Preliminary and Incomplete

Child Endowments, Parental Investments and the Development of Human Capital

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I. Introduction

Growing evidence points to the important role that conditions in early childhood play in determining adult human capital and earnings. Measures of human capital at ages 6-8, for example, can explain 12 (20) percent of the variation in adult educational attainment (wages) (McLeod and Kaiser, 2004; Currie and Thomas, 1999). Child human capital is, in turn, largely determined by parents through initial endowments and the allocation of resources in the household toward investments in children. Thus, to better understand the development or production of human capital and, by extension, why it varies so substantially in society, one must first understand the nature of parental investments, including their productivity, their interaction with initial endowments and their allocation across children. To this end we analyze the intra-household distribution of endowments and investments in the production of human capital in early childhood. The theoretical foundation of our analysis derives from Cunha and Heckman (2007) who present a model in which early childhood is considered a critical period for the production of human capital (cognitive skills in particular) and investments are more productive for children with higher initial endowments. Specifically, we explore 1), whether initial endowments and investments are complements in the production of child human capital, as measured by cognitive ability/achievement, and 2), whether parental investments reinforce initial differences (an implication of complementary production). Third, we move beyond the framework of Cunha and Heckman (2007) to explore how the fertility decision affects child human capital through the distribution of initial endowments and investments in children.

With respect to the first question – whether endowments and investments are complements in the production of human capital - there is very little empirical evidence. This is largely due to lack of data on initial endowments and an exogenous source of investment which is needed for identification. For example, Pitt et al (1990) conclude that endowments and investments are complements. However, the authors have neither a measure of initial endowment nor an exogenous measure of investment. Rather, they approximate initial endowment as the residual of a human capital production function and their measure of investment is the allocation of food within the household.

With respect to the second question, whether parents invest in a compensatory or reinforcing manner, the results are mixed and, again, often hindered by the lack of data on initial endowments and measures of investments. Research conducted without a measure of initial endowment has typically relied on structural methods that do not require measures of initial endowments but rely on strong (and untestable) assumptions (Behrman, Rosenzweig and Taubman, 1994; Ashenfelter and Rouse, 1998). Moreover, measures of investment are typically years of schools or parental time (Hsin, 2009). But these measures are limited: educational investments are typically made later in the life of the child and with the child's own input, and measures of time spent with the child don't vary much within household, except by birth order (Price, forthcoming).

With respect to the third question, how fertility interacts with investments and endowments in the production of human capital, the literature most closely related is that on the quantity-quality tradeoff in children. The original model of the tradeoff postulates that an increase in family size reduces average child quality by increasing the price of producing high quality children. Studies estimating whether such a tradeoff exists typically rely upon an exogenous source of variation in family size such as twin births to estimate how an unexpected increase in family size affects the quality of children. The results of this literature are mixed with some finding no effect of family size on child outcomes (Angrist, Lavy and Scholsser, 2006; Lee, 2009) or a negative effect (Rosenzweig and Wolpin, 1980; Behrman et al, 1989; Black, Devereaux and Salvanjes, 2004; and Rosenzweig and Zhang, 2009). However, this literature, with few exceptions, assumes homogenous children within a household and is concerned primarily with estimating the impact of fertility (quantity of children) on average human capital (quality), and largely ignores how fertility affects the distribution of both endowments and investments (and ultimately human capital) among children in a household.

The innovations of the present study are both conceptual and empirical. Conceptually, we attempt to link the literature on how endowments and investments produce child human capital with the literature on the quantity-quality tradeoff by exploring how the fertility decision affects the distribution of endowments and the parental investment decision in the production of child human capital. Empirically, we argue that our data and specifications represent an improvement over existing work for the following four reasons. First, we have multiple (and arguably better) measures of initial endowments. Specifically, our data include a measure of cognitive development at 8 months of age (Bayley score) in addition to measures of health at birth (eg, birth weight, gestation, length). Second, to answer the first question (whether endowments and investments are complements in the production of child human capital), we exploit exogenous variation in investment in the form of preschool enrollment to aid in identification. Specifically, our sample is a low income sample that spans the launch of Head Start in 1965 and we exploit this exogenous increase in Head Start availability to identify the impact of preschool enrollment on child IQ and cognitive achievement as well as any complementarities with initial endowment in a family fixed effect framework. We find that preschool enrollment has a significant positive effect on cognitive ability and achievement and that there are significant complementarities between investments (preschool) and initial endowments (8 month cognitive development). Specifically, we find that preschool enrollment has a positive and significant impact on 4 year IQ for all, but that the impact is largest for those with a higher initial endowment. By 7 years, the effect of preschool on IQ and achievement has faded for all but the highly endowed for whom the impact persists. These results have important implications for the literature on the interactions between endowments and investments in the production of cognitive ability/achievement as well as the heterogeneous impact of preschool/Head Start on child outcomes.

Third, to answer the question of how parents allocate resources among their children and more specifically, the influence of initial endowments on that decision, we develop an alternative measure of parental investments in response to the limitations of measures typically used (nutrition, education, parental time, etc). This measure of parental investment is a measure of the quality of interaction between the mother and child as observed by a psychologist at 8 months of age. Recent research in the psychological and neuro-biological fields has found the quality of interactions between child and primary care-giver to be a very productive input into offspring human capital and cognitive ability, specifically.[1] With this measure of parental investment, we find that children with a greater initial endowment (as measured by birth weight, gestation, and 8 month Bayley score) receive greater investments as measured by higher quality parental interaction, both across and within households. Moreover, there appear to be important complementarities with this measure of parental investment and initial endowment in the production of 4 year IQ.

[1] Paxson and Schady (2006) are an important exception in the economic literature. Using data from Ecuador, the authors explore the link between poverty and child cognitive development and, in particular, the role of parenting. They find that quality of parenting is lower among poor families and that it is associated with cognitive development.

Our fourth and final empirical contribution is to estimate how fertility affects the average human capital of the children as well as the distribution of investments, endowments and human capital in a household, using three instruments for fertility: changes in access to oral contraception in the 1960s, multiple births and fetal deaths. We find that children in larger families are of lower quality on average as measured by 4 year IQ, 7 year IQ and achievement. However, the size of the impact varies with the choice of instrument, as expected. Importantly, we also find that families with a large number of children are much more likely to reinforce initial differences in endowments than families with a small number of children. In other words, in large families, children with a higher initial endowment receive more investments (relative to their less endowed siblings) than their counterparts in small families, suggesting that modeling investments in children as a simple quantity-quality tradeoff may be too simple. We argue that this observed pattern of fertility and complementary or reinforcing investment is consistent with a model in which investments and endowments are complements in the production of human capital and families that are resource constrained may have more children in order to increase the probability of having a child with a high endowment (assuming that endowments are distributed stochastically) in order to increase the return on their investment. A (near) future version of the paper will include a formal model.

Our results have important implications for our understanding of the human capital production function and the importance of initial endowments and parental investments, both of which are difficult to measure, as well as the role of fertility. In addition, by providing new estimates of the impact of Head Start on multiple measures of cognitive ability and achievement that is based on a strong identification strategy that exploits exogenous variation in Head Start availability within family, it also contributes to the growing literature on the impact of Head Start and other high quality preschool interventions (Currie and Thomas, 1995; Garces, Currie and Thomas, 2002; Ludwig and Miller, 2007.) The rest of the paper is organized in two parts. In the first, we establish that investments and endowments are complements in the production of human capital and that parents tend to invest in a reinforcing manner. In the second part, we explore the quantity-quality tradeoff in children by examining how fertility affects both the average quality of children in a family as well as the distribution of endowments, investments and quality within a family.

II. Are Parental Investments and Endowments Complements in the Production of Human Capital?

A. Background

The theory underlying the first part of our empirical analysis derives from a model originally proposed by Becker and Tomes (1976) that incorporates the insights of Cunha and Heckman (2007). In the model of Becker and Tomes (1976) parents want to maximize each child's total wealth and are also concerned with equity. Parents can maximize total wealth of their children through investments in human capital and/or transfers. Assuming that investments in human capital are subject to diminishing returns, Becker and Tomes (1976) conclude that parents invest in a child's human capital until the marginal rate of return equals the return available on financial investments. Heckman (2007) and Cunha and Heckman (2007) extend the model significantly, incorporating many insights from recent research in child development. They introduce two important concepts that influence our work. The first is the idea of "critical periods" which is the idea that certain periods of childhood are more effective in producing human capital than others. For example, evidence suggests that IQ is can be manipulated at early ages, but that it is largely stable by age 10, implying that investments before age 10 can affect IQ, but that investments after age 10 are unlikely to (O'Connor et al, 2000; Hopkins and Brecht, 1975). This insight guides the selection of our measures of child human capital (IQ at ages 4 and 7, cognitive achievement at age 7). The second concept is the notion of "dynamic complementarity" : human capital in one period raises the productivity of investment in a future period. Two testable implications of this model are 1) that endowments and investments are complements in the production of human capital, and a direct implication of this which is 2) that parents invest more in the human capital of the more highly endowed child because the investment is more productive. In this section we test the first implication and in section III we test the second.

With respect to the first question, there is very little empirical work on the topic. This is largely due to data limitations (ie, lack of measures of initial endowments) and difficulty identifying this effect in a non-experimental setting (ie, the endogeneity of investments). Pitt et al (1990) does find that investments are more productive if expended on a highly endowed child, but the implications of their findings are limited due to the fact that they have no measure of endowment, (but rather uses the residual from a health production function), and because their measure of investment (food resources) is endogenous. The absence of strong empirical support for the notion that investments are more productive among the more highly endowed, however, is particularly notable given that so much of existing empirical work on whether parents invest in a reinforcing manner relies upon it.

B. Data

The National Collaborative Perinatal Project (NCPP) contains comprehensive information on maternal and paternal characteristics, prenatal conditions, birth outcomes and follow-up information through age seven for a cohort of roughly 59,000 births between 1959 and 1965 (of which 17,000 are siblings) in 12 sites (located in 11 central cities) throughout the US. Follow-up information was collected at ages eight months, one year, four years and seven years and includes the results of extensive physical, pathological, psychological, and neurological examinations. The measures of initial endowments available in the data include birth weight, gestation, head circumference and length, and the 8 month Mental and Motor Bayle Scores of development as well as a measure of social/emotional development at 8 months. The 8 month measures of mental and motor development are our preferred measures of endowment because we believe they are less noisy measures of a child's cognitive endowment than other measures such as birth weight.

To generate a Bayley score, the examiner presents a series of test materials to the child and observes the child's responses and behaviors and evaluates individuals along three scales (mental, motor and behavior). We focus on the mental scale which evaluates several types of abilities: sensory/perceptual acuities, discriminations, and response; acquisition of object constancy; memory learning and problem solving; vocalization and beginning of verbal communication; basis of abstract thinking; habituation; mental mapping; complex language; and mathematical concept formation (see Appendix II for the individual items). The 8 month Bayley Motor Development scale assesses muscle control (control of the body) and large and fine motor coordination. Finally, we have a measure of the social/emotional development of the infant which take 1 of 4 values: advanced, normal, suspect and abnormal as determined by a psychologist.

In our sample, the mental Bayley score varies from 0 to 99, with an average of 79 and a standard deviation of 6. Within families, the average difference is 4 (two thirds of the cross sectional standard deviation). In Figure 1A we present the distribution of the 8 month Bayley (standardized mean=0 and standard deviation=1) for our sample and in Figure 2A we present within family differences in the 8 month Bayley measures. There is considerable variation in endowment both across and within families.

With respect to the measures of child human capital available in our data, the average 4 year IQ is 99 and 7 year IQ is 96 with standard deviations of 17 and 15, respectively. Within family, the average differences are 11 and 12 points, respectively. In Figures 1B and 2B, respectively, we present the distribution of 4 year IQ and average within family difference in 4 year IQ, respectively. As with the measure of initial endowment, there is considerable variation in this measure of child human capital both across and within family.

