Children's Cognitive Abilities and Intrahousehold Parental Investment*

C. Andrew Zuppann†
University of Houston

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Abstract

I estimate how new information about children's cognitive abilities leads parents to adjust investment within and across children. I use the National Longitudinal Survey of Youth matched mother-child data to construct measures of both child cognitive ability and parental investment during childhood. I find that parents respond to improvements in a child's cognitive abilities by devoting more resources towards that child. I find that positive information about one child leads to compensating investments in other children, evidence that parents have a concern for equity within the household.

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†University of Houston. E-mail: cazuppann@uh.edu

1 Introduction

I estimate how new information about children's cognitive abilities leads parents to adjust investment within and across children. Theoretical models and empirical studies of human capital and skill development have found that parental investment has greater returns for higher ability children. If parents learn that one child is higher ability than previously thought they may change the time and resources devoted to that child due to this changing return to investment. In a multi-child household, changes in the abilities of one child may influence how parents distribute resources across all their children.

I use the National Longitudinal Survey of Youth 1979 (NLSY) and the National Longitudinal Survey of Youth - Children and Young Adults datasets to construct measures of both child cognitive ability and parental investment during childhood. Cognitive skills are measured by Peabody Individual Achievement Tests (PIATs) on skills in mathematics, reading recognition, and reading comprehension. To measure parental investment, the NLSY asks questions to construct a HOME investment score, "a unique observational measure of the quality of the cognitive stimulation and emotional support provided by a childs family". Examples of these questions include how many books a child has, how often parents read to the child, and whether parents assist with homework. HOME scores have been shown to be a significant determinant in a child's development. I find further evidence of this effect, as children with higher HOME scores are less likely to have behavioral problems in their teen years, more likely to graduate high school, and have a higher income at age 24.

I use two approaches to evaluate how changes in a child's cognitive abilities change parental investment as measured by the HOME score. First, I simply regress the HOME score on a child's previous test scores including individual child fixed effects and a set of child and family level controls. This estimates how changes in past test scores influence

current investment decisions by the parent. These estimates may be confounded by a large set of possible third factors that affect both the child's cognitive ability and parent's investment decisions as well as unmeasured time dependence in parental investment. For instance, if parents' investment decisions last period had a substantial impact on both the child's cognitive ability as well as the ease of investment this period then this approach will erroneously conclude that cognitive abilities are driving home investment instead of the true, and opposite, causal relation.

To account for these potential confounders, my second approach directly estimates how cognitive ability and parental investments depend on the time path of earlier test scores and HOME scores. This allows me to identify plausible surprises to a child's test scores where a child performed better on a test than we would expect given his/her performance on previous tests and what we know about the family environment to that point. I then estimate the relationship between these surprises in ability and subsequent parental investment.

Both approaches find that parents respond to improvements in a child's cognitive abilities by devoting more resources towards that child. A one standard deviation improvement in test scores leads to a one-tenth of a standard deviation improvement in HOME scores. To place that effect in context, a one standard deviation improvement in HOME scores is associated with roughly a 2.5% increase in age 24 wages.

I next estimate a similar model in households with multiple children, focusing on how positive shocks to the ability of one child lead to changes in parental investment across all children within the household. I find two striking results. First, I find that the own-child effect is weaker in multi-child households than single-child households. Second, I find that positive information about one child leads to compensating investments in other children. Taken together, these results suggest that parents have a large concern for equity within the

household. This leads to underinvestment in children who experience positive ability shocks relative to a set of hypothetical parents that care only about maximizing the joint output of the children.

The paper proceeds as follows. Section 2 discusses related literature on childhood development and parental investment. Section 3 presents a stylized model of investment that captures the equity-efficiency tradeoff parents face. Section 4 describes the data and Section 5 discusses my empirical approach. Section 6 presents the results and Section 7 concludes.

2 Related literature

Coming soon!

3 Model

In this section, I present a stylized model of parental decision making in households with two children. I assume that parents make coordinated decisions on their joint consumption level (c) and child investment (I_1, I_2) to maximize the household utility function

$$U(c, k_1, k_2) = v(c) + \alpha \left[k_1^\sigma + k_2^\sigma\right]^{\frac{1}{\sigma}} \tag{1}$$

$v(c)$ represents how parents value their own consumption. k_1 and k_2 are measures of child utility for child 1 and 2, respectively. Parents are altruistic in that they directly care about their children's outcomes. Parental altruism is measured by α; lower values of α lead to less investment in children.

