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Abstract[1]

This paper examines early childhood development (ECD) outcomes and their association with family characteristics, investments, and environmental factors, with particular emphasis on the inter-generational transmission of cognitive abilities. The paper examines the causal relationship between parental cognitive abilities and ECD outcomes of their offspring using a rich data set from rural Guatemala that can account for such unobservable factors. A 10 percent increase in maternal Raven's scores increase children's Raven's scores by 7.8 percent. A 10 percent increase in maternal reading and vocabulary skills increases children's score on a standard vocabulary test by 5 percent. Effects are larger for older children, and the impact of maternal cognitive skills is larger than for paternal skills.

JEL Classification: J12, J24, N36

Keywords: Early childhood development, Guatemala, cognitive development, inter-generational transmission of cognitive abilities, economic productivity

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1. Introduction

Ensuring sustainable reductions in poverty requires increasing both the economic opportunities and the productive capacity of poor populations. Analytical work is thus needed to identify how human development traps evolve through the life cycle of poor children, especially in early childhood and in key transitions though the schooling cycle, and what policies are needed to address them. For instance, Glewwe (1996), Hanushek and Woessmann (2008), Anger and Heineck (2010) and Heineck and Anger (2010), find that cognitive skills play an important role for income generation, while Heckman and Vytlacil (2001) suggest that cognitive abilities are a key determinant of educational achievement. Bowles and Gintis (2002) investigate the transmission of economic success across generations and find that the combined inheritance processes operating through superior cognitive performance and educational attainments of those with well-off parents explains about three-fifths of the intergenerational transmission of economic status. Blanden, Gregg, and Macmillan (2007) focus on the intergenerational transmission of variables that are related to family incomes and have a return in the labor market—education, cognitive ability, non-cognitive skills, and labor market experience—and evaluate the importance of these variables in the extent of socioeconomic mobility between parents and their sons as adults among a 1970 cohort in the United Kingdom. They show that these variables (i.e., education, ability, non-cognitive skills, experience) account for half of the association between parental income and children's earnings, with the cognitive variables accounting for 20 percent of intergenerational persistence.

In Guatemala, recent evidence indicates that cognitive skills such as reading and vocabulary skills and non-verbal problem solving skills (as measured by Raven's Progressive Matrices) are causally linked to higher wages (Behrman et al., 2009). Many of these skills are formed early in life (Heckman, 2000; Carneiro and Heckman, 2003; Heckman, 2005; Cunha and Heckman, 2007). In Guatemala, Maluccio et al. (2009) find that exposure to a nutrition supplement has detectable effects on cognitive skills 30 years later. Paxson and Schady (2007) note that "[I]f poorer children in developing countries grow up with poorer cognitive skills, leading to lower incomes in adulthood, which in turn influence the cognitive skills of their own children, then low levels of cognitive development in early childhood may be one way in which poverty is transmitted across generations" (p. 51). Thus, understanding the causal links between factors perceived to be of importance and these early childhood development (ECD) outcomes has considerable value in terms of informing policy and interventions designed to improve child welfare and break the intergenerational transmission of poverty and inequality.

In this paper, ECD outcomes and their association with family characteristics, investments and environmental factors are examined, with particular emphasis on the inter-generational transmission of cognitive abilities. Given the strong causal links between cognitive abilities and economic productivity in adulthood, the inter-generational transmission of these abilities represents an important pathway by which economic advantage or poverty is perpetuated over time, an issue of particular salience in Latin America, with its long history of inequality. While there are many associational studies on this topic, these cannot be considered causal given that the cognitive abilities of different generations reflect, in part, unobservable factors such as the genetic heritability of such abilities which are common across generations. We examine the causal relationship between parental cognitive abilities and ECD outcomes of their offspring using a rich data set from rural Guatemala that can account for such unobservable factors.