Most of the mothers were recruited for participation in the NCPP primarily through public clinics associated with academic medical centers. As such, they are characterized by greater poverty and less education than the general population at the time. Sample characteristics are presented in Appendix Table 1.

C. Empirical Strategy

The first hypothesis that we test is that initial endowments and investments are complements in the production of human capital. To test this, we estimate models of the following form:

$$\text{Child Human Capital}_{ij} = \gamma_1 \text{Endowment*Investment}_{ij} + \gamma_2 \text{Investment}_{ij} + \gamma_3 \text{Endowment}_{ij} + \gamma_4 X_{ij} + u_j + v_{ij} \quad (1)$$

Where child human capital is measured as IQ at age 4, and IQ, reading and math achievement at age 7; investment is preschool enrollment at age 4, and endowment is measured as the 8 month mental Bayley test score. The main effects of Investment and Endowment are included, as is the interaction term Endowment*Investment which captures the presence, if any, of complementarities in initial endowments and investments in the production of child human capital. Also included as controls in the above equation is u_j, a family-specific fixed effect and X_{ij}, a vector of characteristics that varies across siblings and includes child gender, birth order, maternal age at birth, income at birth and marital status at time of birth. The inclusion of the family fixed effect allows us to control for any unobserved differences across families that might be correlated with both children's endowment and investment.

But interpretation of a positive γ_1 as confirmation of complementarities between endowments and investments in the production of human capital is not straight forward. Investment is likely endogenous and may, for example, simply reflect the fact that parents observe things about their children and the quality of their endowments/human capital that the psychologist (and researcher) does not and this is reflected in the investment measure. [2]

To address this we argue that variation in our measure of investment (preschool enrollment at age 4) is arguably exogenous as it appears to be driven by the launch of Head Start as an 8 week summer program in 1965 which was then expanded in 1966 to a part day 9 month program.[3] In our sample, preschool enrollment increases significantly and discontinuously among 4 year olds in 1966 and continues to increase slightly each year through 1970, the end of our study period

[2] Including the main terms of Endowment and Investment addresses this concern somewhat. However, if the relationship between initial endowments and child human capital is non-linear, then this could be reflected in the interaction term.

[3] In 1960, there were 3.97 million 4 year olds (the primary age of those served by Head Start) and in 1966 Head Start served 733,000 children.

(Figure 3). The sudden increase in preschool enrollment observed (from 7 to 12.5 percentage points, or 73 percent, between 1965 and 1966) combined with the fact that our sample is a low income urban sample, suggests that the arguably exogenous launch of Head Start in 1965/1966 is largely responsible for this growth in preschool enrollment.[4]

Since our sample includes siblings born to the same family before and after 1962 (4 years before the Head Start expansion in 1966), within a given family, some children had no access to Head Start at age 4, while others, by virtue of being born after 1962, did. To control for the fact that access to Head Start increases with birth order, we control for birth order and its interaction with preschool as well.

D. Results

Evidence of the Exogeneity of Preschool Enrollment

Before presenting results of the above regression, we present two pieces of evidence to support our contention that preschool enrollment is exogenous in this sample. First, we link preschool enrollment among high school drop-outs (the population most likely served by Head Start) with local levels of Head Start funding in 1968 (Table 1).[5] We find that Head Start spending per poor person in the city/county of residence in 1968 does not predict preschool enrollment among high school drop outs in 1963, 64 or 65, but that it does predict preschool enrollment in 1966 – 1970 (columns 1-7). Moreover, it appears that Head Start spending is a

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[4] Moreover, evidence presented by Ludwig and Miller (2009) shows that Head Start was launched in 1966 but continued to expand in the years after (owing largely to continual recruitment of providers in the early years) which would explain why the trend in preschool enrollment observed in our data jumps discontinuously in 1966 but then continues to increase in the years immediately after.

[5] These data were generously provided by Ludwig and Miller. For the earliest years of the program they found that only county funding levels for 1968 and 1972 were credible, which is why we use only the 1968 data (1972 is beyond our time frame). While Ludwig and Miller calculate per capita Head Start funding for their analysis, because our sample is a low income sample, we calculate per capita spending per poor person by county for 1968.

better predictor of preschool enrollment among high school drop outs and blacks, consistent with Head Start servicing a disadvantaged population. Regarding the magnitude of the relationship, column 8 suggests that a 100 percent increase in funding leads to a five percentage point increase in preschool enrollment among HS drop outs.[6]

As a second piece of evidence of the exogeneity of preschool enrollment, we show that preschool attendance is uncorrelated with initial endowments, both across and within families. In both the cross section (top panel of Table 2) and within family (bottom panel of Table 2), there is no significant relationship between preschool attendance and multiple measures of initial endowment (birth weight, gestation, 8 month Bayley Score, child social/emotional development), consistent with exogenous preschool enrollment

Preschool Attendance and Human Capital at 4 Years

In the maternal FE regressions, we find that 1) preschool enrollment is highly productive of 4 year IQ (γ_2>0) and that 2) preschool enrollment and initial endowments are indeed complements in the production of 4 year IQ (γ_1>0). Specifically, a child who attends preschool has an IQ at age 4 that is 20 percent of a standard deviation higher than a sibling within the same family who did not go to preschool (Table 3). If that child also had a higher initial endowment, then the effect of preschool attendance on 4 year IQ would be even larger. For example, evaluated at the average within family difference in 8 month Bayley scores, a sibling with a higher Bayley score who attended preschool would have a 4 year IQ that was 33 percent of a standard deviation higher than his siblings with a lower initial endowment. These regressions also include an interaction between birth order and endowment (8 month Bayley) which has no effect on 4 year

[6] Head Start funding in 1968 for these 11 cities ranges from \$4 to \$29 per poor person and preschool enrollment in 1968 ranges from 7 to 15 percentage points among those with a HS degree or less in our NCPP sample.

IQ and which allows us to rule out the possibility that the interaction term preschool*endowment does not reflect a preschool* birth order effect.

Preschool Enrollment and Human Capital at 7 Years (IQ and Achievement)

The results with respect to the impact of preschool enrollment on the human capital of seven year olds differ. Tor 7 year IQ and math achievement scores, the main effects of preschool enrollment and initial endowment decline considerably, but not their interaction, which remains large (Table 3). This suggests considerable heterogeneity in the lasting or longer term effects of preschool on cognitive development. For those with higher initial endowments, the impact of preschool lasts significantly longer than for those with lower initial endowments.

To explore potential sources of heterogeneity in the effect of preschool on 7 year IQ, we interact preschool with birth weight, birth order, and gender and find no significant effects. We do, however, find significant effect for another measure of initial endowment: advanced emotional and social development at 8 months of age which is both positively related to 7 year IQ and interacts positively and significantly with preschool enrollment in the production of 7 year IQ (Table 3B). However, it should be noted that only 203 children are classified as advanced in these data. Moreover, when we include both terns and their interaction with preschool (8 month Bayley*preschool and Advaned emotional development*preschool) the former is unchanged with the latter effect declines slightly and is no longer significant.

Having shown that investments are more productive of human capital among the highly endowed, we turn to testing a direct implication of this: that parents invest more in the highly endowed.

III. Do Parents Invest in a Compensatory or Reinforcing Manner?

A. Background

There is more evidence with respect to this question, though it is still limited by both lack of data on initial endowments and few measures of parental investments that vary within household and do not reflect decisions made by the child. Existing work that does not have measures of initial endowments include Hanushek (1992) who finds that having a siblings with higher measured achievement is positively correlated with own achievement (which he argues is inconsistent with reinforcing investment). Two papers (Ashenfelter and Rouse, 1998 and Behrman, Rosenzweig and Taubman, 1994) base their identification on differences in education and earnings of identical twins relative to fraternal twins, arguing that (unobserved) endowments of identical twins are more similar. They present evidence in favor of complementary investment based on the fact that differences in earnings and schooling are greater for fraternal twins who have more dissimilar endowments. Work based in developing countries such as Pitt et al (1990) relies upon a residual in a human capital production function as a proxy for initial endowment and finds that the more highly endowed receive more investment in the form of nutrition. More recent work (Datar et al, 2009; Hsin, 2009) do proxy for initial endowments with birth weight to estimate how endowments affect parental investment (as measured by breast feeding, nursery school enrollment and maternal time), though neither link endowments and investments with future human capital production. Datar et al (2009) find evidence of reinforcing investments and Hsin (2009) uncovers significant heterogeneity in investment patterns: less educated mothers invest in a re-enforcing manner while more educated mothers invest in a compensatory manner. We return to these results later.

We argue that our work represents an improvement over existing work in that we have multiple (and arguably better) measures of initial endowments. These include measures of health at birth (birth weight, gestation) and measures of cognitive and motor skills at 8 months of age. Moreover, we argue that a second improvement over the current literature is our development of a measure of investment that is, in contrast with existing work which typically defines investment as time, nutrition or education, a measure of the quality of the mother-child interaction as determined by psychologist observation at 8 months of age. We do this for two reasons: 1) data availability and variation in investments within households, and 2) recent research in the psychological and neuro-biological literature showing that the quality of maternal-child attachments in the first years of life is an important determinant of brain development, with significant effects on cognition. We discuss each in turn.

Defining parental investments as time, nutrition or education is problematic. Time is difficult to measure and most variation between siblings within a household is driven by birth order and/or maternal work – both of which likely exert independent effects on child outcomes (Price, forthcoming). Nutrition is easier to measure and there is variation within households – but less so in developed countries where the allocation of food/nutrition is unlikely to vary significantly within household.[7] Finally, education is clearly an important determinant of one's human capital and earnings and does vary within households; however, often these decisions are made at a much later point in the child's life, after many other investments have been made. Moreover, the child is often involved in this decision so that it less arguably reflects parental investment.

[7] Moreover, even if it did, there is no data that we know of that includes allocation of food within households in developed countries.

The second reason we focus on parenting as a measure of parental investment is recent evidence that nurturing environments, and particularly the bond between child and care-giver in the early years, plays an important role in brain development. Much of this literature has been summarized in the Institute of Medicine's From Neurons to Neighborhoods: The Science of Early Childhood Development (2000). The general consensus in the literature is that early attachment between child and care-giver (typically though not exclusively the mother) affects brain development and fosters enhanced cognitive ability.[8]

B. Empirical Strategy

To test whether children with a higher initial endowment receive greater investments, we estimate models of the following form:

$$\text{Parenting}_{ij} = \beta_1 \text{Endowment}_{ij} + \beta_2 X_{ij} + u_j + e_{ij} \qquad (2)$$

Where i indexes each child within family j; Endowment is the child's initial human capital endowment which is measured multiple ways (birth weight, gestation, and 8 month Bayley Score of mental development); u_j is a family-specific fixed effect and X_{ij} is a vector of characteristics described previously.

Our specific measure of investment (referred to as "Parenting" in the above equation) is derived from a psychologist's rating their interaction between mother and child at 8 months of age along the following 7 dimensions: maternal expression of affection (negative to extravagant), handling of the child (rough to very gentle), management of the child (no facilitation to over

[8] Paxson and Schady (2006) represent the first attempt in the economics literature to positively link the quality of parenting with cognitive development in a sample of low income families in Ecuador.

directing), responsiveness to the needs of the child (unresponsive to absorbed), her reaction to the child's test performance (indifferent to defensive), her focus during the child's examination (self to child), and her own evaluation of the child (critical to effusive). A final, 8^{th} dimension is the child's appearance (unkempt to overdressed). To develop a measure of parenting, we use factor analysis (principal factors, unrotated) for the 8 measures (Table 4). Greater detail on the method is provided in Appendix I. We compute the relative importance of each of the 8 measures in the construction of the factor which depends on the share of true variance to total variance. The higher this share, the higher its weight in the construction of the factor. We find that responsiveness and affection towards the child are the most important, while appearance and handling are the least important (Figure 4).