This paper is primarily concerned with σ, a CES parameter representing how parents

value efficiency versus equity across children. If $\sigma = 1$ then child outcomes are perfect substitutes to the parents and they will only care about efficiency when investing. If parents have these preferences, then we expect parents to attempt to maximize the total value of their children's wages. On the other extreme, as σ tends to $-\infty$, parental preferences become Leontieff between their children. Such parents strongly desire equality of outcomes across both their children. Estimating σ would provide a direct measure of the concern for equity versus efficiency within households.

Parental investment is transformed into child outcomes according to a production function

$$k_i = f(I_i, \theta_i) \tag{2}$$

where θ_i represents the innate ability endowment of child i. I assume f is well-behaved and, more importantly, that higher ability children have a greater return from investment, i.e. $f_{I,\theta} > 0$.[1]

Parents also face a budget constraint of resources within the household which may be devoted towards consumption and investment. I assume that the cost of investing in each child is the same and does not depend on ability levels. Despite its appearance this assumption is not restrictive as such dependence can be fully captured in the human capital production function. Also, I abstract from labor supply decisions and decisions of allocation of time inside versus outside the household.

[1] In a model where higher ability children have a lower return to human capital investments, parents still face an equity-efficiency tradeoff and similar results and proofs can be shown. I omit these here for simplicity.

The parents' maximization problem yield the following tangency condition:

$$\left(\frac{k_2}{k_1}\right)^{1-\sigma} = \frac{\partial f()/\partial I_2}{\partial f()/\partial I_1} \tag{3}$$

which states that the relative returns to investment in both children relate to relative outcomes transformed by $(1-\sigma)$. It is straightforward to establish the relationship between σ and efficiency within the household. If $\sigma = 1$ then the parents' optimal investment strategy is to set the marginal returns of investment equal across both children. In other words, they maximize their total return. As σ falls, then the relative marginal returns to investment adjust and parents begin to equalize k_1 and k_2.

Given regularity conditions on parent's subutility of consumption and the human capital production functions, implicit differentiation of Equation 3 yields the following results on how investment responds to changes in ability of the children:

$$\frac{\partial k_i}{\partial \theta_i} \geq 0 \tag{4}$$

$$\frac{\partial k_{-i}}{\partial \theta_i} \gtreqless 0 \tag{5}$$

Equation 4 says that increases in a child's innate ability will cause parents to increase their investments in that particular child, while Equation 5 says that increases in one child's ability may increase or decrease investments in the other child in the household.

Intuitively, these results arise from income and substitution effects following an improvement in one child's ability. This effectively increases the resources available to the household (an income increase) and increases the return to investment in that particular child (a substitution effect). Since child outcomes are normal goods, the substitution and income effects both push parents to invest more in the more able child. For the other child in the house-

hold, the effects push in opposite directions. The income effect is for parents to increase investment in the other child while the substitution effect causes parents to reduce their investment in that child. The total effect is unsigned and is thus an empirical question.

In my empirical approach I will estimate Equations 2, 4, and 5 and so evaluate how parents change their patterns of investment within the household given their beliefs of children's abilities.

4 Data

The National Longitudinal Survey of Youth provides a unique opportunity to investigate how parents invest in their children. Mothers from the 1979 survey can be matched with all their children from the Children and Young Adult survey, who were surveyed biannually from 1986 to 2010. The matched NLSY mother-child data contains detailed information on childhood cognitive abilities, parental investment, and child outcomes. Cognitive abilities are measured using Peabody Individual Achievement Tests (PIATs), given to children age 4-14 in the sample. The PIATs measure ability in mathematics, reading recognition, and reading comprehension.

To measure parental investment, the NLSY asks questions to construct a HOME (Home Observation Measurement of the Environment-Short Form) score, "a unique observational measure of the quality of the cognitive stimulation and emotional support provided by a childs family". Examples of these questions are: 'How many books does the child have?', 'How often do you talk to the child', 'How much tv does the child watch', 'Do you encourage hobbies?', 'Do you lecture after bad grades? HOME scores have been shown to be a significant determinant in a child's development.