2. Conceptual Framework and Estimation Issues

There are numerous cross-sectional studies that document associations between parental resources and measures of ECD. The literature on the inter-generational transmission of cognitive abilities is, perhaps not surprisingly, much smaller given that this requires measures of both parental *and* child cognitive skills. Black, Devereux, and Salvanes (2009) believe that their study is the first attempt to use a large nationally representative dataset from Norway to calculate precise estimates of intergenerational IQ elasticities. However, they focus their analysis on fathers and sons only. They find substantial intergenerational transmission of IQ scores (measured by an unweighted average between three IQ tests: arithmetic, word similarities, and figures): a 10 percent increase in father's score at age 18 is associated with a 3.2 percent increase in son's score. Similarly, Björklund et al. (2010) use IQ data from the Swedish military enlistment tests that take place the year the individual turns 18 to examine both intergenerational and sibling correlations in IQ. Their findings show that the correlation in IQ between fathers (born 1951-1956) and sons (born 1966-1980) is estimated to be 0.347.

Anger and Heineck (2009) use data from the German Socio-Economic Panel Study to assess whether "smart parents raise smart children." They use measures from two IQ tests—

cognitive speed (related to individuals' innate abilities) and verbal fluency (based on learning)—and find that individuals' cognitive skills are positively related to their parents' abilities, even after controlling for educational attainment and family background. A 1-point increase in the age-standardized cognitive ability test score of parents is associated with a 0.45 point increase in coding speed and 0.5 point increase in word fluency of their children. Their results also suggest that mothers' skills are more important than fathers' test scores for sons and daughters. In addition, there is evidence for an own-gender effect with respect to fluid intelligence, as fathers' coding speed is correlated with the abilities of their sons only, and mothers' speed of cognition is more strongly associated with the abilities of their daughters.

Agee and Crocker (2002) use data for 256 children from two communities in Boston, Massachusetts, and conclude that children whose parents have a lower estimated discount rate (parents with higher education levels and higher earned incomes choose a lower discount rate, which implies that parents make greater investments and thus provide more advantageous environments for their children) exhibit higher assessed cognitive skill. Moreover, these authors find that a 12-point decrease in parental IQ, measured by the Peabody Picture Vocabulary Test, is associated with a 4-point decrease in child's full-scale and verbal IQs, measured by the Wechsler Intelligence Scale for Children.

Foulkes et al. (2008) explore the intergenerational transmission of cognitive abilities in Mexico, a context that can be comparable to Guatemala in some aspects. These authors show that significant differences exist in the formation of infant cognitive ability across Mexican social strata: children from lower strata acquire lower cognitive abilities. Furthermore, mother's and father's cognitive skills appear as a significant determinant of children's cognitive ability, measured by the Raven test, in both higher and lower social strata, although maternal coefficients are significantly higher than paternal coefficients.

However, a limitation of a number of these studies is that they capture *associations*, not *causal* relationships because these parental resources, such as their human capital and the subsequent attainments of their children, *both* reflect long-term familial or dynastic decisions regarding investments in children. Consider a three-generation dynasty (G1s—grandparents; G2s—children of G1s and parents of G3s; and G3s—children of G2s and grandchildren of G1s). We observe this dynasty over two periods. In period 1, G1s make investments in G2s. In period 2, G2s make investments in G3s. An outcome of period 1 is some measure of human capital—

say, cognitive skills—that reflects *observable* G1 decisions on investing in the human capital of G2s, *observable* G2 characteristics, and *unobservable* G1 and G2 characteristics. An outcome of period 2 is a measure of ECD such as reading and vocabulary skills. This, too, will be a function of *observable* and *unobservable* parental (G2, and possibly G1) and household characteristics. For example, if aspects of cognitive ability are heritable, observed associations between cognitive skills of G2s and measures of ECD in G3s cannot be interpreted as causal because they also reflect correlated unobservables in inputs into ECD such as heritable cognitive abilities.