For the single measure of investment generated in this fashion and which varies from -7.6 to 6.3 in the sibling subsample (with a higher value indicating greater investment), 65% of the sample receive the same score (.038) corresponding to average or normal values for all 8 measures, but there is still some variance. Figure 5 displays the distribution of this measure of investment in the cross section in the first graph and within family differences in this measure of investment in the second graph. Within family, for exactly half the sample, there is no difference in parenting across siblings. But for those families that exhibit different parenting across siblings, the differences can be quite large. This is consistent with existing work which has shown that in one to two thirds of families, parents "differentiate in terms of closeness, support and comfort" beginning in early childhood (Suitor et al, 2008, page 334). Throughout the text and tables, we refer to this measure of investment as "maternal focus."

C. Results

Before analyzing whether and how initial endowments affect investment decisions of parents (defined as high quality parenting), we explore how parenting varies with various parental characteristics in an OLS setting. We find that parenting is of higher quality among more educated mothers, higher SES mothers, and older mothers and is also highest among the first born (column 1, Table 5). This is consistent with results based on the NLSY (Bradley et al, 2001) and result based on a developing country (Paxson and Schady, 2007). It is also suggestive of potential omitted variable bias in estimates based on the cross section.

Next we explore the relationship between various measures of a child's initial endowment and our measure of parental investment (maternal focus) in the cross section. Specifically, we estimate the strength of the relationship between birth weight, gestation and 8 month Bayley and investment as specified in equation (1). The results (without family fixed effects) are presented in Table 5 and show that all our measures of initial endowments are positively correlated with maternal focus in the cross section. Birth weight (columns 1 and 2), gestation (columns 3 and 4), and 8 month Bayley Scores (column 5) are all positively correlated with parenting in the cross section. Below each column in Table 5 we present the estimates of the magnitude of the relationship between initial endowments and parenting. Because our measure of investment (maternal focus) is without units, our estimates of the magnitude of the relationship between parenting and endowments are presented in terms of standard deviations. A standard deviation in birth weight increases investment by 4 percent of a standard deviation (column 1); a low birth weight (LBW) birth is associated with a reduction in investment of 8 percent of a standard deviation (column 2); prematurity is associated with a decline in investment of 4 percent of a standard deviation (column 4); a standard deviation increase in the 8 month Bayley Score is associated with 9 percent of a standard deviation increase in maternal focus (column 5). The initial endowments, not surprisingly are positively correlated with one another. In column 6 we include the 8 month Bayle Scores of Mental and Motor Development and find that the mental score is more predictive of high quality parenting. When we include both birth weight and Bayley scores, the relationship between Bayley score and investment remains and is much stronger than the relationship between birth weight and investment (column 7). Finally, in an effort to rule out the possibility that children with a higher initial endowment are easier to parent (the marginal cost is lower), we control for measures of the child's social/emotional development at 8 months of age and find that this is not driving the observed relationship between a child's cognitive endowment and the quality of parenting.

However, these estimates can reflect the fact that parents invest more in highly endowed children, or that parents with more highly endowed children might happen to be better at parenting. By including family fixed effects and limiting identifying variation in to that between siblings, we attempt to rule out the latter. The estimates suggest that greater maternal focus is still positively correlated with child endowments, even within family (Table 6). To assess the magnitude of the relationships, we calculate the effect of the average within family difference in each child endowment on investment, as a percent of the average within family difference in investment (0.54 for the whole sample or 1.1 for those with any difference in investment across siblings). The average difference in birth weight between siblings is associated with or can explain 17 percent of the average difference between siblings in "maternal focus." Gestation can explain a similar amount. In column 6-7 we include birth weight and 8 month Bayley score. We find that the average difference in the 8 month Bayley explains 9 percent of the average within family difference in maternal focus among children and that this effect is robust to the inclusion of these additional characteristics of the child. [9]

IV. How Fertility Interacts with Endowments and Investment in the Production of Human Capital

Finally, we explore how fertility interacts with endowments and investments in the production of child human capital. To do so we proceed in three stages. First, following the existing literature on the quantity-quality tradeoff in children, we estimate whether average child human capital varies inversely with family size. We find that it does. Second, we explore how quantity affects not just the average level of quality of offspring, but how it affects patterns differential investment in children within a family. We find that larger families are more likely to invest in a reinforcing manner. Finally, in an attempt to explain this pattern, we hypothesize that low income families who are resource constrained face an incentive to increase the number of children they have in order to increase the probability of having a highly endowed child for whom investments are the most productive. We provide suggestive evidence in support of this hypothesis in the last subsection.

Causal Evidence on how Fertility Affects Average Child Quality (the Quantity-Quality Tradeoff)

Following the existing literature, we estimate whether average child human capital varies inversely with family size (the quantity-quality tradeoff). To instrument for fertility, we exploit

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[9] As noted previously, however, measures of initial endowment measures at 8 months of age may still be endogenous even in the fixed effect setting if it is already a function of parental investment, suggesting that reverse causality is responsible for the relationship. To address this, we instrument of 8 month Bayley score with body length at birth, birth weight and head circumference. When we instrument for Bayley score, we find that it is still positively correlated with parenting and that the results are very similar to the previous OLS and FE results, suggesting reverse causality is not biasing our results.

three sources of exogenous variation in family size. The first is variation in access to oral contraception which was first introduced in 1957 and approved by the FDA in 1961. Variation across states in access to oral contraception varied with some states exercising bans on advertising and/or sales of oral contraception until a 1964 Supreme Court Decision ruling such bans unconstitutional, after which states legalized the advertising and sale of contraception, but not necessarily immediately (Bailey, 2009). We exploit this variation in access to oral contraception during the 1960s to identify the impact of quantity on average child quality. Specifically, the instrument for total fertility is the number of bans interacted with the child's date of birth.[10] Over time, as states removed their bans, access to oral contraception increased, causing total fertility to decline. Thus, the coefficient on the term OC Bans*DOB in the first stage regression below can be interpreted as a difference-in-differences estimate: those states with a ban should witness a greater increase over time in access to oral contraception and corresponding decline in fertility relative to states with no ban on the advertising or sale of oral contraception. We also interact the term with an indicator for whether the mother is Catholic since we believe Catholics (who comprise 38 percent of our sample) to be less affected by relaxation of the OC bans. The first stage regression is:

$$\text{Fertility}_{ij} = \pi_0 + \pi_1 \text{ OC Bans* DOB}_{ij} + \pi_2 \text{ OC Bans*DOB*Catholic}_{ij} + \pi_3 \text{ OC Bans*Catholic}_{ij}$$

$$\pi_4 \text{ DOB}_{ij} + \pi_5 \text{ DOB*Catholic}_{ij} + \pi_6 X_{ij} + \pi_7 \text{ AMC}_j + \pi_8 \text{ Year of Birth}_{ij} + \pi_9 \text{ truncate }_{ij} + \varepsilon_{ij} \quad \text{(3A)}$$

Fertility_{ij} refers to the number of surviving children born to the mother by the focal child's seventh birthday; the terms OC Bans* DOB_{ij} , $\text{OCBans*Catholic}_{ij}$ and OC $\text{Bans*DOB*Catholic}_{ij}$

[10] This instrument is based on the identification strategy used by Bailey, 2009. Appendix Table 2 lists which cities in our sample had advertising and sales bans in place before the supreme court ruling.

are excluded from the first stage. Note that the main term "OC Bans" is not included because it is constant within state and therefore subsumed by the AMC fixed effects. The vector X_{ij} includes family characteristics (income, marital status, maternal age, Catholic, and maternal education at birth) and child characteristics (gender and 8 month Bayley score). Some regressions also include measures of marital status and income at age 7. The term "truncate" in the above regression is included to control for potential non-random truncation of the fertility measure which arises because we only have information on fertility 7 years after the birth of the study child. As a result, we may have incomplete information on fertility for some children and the degree of undercounting is negatively related to whether the study child has another younger sibling in the sample and the birth spacing.[11]

A second source of variation that we exploit is whether a multiple birth occurred after the birth of the study child. We refer to this as IV2 and the first stage is as follows:

$$\text{Fertility}_{ij} = \pi_0 + \pi_1 \text{ Mult Birth} + \pi_2 \text{ Pregnancies}_{ij} + \pi_3 \text{ DOB}_{ij} + \pi_4 X_{ij} + \pi_5 \text{ AMC}_j + \pi_6 \text{ Year of Birth}_{ij} + \pi_7 \text{ truncate}_{ij} + \varepsilon_{ij} \qquad (3B)$$

Mult Birth takes on a value of 1 if the mother had a multiple birth after the birth of the study child (773 instances in these data). However, because the probability of a multiple birth increases in the number of pregnancies, we also control for the number of pregnancies since the study birth (the latter is included in the second stage as well). This instrument has been used

[11] For example, a child with a youngest sibling born 4 years after will have information on completed fertility up to 11 years after his birth as opposed to a child with no sibling in the sample who will only have information on completed fertility up to 7 years after his birth. The term "truncate" is the number of years between the birth of the youngest sibling in the sample and the study child's birth and it is, as expected, positively correlated with fertility, though its inclusion does not alter the results.

previously. It has been subject to the criticism, however, that because multiple births typically have lower endowments, families that invest in a compensatory manner will shift investments away from the multiple births and towards the other children in the bathroom, reducing the negative impact of quantity on child quality (Rosenzweig and Zhang, 2009).

Thus, we use a third IV strategy which is whether the mother had a subsequent fetal/neonatal death:

$$\text{Fertility}_{ij} = \pi_0 + \pi_1 \text{ Fetal/Neonatal Death} + \pi_2 \text{ Pregnancies}_{ij} + \pi_3 \text{ DOB}_{ij} + \pi_4 \text{ X}_{ij} + \pi_5 \text{ AMC}_j + \pi_6 \text{ Year of Birth}_{ij} + \pi_7 \text{ truncate}_{ij} + \varepsilon_{ij} \qquad (3C)$$

All three instruments differ in ways that we believe should be reflected in the second stage results. IV2 based on multiple births would lead to a smaller second stage estimate than the IV strategy based on fetal death (IV3) because we would not expect investments in the existing children to change with a (future) fetal death as it might with a future multiple birth. Moreover, we would expect the IV strategy based on access to oral contraception to differ from the IV strategies based on multiple births and fetal deaths. While the latter constitute unexpected shocks to family size, oral contraception lowers the price of controlling fertility and changes the incentives faced by a mother, allowing her greater control over her fertility, not less (as in the case of multiple births or fetal deaths). We would expect that lowering fertility via increase in access to oral contraception would have a greater (positive) impact on child quality than lowering fertility through an unexpected negative shock to fertility.

The results of the three first stages are presented in Table 7. As expected OC Bans*DOB has a negative and significant effect on fertility, but not so for Catholics (column 3).[12] In column 4

[12] Column 2 differs from 1 in that it includes the child's endowment, column 3 differs from 2 in that it also includes measures of income, marital status and the irregularity of income at age 7.

and 5 are the first stage estimates for IV2 (multiple births) and IV3 (fetal deaths) respectively. Multiple births increases fertility by 1 and fetal death reduces fertility by less than 1 (-.712) suggesting some replacement fertility in the event of a fetal death. The F statistics range from 24 to 63 depending on specification.