I use hourly wages at age 22 and 24 as measures of child outcomes. The children sample is on average 24 years old at the time of the 2010 survey. Over 60% of the sample are at least 22 and report positive wages in the 2010 survey.

I restrict the sample to single-child and two-child households so children have at most one sibling in the sample. I also include a set of mother demographic variables: race, education, age at birth, and AFQT scores.

Table 1 presents summary statistics of the matched mother-children sample.

5 Empirical methodology

I consider three separate claims in investigating how parental investment in children depends on children's abilities. First, I establish that parental investment, as measured by the NLSY HOME score, is important in the production of human capital. Second, I show that a child's HOME scores responds positively to positive surprises in a child's measured cognitive ability. Finally, I show that positive surprises in one child's ability lead to increases in investment in the other child in the household. These claims are empirical analogues to Equations 2, 4, and 5.

Hypothesis 1. *HOME scores are related to achievement and outcomes.*

This hypothesis states that the HOME score, as measured by the NLSY, is an important determinant in the production of childhood abilities. To test this hypothesis, I run regressions of the following form:

$$\text{test}_t = \alpha + \sum_s \beta_s \text{HOME}_{t-s} + \varepsilon$$

and

$$\text{wage} = \alpha + \beta * \text{HOME} + \varepsilon$$

The first specification estimates how parental investment earlier in a child's life affects their present cognitive ability. This specification directly follows Todd and Wolpin (2007). Since I have panel data on all children in the household, I can also control for individual and family fixed effects. The second specification considers how parental investments during childhood manifest themselves in adult outcomes as measured by wages. This approach is essentially cross-sectional so I cannot include individual fixed effects. However, I can include family fixed effects and identify β through variation in HOME scores and wages between siblings.

Hypothesis 2. *Parents of single children adjust investment following changes to beliefs about cognitive ability.*

The second hypothesis is that a positive surprise in a child's ability will lead parents to increase their investment in that child. Identifying positive surprises is crucial for evaluating this hypothesis. My first approach is to use child fixed effects use child fixed effects and look at how HOME scores at time t respond to positive deviations in test scores at time $t-1$:

$$\text{HOME}_{cta} = \alpha + \beta \cdot \text{test}_{t-1} + \lambda_a + \lambda_c + \varepsilon$$

where c is a child, t is a survey wave, and a is the child's age. Because this specification includes child fixed effects, β can be interpreted as answering the question: If a child performs above his or her usual performance in one year, how does parental investment change in the following year?

A second approach to this question relies on more careful identification of plausible surprises to parental beliefs. By considering the full history of test scores and parental investments for a child, I can estimate the expectation of future test scores and ability. To do so, I estimate the following regression:

$$\text{test}_t = \alpha + \sum_s \beta_s \text{test}_{t-s} + \sum_s \gamma_s \text{HOME}_{t-s} + \lambda_a + \varepsilon$$

Having estimated the expected performance of a child in a given year as a function of past determinants, I construct plausible surprises in cognitive ability as the residual from this estimation:

$$\text{surprise}_{test,t} = \text{test}_t - \hat{\text{test}}_t$$

With these constructed surprises, I then directly estimate the effect of cognitive surprises on parental investment using the specification:

$$\text{HOME}_{cta} = \alpha + \beta \cdot \text{surprise}_{t-1} + \varepsilon$$

Hypothesis 3. *Positive surprises to one child's ability change investment for other children in the household.*

The third hypothesis is that parents adjust their investment in all children in the household when they learn that one child is more able than previously thought. This hypothesis can be evaluated in a similar method as Hypothesis 2 with two approaches: regressions including child fixed effects and constructing plausible surprises to parental beliefs and in-

cluding them in the regressions. Formally, these specifications are

$$\text{HOME}_{cta} = \alpha + \beta \cdot \text{test}_{c,t-1} + \gamma \cdot \text{test}_{sibling,t-1} + \lambda_a + \lambda_c + \varepsilon$$

and

$$\text{HOME}_{cta} = \alpha + \beta \cdot \text{surprise}_{c,t-1} + \gamma \cdot \text{surprise}_{sibling,t-1} + \varepsilon$$

The key parameter from these regressions is γ. If $\gamma > 0$, then parents are behaving in a compensating fashion. As one child becomes more able they respond by increasing investments in the other children in the household.