This problem can be interpreted as one in which we wish to model the determinants of a vector of outcomes, investments in human capital, resulting from a dynamic programming problem solved by a dynasty subject to the constraints imposed by constrained dynastic resources. Given the focus of our proposed work, we illustrate this approach as follows.[2] Period 1 is the period where G1s invest in G2s; while period 2 is the period on which G2s, and possibly G1s, invest in G3s. We presume that the measure of a G2s cognitive skill in period 1 ($K_{1,\,G2}$) reflects parental decisions on investing in his or her human capital and is a function of a vector of observable prices, cognitive skills of G1s ($K_{0,\,G1}$) and individual and dynastic characteristics ($Z_{1,\,G1}$) that determine the level and efficacy of investments in dimensions of human capital such as cognitive skills. Consequently, we write a reduced form demand function for cognitive skills for G2s as:

$$K_{1,\,G2} = \alpha_{K,G2}\, K_{0,\,G1} + \alpha_{Z,G2}\, Z_{1,\,G1} + v_{1,G2} \qquad (1)$$

where $v_{1,\,G2} = \varepsilon_H + \varepsilon_k + \varepsilon_1$

is a disturbance term with three components: ε_H , representing the time invariant dynasty's environment and is common to all generations; ε_k , which captures time invariant G2 specific effects such as genetic potential; and ε_1, a white noise disturbance term.

In period 2, analogous to the presence of other stocks or assets the outcome from (1), $K_{1,\,G2}$ appears on the right hand side of the reduced form linear achievement function:[3]

[2] This discussion draws heavily on work by Alderman, Behrman, Lavy, and Menon (2001), Alderman, Hoddinott and Kinsey (2006), Behrman et al., (2008) and Glewwe, Jacoby, and King (2001). Cunha, Heckman, Lochner, and Masterov (2005) provide a detailed exposition of models of this form.

[3] Todd and Wolpin (2007) describe this as an example of a contemporaneous specification of a child's cognitive skills. Also see Todd and Wolpin (2003).

$$K_{2, G3} = \alpha_{K,G3} K_{1, G2} + \alpha_{Z,G3} Z_{2, G2} + v_{2, G3} \quad (2)$$

where $v_{2, G3} = \eta_H + \eta_k + \eta_2$

and $K_{2, G3}$ is, say, the vocabulary skills of the G3 child (realized in period 2), $Z_{2, G2}$ is a vector of other prices, individual and household and dynastic characteristics that influence academic performance—possibly, but not necessarily, with elements common to $Z_{1, G1}$. Like $v_{1,G2}$, $v_{2,G3}$ is a disturbance term with three components: η_H, representing aspects of the dynasty's environment which influence human capital formation and are common to all members of the dynasty (this would capture, for example, attitudes towards schooling that are transmitted across generations); η_k, which captures G3 child-specific effects such as innate ability and motivation that are not controlled by their G2 parents; and η_2, a white noise disturbance term.

The basic difficulty with a least squares regression of (2), as noted by Behrman (1996) is the likelihood that $E(K_{1, G2}\, v_{2, G3}) \neq 0$ because of possible correlation between $K_{1, G2}$ and η_H or between $K_{1, G2}$ and η_k mediated through either the correlation dynastic effects or individual effects or both. That is, either $E(\varepsilon_H \eta_H) \neq 0$ or $E(\varepsilon_k \eta_k) \neq 0$. For example, dynasties with "high" innate cognitive abilities will have children who will, *ceteris paribus*, score higher on tests of cognitive ability in both periods 1 and 2. In cases such as these, estimates of $\alpha_{K,G3}$ using ordinary least squares will be biased.

3. Study Background and Data

3.1 Study Background

The setting for our study is four villages in the eastern region of Guatemala, and the localities to which people from these villages migrated. All four villages chosen were located relatively close to the Atlantic Coast highway, connecting Guatemala City to Guatemala's Caribbean coast. The closest to Guatemala City was Santo Domingo, only 36 kilometers away; Espíritu Santo was furthest away, at 102 kilometers. Beginning in 1969, parents and children participated in a longitudinal study carried out by the Institute of Nutrition in Central America and Panama (INCAP).