OLS and IV estimates of the relationship between quantity and quality are presented in Table 8. An additional child reduces child quality as measured by IQ at age 4 by .06 of a standard deviation in OLS regressions (columns 1 and 2). The IV estimate based on access to oral contraception as an instrument suggest a much larger effect: decreasing fertility by 1 child improves 4 year IQ of the previous children by 38 percent of a standard deviation (5.5 points). The IV estimate based on multiple births is smaller and insignificant (-.026), while the IV estimate based on fetal death is -.114 suggesting that a reduction in fertility by 1 child via fetal death increases child IQ by 11 percent of a standard deviation or 1.7 points. For the 7 year quality measures (IQ, Math and Reading achievement), the results are similar though generally insignificant for the IV2 estimates.

How Fertility Affects the Distribution of Investments within a Family

Next we explore how quantity affects not just the average level of quality of offspring, but how it affects differential investment in and quality of children within a family. To do so we estimate the following:

$$Y_{ij} = \rho_1 \text{ Endowment*Family size} + \rho_2 \text{ Endowment} + \rho_3 Xij + u_j + v_{ij} \qquad (4)$$

Where Y is investment (maternal focus at 8 months), or child quality (IQ at 4 and 7, achievement at 7). The regressor of interest is the interaction between endowment (the 8 month Bayley score) and family size. A positive coefficient on this interaction term indicates that complementary/reinforcing investment increases with family size. Additional controls include X_{ij} which is a vector that includes child gender, family income, maternal age and marital status at birth as well as indicators for year of birth, and u_j is a family fixed effect. Note that the main effect "family size" is excluded because it is subsumed in the family FE. The regression results presented in Table 9 show that complementary/reinforcing investments are increasing in family size (Panel A, column 1). An implication of this result is that the initial endowment should be more highly correlated with later measures of human capital (quality) in larger families. The interaction is very small and insignificant in the IQ regressions, but positive and significant in the 7 year Math and Reading achievement regressions. One possible explanation, however, is that even though a family has higher fertility, it does not necessarily have more children included in the sample. In Panel B of the Table 9, we present estimates in which we restrict the sample to families in which all children are included in the sample (total fertility=total number of children in the sample). Because this represents a small fraction of the families, the resulting sample size is small and non-random. The regression results for this specification suggest that larger families are characterized by greater reinforcing investment and a stronger correlation between initial endowment and child quality at ages 4 and 7. This is somewhat consistent with previous findings of Hsin (2009) who finds that less educated mothers (who also have more children) invest in a re-enforcing manner in contrast to the more educated who invest in a compensatory manner (and also have fewer children.) This may also serve to reconcile results by Rosezweig and Zhang (2009) and Black, Devereaux and Salvanes (forthcoming) who present results consistent with reinforcing investments in China (a poor country) and compensatory investments in Norway (a rich country) using future twin births as an instrument for fertility.

How Fertility Affects the Distribution of Endowments and Human Capital within a Family

We hypothesize that these results may be driven by an incentive for low income families to increase the number of children they have in order to increase the probability of having a highly endowed child (for whom investments are the most productive). We provide some evidence in support of this hypothesis by presenting the maximum and minimum values of endowment (8 month Bayley) by family size (Figure 6). Consistent with a stochastic distribution of endowments, we see 1) that the spread between maximum and minimum values of initial endowment increases with family size and 2) this is driven by a large decline in the minimum and smaller increase in the maximum endowment by family size. In the second and third panels of the figure, we present the same spread for investment and child quality (7 year IQ), respectively, which follow a similar pattern.

We draw four conclusions from this analysis. First, average child quality declines with fertility. Second, larger families are more likely than smaller families to invest in their children in a reinforcing manner. Third, the probability of having a highly endowed child increases with fertility. Fourth, the maximum child quality declines only slightly with increased fertility, if it all, while the minimum child quality declines significantly, leading to greater variance in child quality within large families. Assuming that endowments are stochastically distributed and that investments and endowments are complements in the production of human capital, we argue that the above findings suggest a model of behavior in which parents who are resource constrained may have more children in an effort to increase the probability of a highly endowed child for whom investments are more productive. A future version of the paper will include a formal model.

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Table 1: Correlation between HS Spending Per Poor Person and Preschool Enrollment

	Mother HS Drop Outs							1968		
	1963-1964	1965	1966	1967	1968	1969	1970	HS Drop Out	HS Grads (no college)	Black
HS spending per poor person in 1968	8.07E-05	0.000106	0.00606	0.00414	0.0048	0.00543	0.00273		0.00385	0.00811
	[0.000757]	[0.00104]	[0.00210]	[0.00172]	[0.00218]	[0.00181]	[0.00129]		[0.00229]	[0.00382]
Ln(HS spending per poor person 1968)								0.0494		
								[0.0177]		
Observations	3905	3245	3325	3483	3708	3190	746	3708	1997	3371
R-squared	0.004	0.011	0.022	0.015	0.013	0.021	0.048	0.015	0.017	0.018

Robust standard errors in brackets (clustered on city of birth)
regressions include controls for offspring gender, birth order dummies, maternal race, and maternal age and marital status at birth
Head Start spending per poor person measured at a county or city level generously provided by Ludwig and Miller.

Table 2 Determinants of Investment Across Families: Dependent Variable= Preschool

Panel A: OLS Regressions	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Birth Weight - Standardized	-0.00247						-0.00297
	[0.00402]						[0.00419]
Low Birth Weight		0.00111					
		[0.0107]					
Weeks of Gestation at Birth			-0.00094				
			[0.00112]				
Premature birth				0.0151			
				[0.0113]			
8 Month Mental Bayley - Standardized					0.000834	0.00384	0.00158
					[0.00354]	[0.00448]	[0.00369]
8 Month Motor Bayley - Standardized						-0.00517	
						[0.00423]	
Maternal Education at Birth	0.00392	0.00391	0.00386	0.00387	0.00391	0.00391	0.00392
	[0.000820]	[0.000820]	[0.000819]	[0.000819]	[0.000819]	[0.000819]	[0.000820]
Maternal Age at Birth	0.000277	0.00027	0.000236	0.00026	0.00024	0.000245	0.00027
	[0.000762]	[0.000762]	[0.000762]	[0.000762]	[0.000761]	[0.000762]	[0.000762]
Family income (real) at pregnancy in $1000	0.000216	0.000212	0.000203	0.000202	0.000211	0.000204	0.000216
	[0.000286]	[0.000286]	[0.000286]	[0.000286]	[0.000286]	[0.000286]	[0.000286]
Married	-0.00713	-0.00722	-0.00859	-0.00848	-0.00754	-0.0073	-0.0071
	[0.00987]	[0.00987]	[0.00987]	[0.00987]	[0.00985]	[0.00986]	[0.00987]
Black	0.0208	0.0208	0.0197	0.0196	0.0202	0.0211	0.0207
	[0.0479]	[0.0479]	[0.0478]	[0.0478]	[0.0478]	[0.0478]	[0.0479]
White	-0.102	-0.102	-0.103	-0.103	-0.103	-0.103	-0.102
	[0.0472]	[0.0472]	[0.0472]	[0.0472]	[0.0472]	[0.0472]	[0.0472]
Hispanic	-0.0611	-0.0614	-0.0617	-0.0618	-0.0616	-0.0613	-0.0611
	[0.0543]	[0.0543]	[0.0542]	[0.0542]	[0.0542]	[0.0542]	[0.0543]
Male	-0.013	-0.0134	-0.0135	-0.0134	-0.0134	-0.0136	-0.0129
	[0.00662]	[0.00659]	[0.00658]	[0.00658]	[0.00657]	[0.00658]	[0.00663]
First born	0.0373	0.0377	0.0369	0.037	0.0373	0.0391	0.0368
	[0.0132]	[0.0132]	[0.0132]	[0.0132]	[0.0132]	[0.0132]	[0.0132]
Second Birth	0.0349	0.0352	0.0348	0.035	0.0349	0.0355	0.0347
	[0.0112]	[0.0112]	[0.0112]	[0.0112]	[0.0112]	[0.0112]	[0.0112]
Third or Fourth Birth	0.0112	0.0114	0.0105	0.0107	0.0112	0.0114	0.0111
	[0.00958]	[0.00957]	[0.00957]	[0.00958]	[0.00957]	[0.00957]	[0.00958]
Observations	10156	10156	10132	10132	10167	10160	10156
R-squared	0.047	0.047	0.048	0.048	0.047	0.047	0.047
Panel B: Maternal FE Regressions							
Birth Weight - Standardized	0.00039						0.00151
	[0.00857]						[0.00880]
Low Birth Weight		-0.00928					
		[0.0191]					
Weeks of Gestation at Birth			-0.00209				
			[0.00190]				
Premature birth				0.00789			
				[0.0187]			
8 Month Motor Bayley - Standardized						-0.00298	
						[0.00680]	
8 Month Mental Bayley - Standardized					-0.00309	-0.00147	-0.00327
					[0.00569]	[0.00679]	[0.00584]
Observations	10157	10157	10133	10133	10168	10161	10157
R-squared	0.739	0.739	0.739	0.739	0.738	0.738	0.739

Standard errors in brackets

AMC FE and year of birth indicators included in top panel

Maternal FE and year of birth indicators included in bottom panel

Table 3 Are Investments and Endowments Complements in the Production of Child Human Capital?

	IQ 4	IQ 7	Read	Math
Investment(preschool)*8 Month Bayley	0.165	0.104	0.0298	0.16
	[0.0420]	[0.0415]	[0.0473]	[0.0507]
8 Month Mental Bayley - Standardized	0.152	0.164	0.0199	0.0381
	[0.0298]	[0.0293]	[0.0315]	[0.0337]
Investment(Preschool)	0.163	0.0196	-0.0287	0.00878
	[0.0382]	[0.0395]	[0.0411]	[0.0440]
BO*8 Month Bayley	-0.00707	-0.0103	0.00393	0.00798
	[0.00709]	[0.00711]	[0.00763]	[0.00817]
Maternal Age at Birth	-0.0074	-0.0224	-0.00563	0.0177
	[0.0224]	[0.0226]	[0.0235]	[0.0252]
Family income (real) at pregnancy in $1000	0.000584	0.00101	-0.00134	8.57E-05
	[0.00117]	[0.00120]	[0.00125]	[0.00134]
Married	-0.0391	-0.0175	-0.0477	-0.101
	[0.0494]	[0.0503]	[0.0522]	[0.0558]
Male	-0.111	0.0282	-0.17	-0.0746
	[0.0214]	[0.0219]	[0.0227]	[0.0243]
First born	-0.202	-0.0144	-0.0598	-0.133
	[0.101]	[0.0852]	[0.0886]	[0.0948]
Second Birth	-0.0788	-0.00775	-0.0385	-0.00745
	[0.0789]	[0.0691]	[0.0717]	[0.0767]
Third or Fourth Birth	-0.0199	0.00099	0.013	0.0223
	[0.0539]	[0.0501]	[0.0519]	[0.0556]
Observations	9956	9229	9204	9205
R-squared	0.844	0.845	0.815	0.787

Standard errors in brackets

Maternal FE and all controls from previous table included in all regressions

Table 3B Heterogeneity in Impact of Preschool on 7 Year IQ

	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE
Preschool	0.193	0.01	0.197	0.0102	0.221	-0.0476	0.182	-0.00642	0.19	0.0223	0.00722	-0.112	0.0596	-0.0265
	[0.0257]	[0.0393]	[0.0256]	[0.0391]	[0.0492]	[0.0770]	[0.0353]	[0.0498]	[0.0251]	[0.0388]	[0.0925]	[0.121]	[0.109]	[0.152]
Preschool*bw			-0.0331	-0.00195									-0.0406	-0.0361
			[0.0303]	[0.0455]									[0.0315]	[0.0476]
Preschool*BO					-0.0107	0.0158							-0.0161	0.0174
					[0.0132]	[0.0192]							[0.0128]	[0.0189]
Preschool*male							0.0217	0.0366					0.0209	0.0465
							[0.0502]	[0.0681]					[0.0496]	[0.0683]
Preschool*8 Month Bayley									0.0679	**0.108**			0.0447	**0.114**
									[0.0301]	[0.0408]			[0.0347]	[0.0484]
Preschool*advanced social/emotional development											0.65	**0.614**	0.648	**0.403**
											[0.261]	[0.329]	[0.265]	[0.337]
Preschool*normal social/emotional development											0.195	0.127	0.18	-0.0392
											[0.0960]	[0.125]	[0.104]	[0.142]
Birth Weight - Standardized			0.127	0.146									0.0758	0.113
			[0.0109]	[0.0211]									[0.0113]	[0.0218]
8 Month Mental Bayley - Standardized									0.186	0.127			0.168	0.121
									[0.00959]	[0.0148]			[0.0111]	[0.0167]
Advanced Social/Emotional Development											0.491	0.233	0.0926	0.017
											[0.0758]	[0.0997]	[0.0781]	[0.102]
Normal Social/Emotional Development											0.265	0.0989	0.00523	-0.045
											[0.0324]	[0.0446]	[0.0353]	[0.0476]
Observations	9339	9340	9330	9331	9228	9229	9339	9340	9339	9340	9325	9326	9205	9206
R-squared	0.289	0.839	0.3	0.842	0.289	0.84	0.289	0.839	0.322	0.844	0.298	0.84	0.327	0.848

Standard errors in brackets

Regressions include controls listed previously

ALL OLS regressions include controls for maternal characteristics (education, age, race, family income), offspring characteristics (birth order, gender, year of birth and AMC indicators.)