6 Results

Table 2 present estimates that verify hypothesis 1. I focus exclusively on age 14-15 test scores as a function of all previous HOME scores, although similar patterns are found for test scores at earlier ages. Parental investment, as measured by HOME scores in the NLSY, is associated with improvements in cognitive ability measures later in life. These results hold even with the inclusion of family fixed effects. Siblings with higher levels of parental investment have higher cognitive ability measurements than their siblings.

Table 3 shows estimates of how HOME scores at various childhood ages affect wages and education. In the first panel, we see a consistently positive influence - higher levels of parental investment are associated with higher wages and an increased probability of graduating high school. However, the second panel suggests that these results may be do to unobserved differences across families. Estimates fall to close to zero upon the inclusion

of family fixed effects. Taken together, these estimates suggest that parental investment influences childhood cognitive abilities but these effects may fade out over time.

Evidence for Hypothesis 2 is shown in Tables 4 and 5. I focus only on single-child family to estimate how improvements in cognitive ability affect parent's investment decisions. Table 4 shows that when children have an above average year (relative to their own history) then parents subsequently increase their levels of parental investment.

Table 5 shows that these effects not only persist but are much larger in magnitude using more plausible surprises to parental beliefs of ability. A one standard deviation in all three of the PIAT test scores leads parents to increase our measure of parental investment by one-tenth of a standard deviation. As hypothesized, when the marginal return to parental investment increases, parents devote more resources to that investment.

Turning to the question of how the abilities of own child influence parental investment in other children, Tables 6 and 7 present estimates to test Hypothesis 3. Table 6 suggests that there may not be any effect of improvements in one child's cognitive ability on parental investment on other children. A finding of no effect may still be of interest though, as it is evidence that parents are not reducing investment in the child who became relatively less able.

However, looking at results using more plausible surprises to cognitive ability, I find substantial evidence for compensating parental investment across children. Table 7 shows that surprise information about one child's ability leads to increased parental investment to both children in the household. A one standard deviation increase in one sibling's ability leads parents to increase our measure of parental investment by roughly one-thirtieth of a standard deviation.

Two other striking results emerge from Table 7. First, investment increases more to the

child who experienced the shock. This is consistent with the model predictions that income and substitution effects push in the same direction for that child but in opposite directions for other children in the household.

Second, the magnitude of parents increasing their investment to a child they learn is more able is smaller in a two-child household than a one-child household. This is further evidence that parents have preferences for equity within the household. If the parents were concerned solely with efficiency, then we would expect the same increase in ability to generate the same change in investment behavior where the cost of investing equalizes the new marginal return. Instead, we see that parents who are faced with a trade-off across children do not increase their investments by as much as those without.

7 Conclusion

I have shown that parents care about their children. Parental investment increases cognitive ability and children who become more able receive greater resources from their parents. Parents also appear to care about equity across their children. If one child becomes smarter parents increase their investment in all the children in the household. Further, the increase in investments to the newly able child is less than what would have occurred without siblings.

REFERENCES

Coming soon!

Table 1: Summary statistics of NLSY matched sample, 1-2 children households

maternal characteristics	
% black	12.6%
% hispanic	5.8%
years of education	12.8
mother's age at birth	26.6
child characteristics	
HOME(2-3)	173.3 (39.4)
HOME(4-5)	221.5 (27.3)
HOME(6-7)	216.2 (30.5)
HOME(8-9)	212.4 (31.2)
HOME(10-11)	213.9 (31.4)
HOME(12-13)	212.4 (32.1)
HOME(14-15)	208.3 (32.1)
Hourly wage, age 22	10.2 (5.3)
Hourly wage, age 24	11.3 (5.9)
% graduated HS	71.1%
# of 1 child HHs	1179
# of 2 child HHs	1696

Table 2: Estimates of 'cognitive production function'