The principal hypothesis of the study was that improved nutrition results in accelerated physical growth and mental development of pre-school-aged children. This was tested by providing free nutritional supplements, assigned at random within pairs stratified by village size. In two of the villages, a high protein-energy drink (*atole*) was provided. In the other two villages, a zero-protein, low calorie drink (*fresco*) was provided. The nutritional supplements were distributed in each village in centrally-located feeding centers and were available twice daily, to all members of the village on a voluntary basis. All residents of all villages also were offered high quality curative and preventative medical care free of charge throughout the intervention. The purpose of the protein-free supplement group was to control for social stimulation associated with attending the feeding center; it was not expected to improve nutritional status. Both drinks were micronutrient-fortified in equal concentrations per unit of volume (Habicht and Martorell 1992; Read and Habicht 1992).

The INCAP Longitudinal Study (1969-77) corresponding to the intervention, included all children less than 7 years of age at any point during the intervention. Newborns were included for study until September 1977 and children were followed through age 7 years or until study closeout, whichever came first. All children in the sample, then, were born between 1962 and 1977. The associated surveys carried out were rich in data about home environment and child growth, cognitive development, diet, and morbidity. Subsamples of the original 2,392 children surveyed during 1969–77 were conducted in 1988–89 and 2002–04.[4] As part of the Intergenerational Transfers Study (IGT), between January 2006 and August 2007, an additional survey round was undertaken that involved interviewing:

- The biological parents and current partners of biological parents of the original sample member;
- The spouses or partners of the original sample member;[5] and

[4] The Human Capital Study (HCS), 2002–04, targeted all sample members of the INCAP Longitudinal Study (1969–77) living in Guatemala. Of the original 2392 sample members, 1855 (78 percent) were determined to be alive and known to be living in Guatemala (11 percent had died—the majority in early childhood, 7 percent had migrated abroad, and 4 percent were not traceable). Of these 1855 individuals eligible for re-interview in 2002–04, 1113 lived in the original villages, 155 lived in nearby villages in the department of El Progreso, 419 lived in or near Guatemala City, and 168 lived elsewhere in Guatemala. For the 1855 traceable sample members living in Guatemala, 1051 (57 percent) finished the complete battery of applicable interviews and measurements and 1571 (85 percent) completed at least one interview during the HCS. Spouses of original sample members were also included in the survey (Grajeda et al., 2005).

[5] Spouses included both formally married persons as well as cohabiting persons describing themselves as being in a union.

- The children[6] under 12 years old of the original sample member, living in the same household.

The target sample included original sample members from the INCAP Longitudinal Study who lived in the IGT study area and had participated in HCS, as well as their parents, spouses, and children under 12 years old.[7] We designated parents of original sample members as the elder or grandparent generation, which we refer to as the first generation or the "G1" generation. Next, we designated original sample members, their siblings, and their spouses, as the middle or parent generation, i.e., the second generation referred to as "G2s." Finally, we designated children of original sample members as the child (or grandchild) generation, i.e., the third generation referred to as "G3s." Note that these designations correspond precisely to those used in our conceptual framework.

3.2 Data: Outcomes

These surveys contain the following data:

Measures of ECD in G3s: In addition to detailed schooling histories for all children, three tests of cognitive ability were administered as part of the IGT: i) the Raven's Colored Progressive Matrices (Raven, 1989); ii) the Spanish version of the Peabody Picture Vocabulary Test (*Test de Vocabulario en Imagenes Peabody* or TVIP) (Dunn et al., 1986); and iii) the pre-school battery test (Engle et al., 1992). The Raven's test, a test of nonverbal assessment of cognitive ability (Raven, Court, and Raven, 1984), was given to children 5-12 years old and took about 20-30 minutes to administer. Raven's Progressive Matrices are considered to be a measure of eductive ability, "the ability to make sense and meaning out of complex or confusing data; the ability to perceive new patterns and relationships, and to forge (largely nonverbal) constructs which make it easy to handle complexity" (Harcourt Assessment, 2008). The test consists of three series of 12 pattern-matching exercises with the respondent asked to supply a "missing

[6] Children include biological or adopted children of either the original sample member or his/her spouse. To be considered adopted, the child had to consider the original sample member to be his or her parent and vice versa. All children (so-defined) under 12 years old that lived in the same household as the original sample member, or in the household of his or her spouse, were included. In addition, children of original sample members who lived with a former spouse who was not an original sample member also were included in the target sample.