ALL FE regressions include controls for maternal age, family income, birth order, gender and year of birth indicators

Note: only 208 observations with advanced social/emotional development at 8 months of age.

Table 4 Development of Measure of Parental Investment: Factor Analysis

Factor analysis/correlation — Number of obs = 31538
Method: principal factors — Retained factors = 4
Rotation: (unrotated) — Number of params = 26

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.63941	1.43574	1.2078	1.2078
Factor2	0.20367	0.07795	0.1501	1.3579
Factor3	0.12572	0.09792	0.0926	1.4505
Factor4	0.0278	0.11383	0.0205	1.471
Factor5	-0.08604	0.07669	-0.0634	1.4076
Factor6	-0.16273	0.00774	-0.1199	1.2877
Factor7	-0.17047	0.04959	-0.1256	1.1621
Factor8	-0.22006	.	-0.1621	1

LR test: independent vs. saturated: chi2(28) = 2.9e+04 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
Appearance of Child	0.178	0.0487	0.125	0.1138	0.9374
Responsivenes of Mother	0.5823	0.0461	0.154	-0.0168	0.6348
Affection	0.6186	-0.1655	-0.0911	0.0181	0.5814
Reaction to Evaluation	0.4591	-0.2277	-0.1435	0.0064	0.7168
Management of child	0.3933	0.2533	-0.089	0.0171	0.7729
Attention to child	0.3063	0.0578	0.0539	-0.1175	0.8861
Reaction to child's need	0.4592	0.21	-0.1194	0.0102	0.7306
Handling of Child	0.4646	-0.0913	0.1799	0	0.7434

Scoring coefficients (method = regression)

Variable	Factor1	Factor2	Factor3	Factor4
Appearance of Child	0.05802	0.0406	0.11038	0.1139
Responsivenes of Mother	0.25884	0.0587	0.1866	-0.02302
Affection	0.29163	-0.18853	-0.11504	0.02567
Reaction to Evaluation	0.17593	-0.21726	-0.14969	0.00557
Management of child	0.14864	0.23788	-0.08999	0.0194
Attention to child	0.10536	0.05061	0.048	-0.12299
Reaction to child's need	0.18021	0.21161	-0.1253	0.0113
Handling of Child	0.17709	-0.08486	0.18924	0.00044

Table 5 Determinants of Investment Across Families: Dependent Variable=Maternal Focus on Child

Panel A: OLS Regressions	(1)	(2)	(3)	(4)	(5)	(6)
Birth Weight - Standardized	0.0371					
	[0.00881]					
Low Birth Weight		-0.0694				
		[0.0232]				
Weeks of Gestation at Birth			0.00678			
			[0.00242]			
Premature birth				-0.0323		
				[0.0244]		
8 Month Mental Bayley - Standardized					0.0715	0.0471
					[0.00754]	[0.00964]
8 Month Motor Bayley - Standardized						0.0365
						[0.00921]
Maternal Education at Birth	0.00778	0.00787	0.00803	0.00798	0.00783	0.0079
	[0.00175]	[0.00175]	[0.00175]	[0.00175]	[0.00174]	[0.00174]
Maternal Age at Birth	0.0169	0.0171	0.0172	0.0171	0.0168	0.0168
	[0.00168]	[0.00168]	[0.00168]	[0.00168]	[0.00168]	[0.00168]
Family income (real) at pregnancy in $1000	0.00119	0.00124	0.00119	0.0012	0.00116	0.00112
	[0.000627]	[0.000627]	[0.000628]	[0.000628]	[0.000626]	[0.000625]
Married	0.0789	0.0794	0.0789	0.079	0.0821	0.08
	[0.0214]	[0.0214]	[0.0214]	[0.0214]	[0.0213]	[0.0213]
Black	-0.288	-0.291	-0.284	-0.287	-0.3	-0.304
	[0.0893]	[0.0893]	[0.0898]	[0.0898]	[0.0891]	[0.0890]
White	-0.198	-0.194	-0.194	-0.193	-0.203	-0.204
	[0.0874]	[0.0874]	[0.0878]	[0.0879]	[0.0872]	[0.0871]
Hispanic	-0.277	-0.274	-0.269	-0.271	-0.282	-0.283
	[0.103]	[0.103]	[0.104]	[0.104]	[0.103]	[0.103]
Male	-0.00509	-0.00019	0.00308	0.00251	0.00169	0.00317
	[0.0145]	[0.0144]	[0.0144]	[0.0144]	[0.0143]	[0.0143]
First born	0.258	0.252	0.251	0.251	0.237	0.228
	[0.0286]	[0.0286]	[0.0286]	[0.0286]	[0.0285]	[0.0286]
Second Birth	0.114	0.11	0.111	0.111	0.103	0.0998
	[0.0245]	[0.0244]	[0.0245]	[0.0245]	[0.0244]	[0.0244]
Third or Fourth Birth	0.0688	0.0662	0.0678	0.0677	0.0622	0.0624
	[0.0210]	[0.0210]	[0.0210]	[0.0210]	[0.0209]	[0.0209]
Observations	12600	12600	12571	12571	12615	12606
R-squared	0.041	0.04	0.04	0.039	0.047	0.047
Indicator variables for AMC and year of birth also included; mean of dependent var 0, std dev 0.82, min -7.5, max 7.6.						
Relationship between of std dev invrease in endowment and std deviation increase in parenting	4%	-8%		-4%	9%	6%

Table 6 Determinants of Investment Within Families: Dependent Variable=Maternal Focus on Child

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Birth Weight - Standardized	0.0546						0.0341
	[0.0193]						[0.0199]
Low Birth Weight		-0.0556					
		[0.0427]					
Weeks of Gestation at Birth			0.0135				
			[0.00422]				
Premature birth				-0.0792			
				[0.0412]			
8 Month Mental Bayley - Standardized					0.0607	0.0402	0.0555
					[0.0124]	[0.0150]	[0.0127]
8 Month Motor Bayley - Standardized						0.0377	
						[0.0153]	
Maternal Age at Birth	-0.00049	-0.00318	0.00245	-0.00076	-0.00121	0.00101	0.00115
	[0.0221]	[0.0221]	[0.0221]	[0.0221]	[0.0220]	[0.0220]	[0.0220]
Family income (real) at pregnancy in $10(	-0.00028	-0.00029	-0.00033	-0.00035	-0.00032	-0.00036	-0.00021
	[0.00113]	[0.00113]	[0.00113]	[0.00113]	[0.00113]	[0.00113]	[0.00113]
Married	0.0802	0.0797	0.0777	0.0763	0.083	0.0861	0.0815
	[0.0461]	[0.0461]	[0.0462]	[0.0462]	[0.0461]	[0.0461]	[0.0460]
Male	-0.00685	0.00252	0.00703	0.00649	0.00411	0.0047	-0.00124
	[0.0211]	[0.0208]	[0.0208]	[0.0208]	[0.0207]	[0.0208]	[0.0211]
First born	0.214	0.211	0.228	0.231	0.213	0.2	0.204
	[0.0749]	[0.0750]	[0.0751]	[0.0751]	[0.0748]	[0.0753]	[0.0748]
Second Birth	0.0468	0.0463	0.0626	0.0627	0.0501	0.0443	0.0445
	[0.0606]	[0.0607]	[0.0609]	[0.0609]	[0.0606]	[0.0607]	[0.0605]
Third or Fourth Birth	0.000256	0.000429	0.0123	0.0122	0.00231	0.0019	0.00165
	[0.0438]	[0.0439]	[0.0440]	[0.0440]	[0.0438]	[0.0438]	[0.0438]
Observations	12601	12601	12572	12572	12616	12607	12601
R-squared	0.673	0.672	0.673	0.673	0.673	0.673	0.674

Standard errors in brackets

Maternal FE and year of birth indicators included

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Relationship between of std dev invrease in endowment and std deviation increase in parenting	7%	-7%		-10%	7%	5%	7%

Table 7 First Stage Regressions Dependent Variable = Total Fertility

	IV	IV	IV	IV2	IV3
OC bans*DOB	-0.117	-0.107	-0.11		
	[0.0198]	[0.0206]	[0.0212]		
OC bans*DOB*Catholic	0.099	0.0923	0.0988		
	[0.0187]	[0.0191]	[0.0198]		
Multiple pregnancies since study child, 7 years later				1.024	
				[0.106]	
Fetal/Neonatal Death since study child					-0.712
					[0.0265]
Maternal Education at Birth	-0.0396	-0.038	-0.0393	-0.0378	-0.0384
	[0.00496]	[0.00479]	[0.00526]	[0.00493]	[0.00497]
Maternal Age at Birth	0.117	0.116	0.116	0.152	0.157
	[0.00233]	[0.00239]	[0.00246]	[0.00242]	[0.00240]
Black	0.318	0.31	0.329	0.33	0.324
	[0.0391]	[0.0398]	[0.0415]	[0.0382]	[0.0373]
Hispanic	0.094	0.0655	0.031	0.0539	0.0156
	[0.0817]	[0.0834]	[0.0829]	[0.0714]	[0.0695]
Family income (real) at pregnancy in $1000	-0.0043	-0.00429	-0.00414	-0.00313	-0.00297
	[0.000783]	[0.000801]	[0.000826]	[0.000749]	[0.000733]
Male	-0.014	-0.00787	-0.0121	-0.00727	-0.00203
	[0.0195]	[0.0202]	[0.0208]	[0.0190]	[0.0186]
Married	0.449	0.45	0.417	0.425	0.434
	[0.0305]	[0.0316]	[0.0326]	[0.0304]	[0.0299]
Truncate	0.00112	0.00112	0.00111	0.000593	0.000429
	[3.25e-05]	[3.36e-05]	[3.46e-05]	[3.01e-05]	[2.97e-05]
First born	-1.564	-1.556	-1.559	-1.734	-1.764
	[0.0224]	[0.0232]	[0.0242]	[0.0218]	[0.0212]
8 Month Mental Bayley - Standardized		-0.0654	-0.0673	-0.0563	-0.0615
		[0.0130]	[0.0136]	[0.0126]	[0.0124]
Real income age 7 in $1000			-0.00606	0.000161	0.00167
			[0.00136]	[0.00125]	[0.00122]
Irregular source of income at age 7			-0.0544	-0.0481	-0.0557
			[0.0247]	[0.0225]	[0.0221]
Married at age 7			0.204	0.017	-0.0164
			[0.0300]	[0.0280]	[0.0273]
Number of pregnancies since study child, 7 years later				0.611	0.798
				[0.0123]	[0.0135]
Observations	28836	26832	24945	24802	24802
R-squared	0.403	0.404	0.409	0.508	0.525

