblings	-4.36***
	(1.46)
Female	2.81***
	(0.71)
Black	-19.43***
	(0.99)
Hispanic	-10.88***
	(1.09)
Broken home	-3.17***
	(0.83)
Urban	1.95**
	(0.86)
South	0.14
	(0.79)
Constant	50.66***
	(1.68)
Observations	4597
R-squared	0.32

* significant at 10%; ** significant at 5%; *** significant at 1%