[7] See McNiven (2008) for further details. Melgar et al. (2008) describe how respondents were traced and full details on the data that were collected.

piece" and with the patterns getting progressively more complex and hence harder to match correctly.

The TVIP, a validated test in Spanish used previously in Guatemala, evaluates receptive language and was performed on children 3-12 years of age, and usually took 15-20 minutes. Many children under 5 years of age, however, did not perform sufficiently well on the test to receive a valid score.

Measures of parental cognitive ability: The HCS study obtained data on three measures of parental ability: i) attained (or completed) schooling; ii) reading comprehension skills; and iii) nonverbal cognitive ability. Attained schooling is measured as the number of grades completed.[8]

Reading comprehension skills were measured via a two-part standardized test. Respondents who reported having passed fewer than four years of schooling, or those who reported four to six years of schooling but could not correctly read aloud the headline of a local newspaper article, were first given a literacy test. Individuals who passed this literacy screen, or who reported more than six years of schooling (and thus were presumed to be literate) then took the Inter-American Series test vocabulary and reading comprehension modules (*Serie Interamericana* or SIA, for its acronym in Spanish). The SIA was designed to assess reading abilities of Spanish-speaking children in Texas (Manuel 1967) and includes several "levels" of difficulty. Level 2 for comprehension and Level 3 for vocabulary were used (approximately 3rd and 4th grade equivalents). The reading comprehension module had 40 questions and the vocabulary module 45 questions, yielding a maximum possible score of 85 points on the SIA. Questions on the test become progressively harder. Those who did not pass the literacy screen pre-test were given a zero (applicable to 19 percent of the sample). All individuals (regardless of results on the literacy screen) were administered Raven's Progressive Matrices. We administered three of the five scales (A, B, and C with 12 questions each for a maximum possible score of 36), since pilot data suggested that few respondents were able to progress beyond the third scale.

Other individual, parental, household, dynastic, and locality characteristics: The INCAP data have a rich set of covariates that can also be used in this analysis. These include:

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[8] The formal educational system in Guatemala is divided into primary, secondary, and post-secondary education. Primary school comprises grades one to six, and children are expected to enroll in the calendar year in which they turn seven years old. Secondary school consists of five to seven grades, divided into two parts. The first three years of lower secondary school (to grade nine) are the so-called "basic" grades, and instruction is expected to provide academic and technical skills necessary to join the labor force. The fourth through seventh years of upper secondary school are the so-called "diversified" grades, and students can choose from among several tracks.

For G1s: Basic demographic characteristics (e.g., age, education, religion, number of siblings), current cognitive abilities, living arrangements, measures of health, self-reported perceptions of disabilities, marital history, including the living arrangements and each partner's asset holdings at the time of marriage, shocks experienced during childhood, income generation and work history, and wealth at the time of the original intervention, proximity to the feeding centers.

For G2s: Basic demographic characteristics (e.g., age, education, religion, number of siblings), living arrangements, measures of health, marital history, including the living arrangements and each partner's asset holdings at the time of marriage, income generation and work history, and exposure to the original intervention.