Robust standard errors in brackets

Table 8 Impact of Total Fertility on 4 Year IQ, 7 Year IQ and 7 Year Achievement

	4 Year IQ					7 Year IQ				
	OLS	**OLS**	**IV**	**IV2**	**IV3**	**OLS**	**OLS**	**IV**	**IV2**	**IV3**
Total fertility	-0.066	-0.0597	-0.38	-0.026	-0.114	-0.0625	-0.0547	-0.267	-0.0497	-0.0929
	[0.00339]	[0.00344]	[0.0972]	[0.0386]	[0.0171]	[0.00312]	[0.00316]	[0.0887]	[0.0374]	[0.0159]
First born	-0.0627	-0.0846	-0.584	-0.0155	-0.168	0.025	-0.002	-0.334	0.0148	-0.0567
	[0.0141]	[0.0143]	[0.152]	[0.0684]	[0.0326]	[0.0128]	[0.0132]	[0.139]	[0.0659]	[0.0302]
8 Month Mental Bayley - Standardized		0.196	0.175	0.195	0.19		0.177	0.163	0.177	0.176
		[0.00848]	[0.0115]	[0.00874]	[0.00858]		[0.00898]	[0.0111]	[0.00922]	[0.00883]
Maternal Education at Birth	0.0206	0.0192	0.00698	0.0206	0.0175	0.0156	0.0145	0.00723	0.0148	0.0168
	[0.00280]	[0.00282]	[0.00413]	[0.00326]	[0.00269]	[0.00216]	[0.00222]	[0.00350]	[0.00259]	[0.00234]
Maternal Age at Birth	0.0127	0.011	0.0483	0.0034	0.0167	0.0105	0.00875	0.0334	0.00626	0.0121
	[0.00111]	[0.00111]	[0.0114]	[0.00596]	[0.00282]	[0.00103]	[0.00104]	[0.0104]	[0.00583]	[0.00263]
Black	-0.325	-0.318	-0.215	-0.328	-0.3	-0.335	-0.331	-0.261	-0.332	-0.351
	[0.0190]	[0.0192]	[0.0390]	[0.0230]	[0.0201]	[0.0177]	[0.0183]	[0.0352]	[0.0220]	[0.0185]
Hispanic	-0.468	-0.478	-0.454	-0.483	-0.476	-0.465	-0.453	-0.429	-0.453	-0.482
	[0.0375]	[0.0383]	[0.0490]	[0.0385]	[0.0391]	[0.0350]	[0.0361]	[0.0416]	[0.0365]	[0.0368]
Family income (real) at pregnancy	0.00528	0.00512	0.00373	0.00518	0.00493	0.00294	0.00295	0.00208	0.0029	0.00498
	[0.000444]	[0.000447]	[0.000659]	[0.000462]	[0.000454]	[0.000401]	[0.000408]	[0.000569]	[0.000423]	[0.000405]
Male	-0.167	-0.17	-0.172	-0.173	-0.173	0.00348	0.00602	0.00575	0.00515	0.00378
	[0.0101]	[0.0102]	[0.0122]	[0.0103]	[0.0103]	[0.00936]	[0.00960]	[0.0105]	[0.00961]	[0.00947]
Married	0.113	0.115	0.258	0.107	0.144	0.0717	0.074	0.162	0.0728	0.132
	[0.0138]	[0.0141]	[0.0471]	[0.0216]	[0.0159]	[0.0137]	[0.0142]	[0.0400]	[0.0211]	[0.0149]
Number of pregnancies since study child, 7 years later				-0.0607	-0.00592				-0.0323	-0.00699
				[0.0248]	[0.0119]				[0.0242]	[0.0114]
Real income age 7 in $1000						0.0164	0.0159	0.0146	0.0157	
						[0.000620]	[0.000642]	[0.000876]	[0.000648]	
Irregular source of income at age 7						-0.011	-0.0116	-0.0187	-0.0118	
						[0.0110]	[0.0112]	[0.0126]	[0.0113]	
Married at age 7						0.00621	-0.00348	0.0366	0.00289	
						[0.0128]	[0.0132]	[0.0221]	[0.0133]	
Observations	28836	26832	26832	26471	26471	30634	27766	27766	27603	29485
R-squared	0.271	0.299	0.018	0.301	0.292	0.318	0.338	0.211	0.34	0.313

Robust standard errors in brackets

	7 Year Math Score					7 Year Reading Score				
Total fertility	**-0.0448**	**-0.0433**	**-0.21**	**-0.046**	**-0.0589**	**-0.0546**	**-0.0528**	**-0.429**	**-0.0478**	**-0.0483**
	[0.00337]	[0.00340]	[0.0834]	[0.0377]	[0.0170]	[0.00308]	[0.00315]	[0.108]	[0.0380]	[0.0178]
Observations	30528	27676	27676	27512	29388	30515	27664	27664	27500	29375
R-squared	0.156	0.171	0.085	0.171	0.158	0.216	0.225		0.226	0.208

Robust standard errors in brackets

Table 9 Does Quantity Affect Within Family Distribution of Investment and Quality

Panel A: Total Fertility	Investment	IQ7	Math	Read
Endowment*Fertility	0.0223	0.00465	0.0233	0.0181
	[0.00931]	[0.00697]	[0.00825]	[0.00765]
8 Month Mental Bayley - Standardized	-0.0298	0.109	-0.0347	-0.0439
	[0.0477]	[0.0359]	[0.0424]	[0.0397]
Observations	23216	26182	26122	26113
R-squared	0.894	0.933	0.903	0.919

Panel B: Total Fertility (all births included in sample)	Investment	IQ7	Math	Read
Endowment*Fertility	0.013	0.0665	0.13	0.0834
	[0.0649]	[0.0446]	[0.0524]	[0.0514]
8 Month Mental Bayley - Standardized	0.00201	-0.081	-0.314	-0.229
	[0.176]	[0.121]	[0.142]	[0.139]
Observations	1553	1722	1718	1717
R-squared	0.653	0.788	0.683	0.75

Panel C: Total Fertility (number of births in sample)	Investment	IQ7	Math	Read
Endowment*Fertility	0.0269	0.0306	0.0314	0.0152
	[0.0141]	[0.0123]	[0.0153]	[0.0143]
8 Month Mental Bayley - Standardized	-0.0141	0.0508	-0.00341	0.00686
	[0.0411]	[0.0354]	[0.0438]	[0.0407]
Observations	34985	33202	33045	33028
R-squared	0.887	0.933	0.896	0.916

Figure 1A & 1B: Variation in 8 Mo Bayley & IQ 4

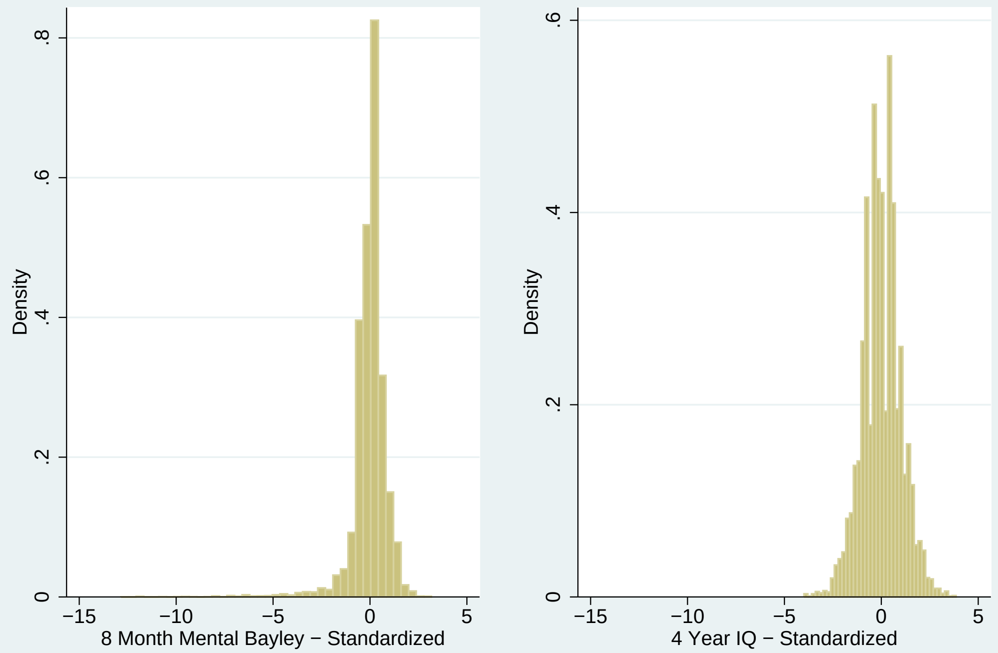
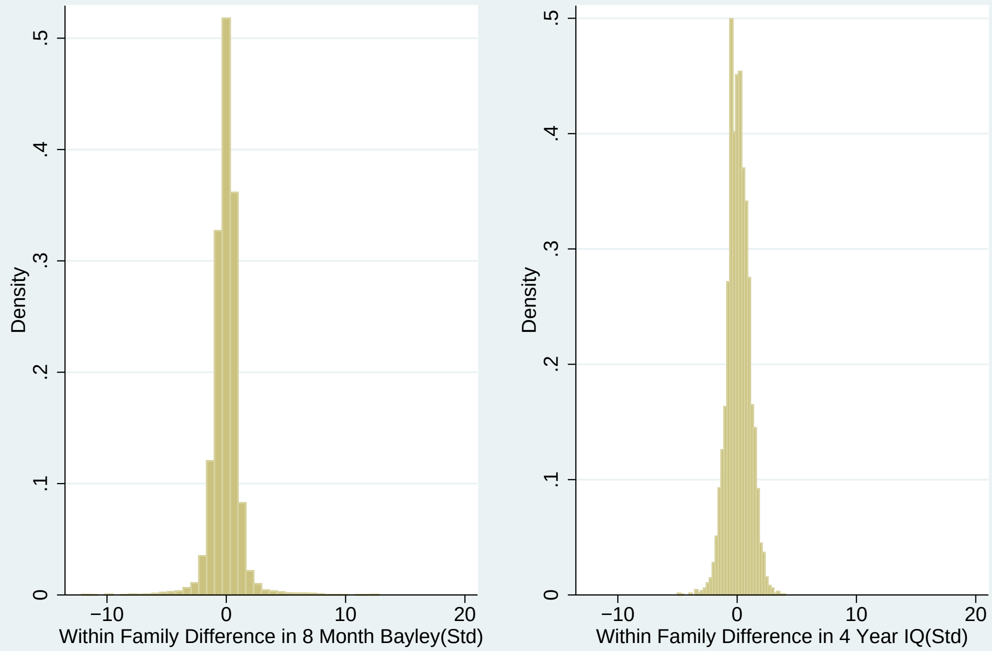