Age 14-15:	math		reading recog.		reading comp.	
HOME (12-13)	.06***	(0.007)	.08***	(0.008)	.07***	(0.006)
HOME (10-11)	.07***	(0.008)	.03***	(0.008)	.03***	(0.007)
HOME (8-9)	-.01	(0.007)	-.01	(0.008)	.01*	(0.006)
HOME (6-7)	.03***	(0.007)	.02*	(0.008)	.02***	(0.006)
HOME (4-5)	.08***	(0.007)	.07***	(0.008)	.07***	(0.006)
N	543		544		540	
Family fixed effects:	No		No		No	
Age 14-15:	math		reading recog.		reading comp.	
HOME (12-13)	.07***	(0.008)	.14***	(0.008)	.06***	(0.007)
HOME (10-11)	.04***	(0.011)	.07***	(0.011)	.03***	(0.009)
HOME (8-9)	.08***	(0.008)	.12***	(0.009)	.12***	(0.007)
HOME (6-7)	.00	(0.009)	-.02*	(0.01)	.02*	(0.006)
HOME (4-5)	.03***	(0.008)	-.005	(0.007)	.007	(0.007)
N	543		544		540	
Family fixed effects:	Yes		Yes		Yes	

One and two child families only. Regressions without family fixed effects include controls for mother's AFQT, race, and education.

Table 3: Estimates of HOME's impact on later life outcomes

	Age 24 wage		Age 22 wage		Prob(HS. degree)	
HOME(14-15)	.01**	(.005)	.01*	(.005)	.0008***	(.0003)
HOME(12-13)	.02**	(.009)	.02***	(.008)	.0006**	(.0002)
HOME(10-11)	.03***	(.010)	.02**	(.007)	.0006**	(.0003)
HOME(8-9)	.02**	(.011)	.02**	(.007)	.0007**	(.0002)
HOME(6-7)	.01	(.011)	.01*	(.008)	.0002	(.0003)
Family fixed effects:	No		No		No	
	Age 24 wage		Age 22 wage		Prob(HS. degree)	
HOME(14-15)	.006	(.007)	.01	(.03)	.0007	(.001)
HOME(12-13)	.000	(.016)	.01	(.012)	.0007	(.0002)
HOME(10-11)	.07**	(.03)	-.000	(.016)	.0001	(.0003)
HOME(8-9)	-.003	(.05)	-.03	(.03)	.0006	(.0007)
HOME(6-7)	.15	(.002)	.03	(.03)	.0000	(.0008)
Family fixed effects:	Yes		Yes		Yes	

Each cell is the estimate of a separate regression. One and two child families only. Regression without family fixed effects include controls mother's AFQT, race, and education.

Table 4: Estimates of test scores' impact on subsequent HOME scores, single child families

	(1)		(2)		(3)	
math	.023**	(.007)				
reading recog.			.003	(.004)		
reading comp					.08***	(.01)
N	1699		1693		1408	
Child fixed effects	Yes		Yes		Yes	

Single child households only.

Table 5: Estimates of 'surprises' in test scores' impact on subsequent HOME scores, single child families

	(1)		(2)		(3)	
math (residual)	.35**	(.05)				
reading recog. (residual)			.37***	(.05)		
reading comp. (residual)					.39***	(.07)
N	1699		1693		1408	
Child fixed effects	Yes		Yes		Yes	

Single child households only.

Table 6: Estimates of sibling's test scores' impact on subsequent HOME scores, two child families

	(1)		(2)		(3)	
math	.005	(.04)				
reading recog.			.03	(.04)		
reading comp					0.11***	(.04)
sibling math	-.03	(.03)				
sibling reading recog.			-.08	(.05)		
sibling reading comp					.02	(.01)
N	4538		4508		3300	
Family fixed effects	Yes		Yes		Yes	

Two child households only.

Table 7: Estimates of 'surprises' in sibling's test scores' impact on subsequent HOME scores, two child families

	(1)		(2)		(3)	
math (residual)	.19**	(.08)				
reading recog. (residual)			.13*	(.06)		
reading comp. (residual)					.35**	(.11)
sibling math (residual)	.11**	(.04)				
sibling reading recog. (residual)			.19***	(.04)		
sibling reading comp. (residual)					.13*	(.07)
N	4538		4508		3300	
Family fixed effects	Yes		Yes		Yes	

Two child households only.