Finally, we have detailed qualitative and archival data from Pivaral (1972) and Bergeron (1992) as well as two specially commissioned studies undertaken in 2002 and 2005 (Estudio 1360, 2002 and 2005). These allow us to control for observable community characteristics. Specifically, we can construct community-level covariates that relate as closely as possible to the timing of key education-related decisions in a child's development. For example, we can include controls such as the availability of a permanent (cement-block) structure for the primary school when the child was seven and 12 years old and primary school student-teacher ratios when the respondent was seven and 12 years old. While these variables reflect community characteristics, they vary by individual or, to be precise, by single-year age cohorts within each village.

4. Results

4.1 Raven's Progressive Matrices

We begin by focusing on the relationship between scores on Raven's Progressive Matrices by G3s, obtained as part of the IGT survey, and scores of their mothers, obtained as part of the HCS survey. Figure 1 shows mean scores on Raven's Progressive Matrices for G3s by age and sex. These rise as children become older at a rate of approximately two additional correct answers per year. Boys at all ages do better than girls. While the difference between the mean age-specific Raven scores for boys and girls is statistically significant (p=0.024), the magnitude of the difference is small (0.4 points or half of a correct answer). As the test becomes harder (i.e., as we move from series A to series AB to series B), mean scores fall (see Table 1). Even on the easiest test, however, children answer, on average, only two-thirds of these questions correctly (each series includes 12 questions). Figure 2 shows the distribution of children's Raven scores. Children are divided into two exclusive groups according to the level of maternal score which could be high (above the sample mean) or low (below the sample mean). The density distribution of children's Raven scores when their mothers have a high score is, as expected, shifted to the right. The Kolmogorov-Smirnov test rejects equality of these distributions ($p<0.001$). Figure 3 is a scattergram of scores on Raven's Progressive Matrices for children and their mothers. Superimposed on this is a line of predicted values for children's scores derived from regressing child's Raven scores on mother's Raven scores, showing a positive correlation between these. The Pearsonian correlation coefficient is 0.246 and is statistically significant at 1 percent.

Table 2 provides our initial results of estimating equation (2). Our outcome variable ($A_{2, G3}$) is the G3 score on Raven's Progressive Matrices. Our measure of maternal cognitive skill ($K_{1, G2}$) is mothers' score on Raven's Progressive Matrices obtained from the HCS survey. Our vector of control variables ($Z_{2, G2}$) include child age (expressed as a series of six dummy variables with the youngest group being the reference category), sex, and mothers' date and place of birth. (Table 1 provides summary statistics for the variables reported in Table 2.) The first column (1) provides OLS estimates of the determinants of children's cognitive skills. We see that, as in Figure 1, these scores rise with age and that, conditioning on other covariates, boys score slightly higher than girls. In this specification maternal age is not associated with children's Ravens, nor is maternal place of birth. We also see that the coefficient on mothers' Ravens scores, $\alpha_{K,G3}$, have a positive and statistically significant association with the scores of their children, as anticipated by Figure 3.

For reasons described in Section 2, these OLS estimates of $\alpha_{K,G3}$ are likely to be biased. One way of addressing this is to use an instrumental variables estimation strategy, treating mothers' Raven's scores as endogenous. In selecting instruments, we are mindful of both statistical requirements and those implied by our conceptual model. Statistical requirements are those of relevance—instruments must be correlated with maternal cognitive skills (put another way, they are not weak instruments in the Stock-Yogo (2005) sense)—and uncorrelatedness, conditional on mothers' Ravens scores, they have no additional effect on second stage outcomes. In the results below we report the Kleibergen-Paap (2006) LM test statistic (a generalized version of the Anderson, 1951, test), where the null hypothesis is that the model is under-identified. We report the Kleibergen-Paap Wald F-statistic which, together with the critical values presented by Stock and Yogo (2005), allows us to assess, at different levels of significance, the hypothesis that the instruments are weak, where weak in this case means having bias in the IV results that is larger than a certain percentage bias in the OLS results. Finally, we report results derived from the Hansen J statistic for over-identification, which tests the null hypothesis that the over-identifying restrictions are valid (i.e., that the model is well specified and the instruments do not belong in the second-stage equation) at conventional significance levels. We consider three sets of possible instruments.