Figure 2A & 2B: Within Family Difference in 8 Mo Bayley & IQ4



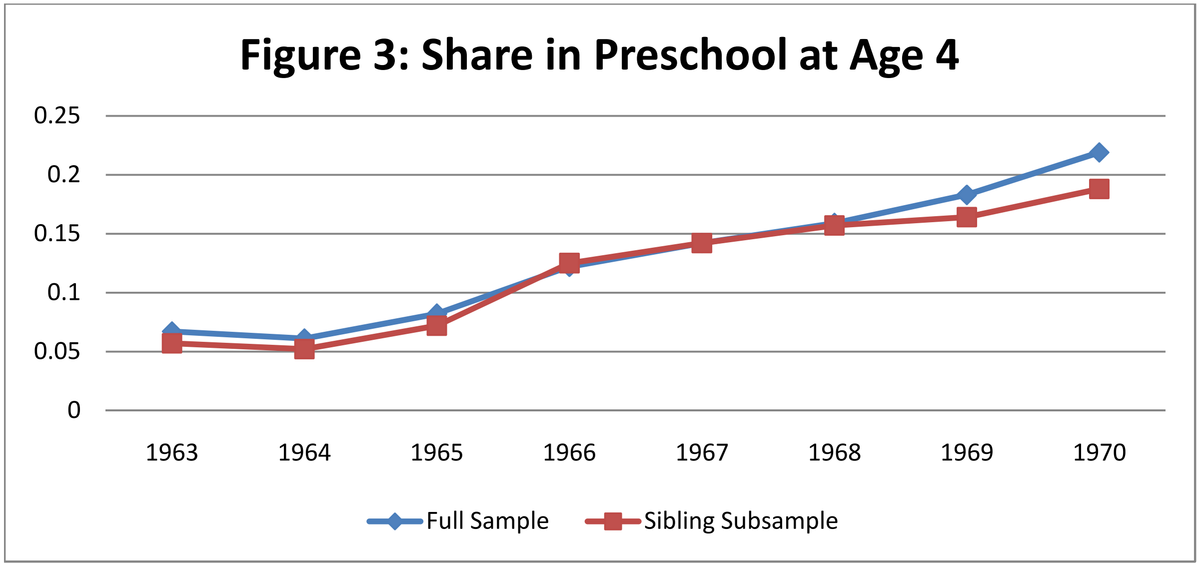


Figure 3: Share in Preschool at Age 4
0.25
0.2
0.15
0.1
0.05
0
1963
1964
1965
1966
1967
1968
1969
1970
Full Sample
Sibling Subsample

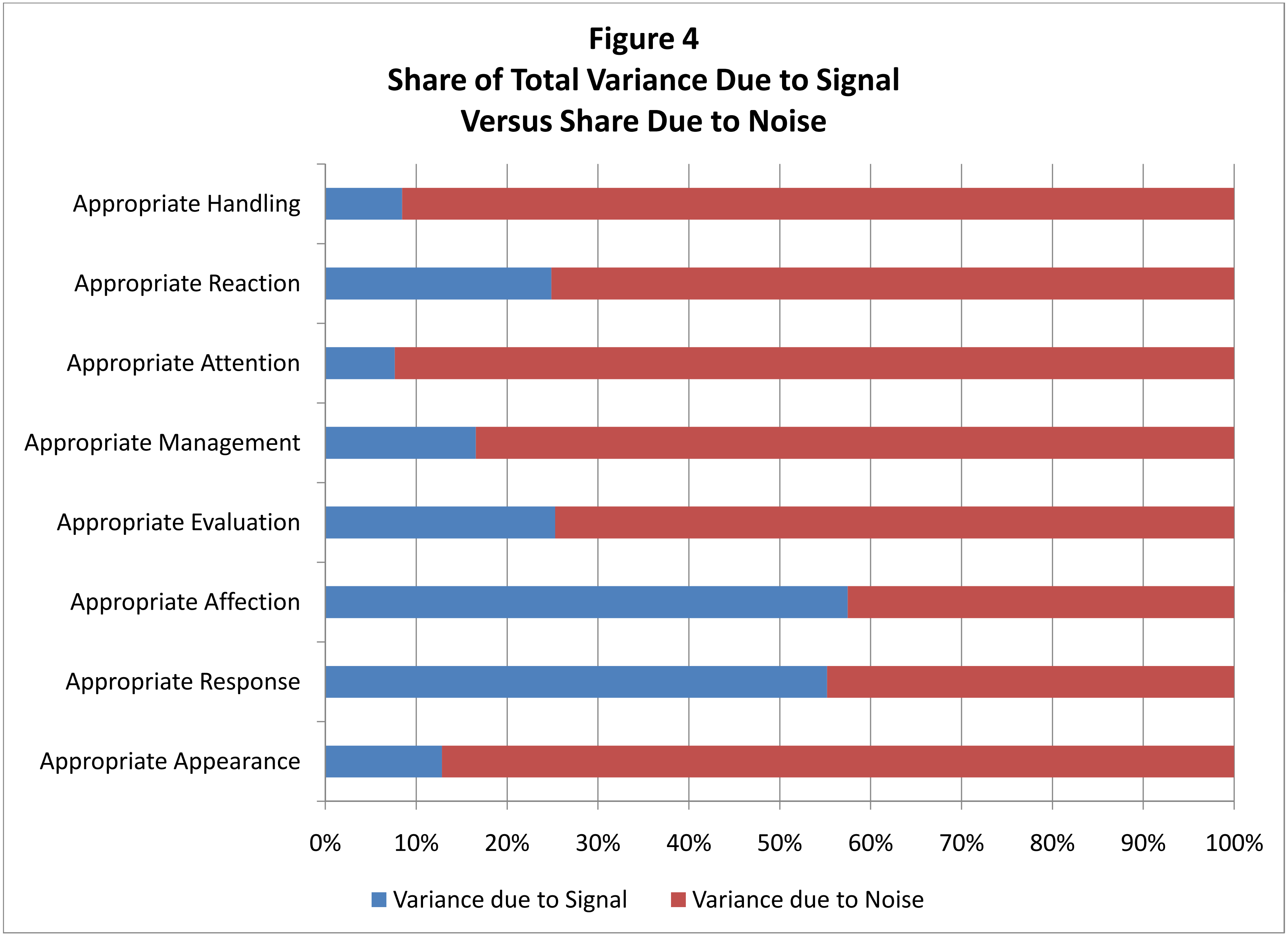


Figure 4
Share of Total Variance Due to Signal
Versus Share Due to Noise
Appropriate Handling
Appropriate Reaction
Appropriate Attention
Appropriate Management
Appropriate Evaluation
Appropriate Affection
Appropriate Response
Appropriate Appearance
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Variance due to Signal
Variance due to Noise

Figure 5A: Variation in Investment, Between & Within Families

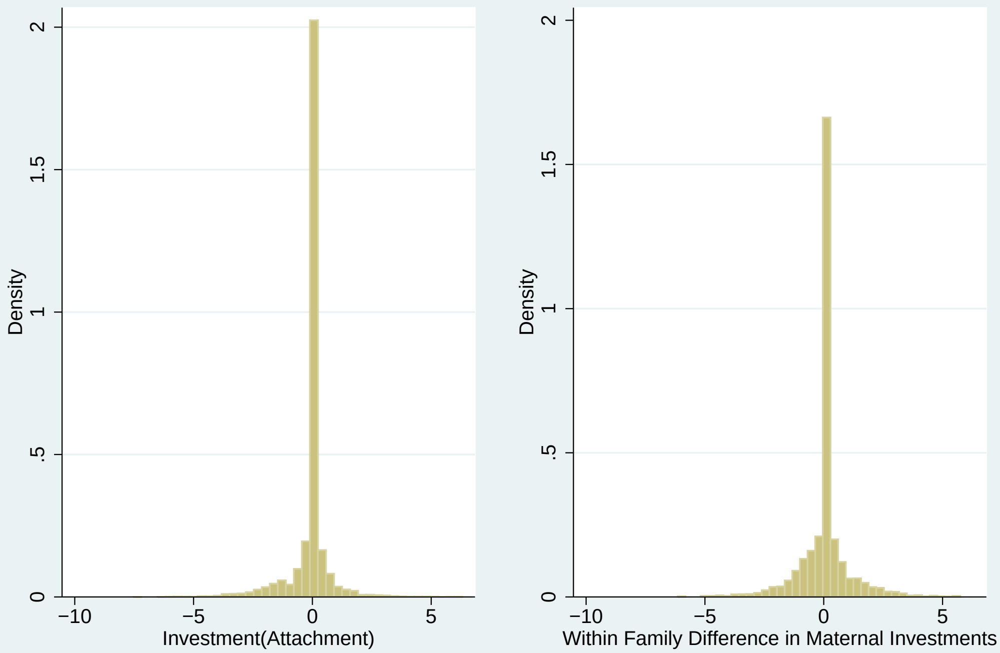
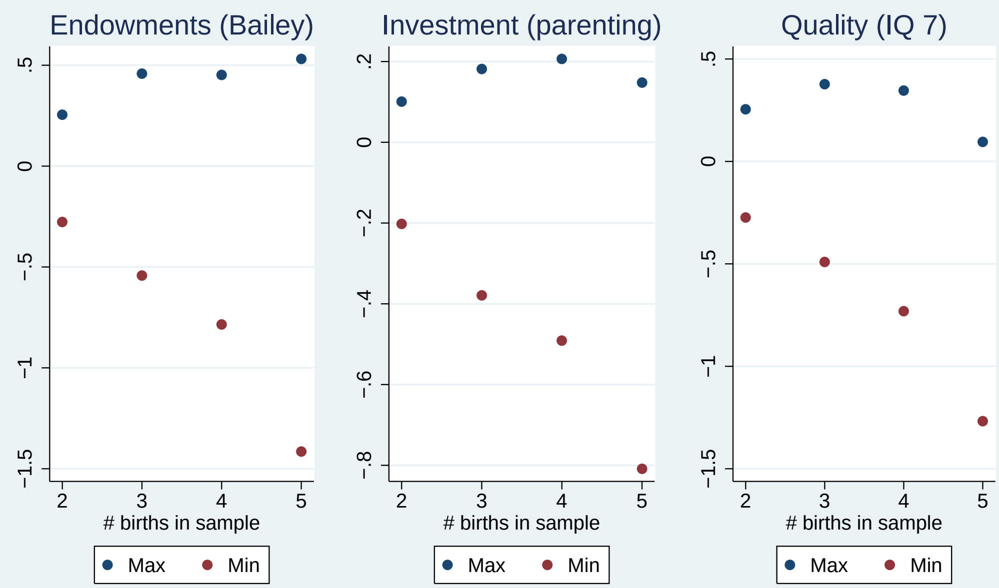
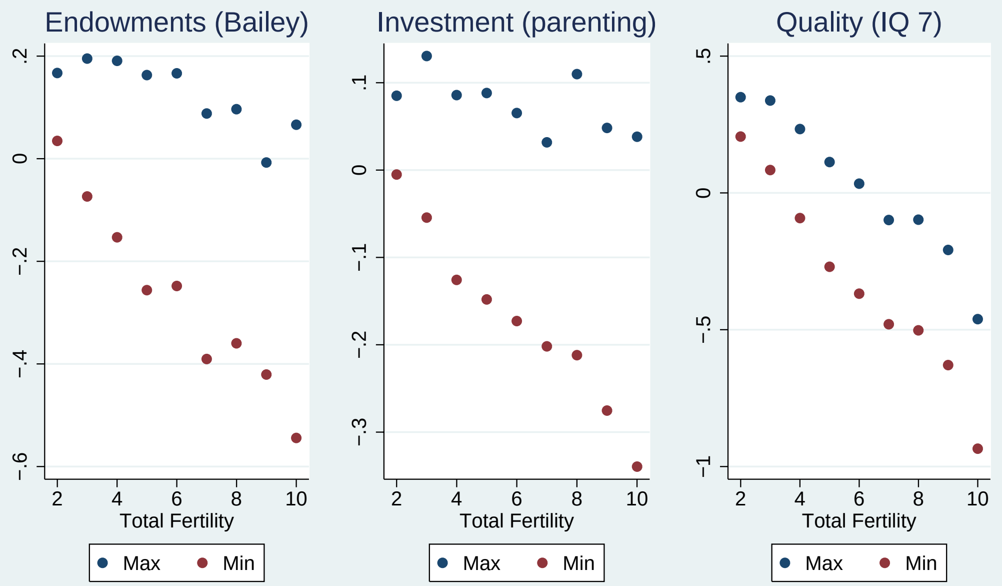


Figure 6: Variation in Endowments, Investments and Quality Within Family by Family Size



Family size defined by number births in sample

Figure 6: Variation in Endowments, Investments and Quality Within Family by Family Size



Family size defined by total fertility

Appendix I: The Measurement Model

Let i denote parental investment, which we assume is a latent variable. Let d_k denote error-ridden measurements of i that take on discrete values, k = 1, ..., K. The variables d_k take on discrete values in the set $\{1, \dots, L\}$. We impose an ordered choice representation. Let d_k^* denote the latent value of d_k and assume that

$$d_k^* = x\beta_k + \alpha_k i + \varepsilon_k$$

The variables x are observed quantities that affect the measurement of d_k^*. The components ε_k are independent measurement errors. Let $\{c_{k,0}, c_{k,1}, \dots, c_{k,L}\}$ denote constants. We observe the discrete random variable d_k:

$$d_k = l \leftrightarrow c_{k,l-1} \leq d_k^* \leq c_{k,l}$$

Estimating and Predicting the Factor Scores

Our goal is to estimate the density of the factor i conditional on the random vector $\{d_1, \dots, d_k\}$, which we denote by $f(i|d_1, \dots, d_K)$. A simple recursive algorithm can be developed if we assume that the factor i and measurement errors ε_k are such that $\varepsilon_k \sim NI(0, \sigma_k^2)$.[1] To see why, let $i \sim N(a_0, P_0)$ denote the unconditional distribution of the factor i. Under the assumption of normality, the conditional density $f(i|d_1, \dots, d_K)$ is the density of a normal random variable with mean a_K and variance P_K. Such means and variances can be estimated recursively. To see why, suppose that we observe $d_1 = l$ and let $\omega \sim N(0,1)$. Clearly, $i = a_0 + P_0^{1/2}\omega$. In what follows, let $a_k = E(i|d_1 = l_1, \dots, d_k = l_k)$ and $P_k = Var(i|d_1 = l_1, \dots, d_k = l_k)$. We can update the mean and variance of the factor:

---

[1] Because the measurements are discrete, it is necessary to normalize the variances so that for all k, $\sigma_k^2 = 1$.

$$a_1 = E\left(a_0 + P_0^{1/2}\omega \middle| d_1 = l\right) = a_0 + P_0^{1/2} E(\omega | d_1 = l)$$

Note that:

$$E(\omega | d_1 = l) = E\left(\omega \middle| c_{1,l-1} \leq x\beta_1 + \alpha_1 a_0 + \alpha_1 P_0^{1/2}\omega + \varepsilon_1 \leq c_{1,l}\right) =$$

$$= E\left(\omega \middle| c_{1,l-1} - x\beta_1 - \alpha_1 a_0 \leq \alpha_1 P_0^{1/2}\omega + \varepsilon_1 \leq c_{1,l} - x\beta_1 - \alpha_1 a_0\right) =$$

$$= \frac{\alpha_1 P_0}{(\alpha_1^2 P_0 + \sigma_1^2)^{1/2}} \left[\frac{f(\delta_{1,l-1}) - f(\delta_{1,l})}{F(\delta_{1,l}) - F(\delta_{1,l-1})}\right]$$

where $\delta_{1,l} = \frac{c_{1,l} - x\beta_1 - \alpha_1 a_0}{(\alpha_1^2 P_0 + \sigma_1^2)^{1/2}}$, while f(.) and F(.) represent the density and distribution functions of a standardized normal random variable. We can proceed in a similar fashion to update the variance:

$$P_1 = Var\left(a_0 + P_0^{1/2}\omega \middle| d_1 = l\right) = P_0 Var(\omega | d_1 = l)$$

Again, note that:

$$Var(\omega | d_1 = l) = Var\left(\omega \middle| c_{1,l-1} - x\beta_1 - \alpha_1 a_0 \leq \alpha_1 P_0^{1/2}\omega + \varepsilon_1 \leq c_{1,l} - x\beta_1 - \alpha_1 a_0\right) =$$

$$\frac{(\alpha_1 P_0)^2}{(\alpha_1^2 P_0 + \sigma_1^2)} \left[1 + \frac{\delta_{1,l-1} f(\delta_{1,l-1}) - \delta_{1,l} f(\delta_{1,l})}{F(\delta_{1,l}) - F(\delta_{1,l-1})} - \left(\frac{f(\delta_{1,l-1}) - f(\delta_{1,l})}{F(\delta_{1,l}) - F(\delta_{1,l-1})}\right)^2\right] + P_0 \sigma_1^2$$

This rationale yields the following recursive rule for updating the means and variances:

$$a_{k+1} = a_k + \frac{\alpha_{k+1} P_k}{(\alpha_{k+1}^2 P_k + \sigma_{k+1}^2)^{1/2}} \left[\frac{f(\delta_{1,l-1}) - f(\delta_{1,l})}{F(\delta_{1,l}) - F(\delta_{1,l-1})}\right]$$

$$P_{k+1} = \frac{(\alpha_{k+1}P_k)^2}{(\alpha_{k+1}^2 P_k + \sigma_{k+1}^2)}\left[1 + \frac{\delta_{k+1,l-1}f(\delta_{k+1,l-1}) - \delta_{k+1,l}f(\delta_{k+1,l})}{F(\delta_{k+1,l}) - F(\delta_{k+1,l-1})} - \left(\frac{f(\delta_{k+1,l-1}) - f(\delta_{k+1,l})}{F(\delta_{k+1,l}) - F(\delta_{k+1,l-1})}\right)^2\right] + P_0\sigma_{k+1}^2$$

One can then estimate the factor score with the quantity $a_K = E(i|d_1 = l_1, \dots, d_K = l_K)$, which is the mean of the factor conditional on all measurements $d_1, \dots, d_K$.

<u>Relaxing Normality</u>

Although convenient, the normality assumption may be too strict for our dataset. Instead, we assume that the factor is distributed according to a mixture of J normal distributions. That is, we assume that $i \sim MN\left(a_{0,j}, P_{0,j}, \pi_{0,j}\right)_{j=1}^{J}$where the term $\pi_{0,j}$ is the weight of mixture j. We impose the condition that $\sum_{j=1}^{J} \pi_{0,j} = 1$. It is easy to extend the recursive rules above for the mean and variances for each mixture component. It is also necessary to include a recursive rule for the mixture weights $\pi_{0,j}$. To derive the rule, note that the probability that $d_1 = l$ conditional on the mixture element j is

$$\Pr(d_1 = l|x, element\ j) = F_j(\delta_{1,l}) - F_j(\delta_{1,l-1})$$

Therefore, we update the weight of the mixture according to the rule:

$$\pi_{1,j} = \frac{\pi_{0,j}\Pr(d_1 = l|x, element\ j)}{\sum_{m=1}^{J} \pi_{0,m}\Pr(d_1 = l|x, element\ m)}$$

<u>Results</u>

We estimate a model with two mixtures. We test and reject the normality of the factor. The estimation of the measurement model allows us to compute the relative importance of each measure in the construction of the factor. The contribution of each measurement depends on the share of true variance to total variance. The higher this share, the higher its weight in the construction of the factor. In Figure 3, we plot $\frac{\alpha_{k+1}^2 P_k}{\alpha_{k+1}^2 P_k + \sigma_{k+1}^2}$ as well as $\frac{\sigma_{k+1}^2}{\alpha_{k+1}^2 P_k + \sigma_{k+1}^2}$. The former represents the fraction of total variance that is due to the variance of the signal. The latter represents the share of total variance that is due to the variance of the measurement error. Measures that have high values of $\frac{\alpha_{k+1}^2 P_k}{\alpha_{k+1}^2 P_k + \sigma_{k+1}^2}$ are given high weights in the construction of the factor. Based on our estimates, we conclude that the measures "Appropriate Response" and "Appropriate Affection" have the highest weights in the construction of the factor, while "Appropriate Handling" and "Appropriate Attention" have the lowest weights in the construction of the factor.

Appendix II – Individual Items Bayley Scale of Mental Development (8 Month)

1. Social smiles
2. Visually recognizes mother
3. Eyes follow pencil
4. Reacts to paper on face
5. Searches with eyes for sound
6. Vocalizes to social stimulus
7. Manipulates ring
8. Vocalizes 2 syllables
9. Regards cube
10. Glances from one object to another
11. Anticipatory adjustment to lifting
12. Reacts to disappearance of face
13. Reaches for ring
14. Plays with rattle
15. Fingers hand in play
16. Follows vanishing ring
17. Aware of strange situation
18. Follows vanishing spoon
19. Eyes follow ball across table
20. Carries ring to mouth
21. Manipulates table edge slightly
22. Inspects own hands
23. Closes on dangling ring
24. Turns head to sound of bell
25. Turns head to sound of rattle
26. Reaches for cube
27. Active table manipulations
28. Regards pellet
29. Approaches mirror image
30. Picks up Cube
31. Exploitive paper play
32. Retains 2 cubes
33. Discriminates strangers
34. Vocalizes attitudes
35. Recovers rattle in crib or playpen
36. Reaches persistently

37. Turns head after dropped object
38. Lifts cup
39. Reaches for second cube
40. Enjoys frolic play
41. Transfers object hand to hand
42. Sustains inspection of ring
43. Plays with string
44. Picks up cube directly and easily
45. Pulls string, secures ring
46. Enjoys sound production
47. Lifts cup by handle
48. Retains 2 cubes
49. Attends to scribbling
50. Looks for dropped object
51. Manipulates Bell: Interest in details
52. Responds playfully to mirror
53. Vocalizes 4 different syllables
54. Pulls string purposively to secure ring
55. Responds to social play
56. Attempts to secure 3 cubes
57. Rings bell imitatively
58. Responds to name
59. Says Da-Da or equivalent
60. Uncovers toy
61. Adjusts to words
62. Fingers holes in peg board
63. Puts cube in cup
64. Looks for contents of box

Appendix Table 1 Sample Means

	Overall		Difference Within Family			
			Raw		Standardized	
Maternal Characteristics	mean	Std Dev	mean	Std Dev	mean	Std Dev
Maternal Age	25.68	5.09				
Maternal Education	11.11	4.59				
Socio economic Index (Duncan)	50.44	21.25				
Married	0.86					
Black	0.42					
White	0.54					
Hispanic	0.03					
First Birth	0.13					
Second Birth	0.23					
Third or Fourth Birth	0.35					
Male	0.50					
Investments						
Maternal Investment	-0.07	0.83	0.54	0.9		
Preschool Attendance	0.13		0.15			
Cognitive Measures						
8 Month Bayley Score	79.32	6.04	4.6	5.8	0.75	0.93
4 year IQ	98.77	16.70	11.9	9.7	0.72	0.58
7 Year IQ	96.31	14.80	10.7	8.8	0.7	0.58
Newborn Health						
Birth Weight (kg)	3.18	0.57	0.44	0.49	0.66	0.73
Gestation at Birth (weeks)	39.23	3.00	3.2	5.2		
Lbw	0.11		0.14			
Premature	0.10		0.17			

standardized: distrbution tranformed to normal with mean 0 and standard deviation of 1

Appendix Table 2 Bans on Advertising and Sale of Oral Contraception Prior to Griswald

City	Advt Ban	Sales Ban
Boston	Yes	Yes
Buffalo	Yes	Yes
new Orleans	Yes	Yes
NYC	Yes	No
Baltimore	No	No
Richmond	No	No
Minneapolis	Yes	Yes
Portland	Yes	Yes
Philadelphia	Yes	No
Providence	No	No
Memphis	No	No