One potential instrument is the nutritional supplement trial itself. As described above, exposure to the *atole* supplement can be credibly thought of as exogenous because it was randomized at the community level and because the duration of exposure, particularly in the critical first three years of life, is a function of year of birth and the exogenous introduction and closing of the trial. Further, Maluccio et al. (2009) show that exposure to *atole* between 0 and 36 months increases the Raven's scores of women in the HCS sample. However, Behrman et al. (2009) demonstrate that the positive effects of *atole* are transmitted intergenerationally. Offspring of women exposed to *atole*, compared with offspring of women exposed to *fresco* had higher birthweights, were taller, and had greater head circumference. This would suggest that exposure to the *atole* supplement will not satisfy the uncorrelatedness condition. In practice, this is what we observe. If we use maternal exposure to *atole*, defined (as in Behrman et al., 2009) as exposure to this supplement at any age under 7 years, as an instrument, we typically obtain p-values on the Hansen J test below 0.10, indicating that we cannot accept the null that the over-identifying restrictions are valid.

A second set of instruments emanates from the observation that formal education levels amongst G1s are low. For example, fewer than 10 percent of the maternal grandmother's of the G3s in our sample have more than three grades of schooling. Given these low levels of educational attainment, together with the rudimentary supply of schooling available 60 years ago, we could attempt the claim that levels of G1 schooling are effectively random and, as such, they are exogenous representations of G1 cognitive skills ($K_{0,\ G1}$). When we included grades of education of the maternal grandmother and the maternal grandfather as instruments, we can reject the null that the model is under-identified, that the instruments are weak (where weak in this case means having bias in the IV results that is larger than 20 percent of the bias in the OLS results) and we fail to reject the null hypothesis that the over-identifying restrictions are valid at any conventional significance levels. However, such a representation violates the spirit of our dynastic model of the formation of cognitive skills.

In light of these results, we adopt a different approach. We begin with the observation that the claim made in the previous paragraph—that G1 grade attainment is random—is likely to be incorrect. There could be any number of reasons why some G1s advanced further in school than others, including the possibility that the G1, at a young age, was exposed to some exogenous shock that was correlated with their own grade attainment (and by extension, given the results above, with G2s' cognitive skills) but not that of their grandchildren.[9] We have two such shocks in our data: whether the mother of the G1 divorced before the G1 was 12 (which is negatively correlated with G1 schooling); and whether the G1 co-resided with her grandparents (which is positively correlated with G1 schooling). Second, the resources available in G1 households before G2s commenced schooling could also be a possible instrument. We have a crude representation of these resources. Specifically, in 1967 INCAP conducted a socio-economic survey in these four villages, obtaining data on land access, holdings of consumer durables (which were in fact very low) and housing quality.[10] We argue that a representation of these resources, their first principal component, can be considered exogenous.[11] Specifically, in 1967 all G1 households in our sample were subsistence farmers, growing maize and beans, and in a few cases (where the terrain and soil were suitable) some vegetables or tobacco (Estudio 1360). There was no use of hybrid seeds or chemical fertilizers. Access to land reflected the vagaries of the development of these villages. Specifically, these settlements were originally formed around land loaned to peasants in return for their labor on landowners. After 1944, peasants gained rights to this land free of labor or rent obligations and were granted legal ownership (Bergeron, 1992). In the 1960s, agricultural production on these lands depended on the quality of land that had been made available to these families several decades ago, rainfall and adverse events such blights and insect infestations (Estudio 1360). We assume that these

[9] Carneiro, Meghir, and Parey (2007) adopt a similar approach using variations in costs of schooling as instruments for maternal education.
[10] We note, with considerable thanks, the work of Mr. Peter Russell who recovered these data from 40-year-old tapes and transformed them into a usable form for us.
[11] This index misses dimensions of wealth such as financial and productive assets. However, in the late 1960s and early 1970s, such non-measured assets were uncommon and also likely to be highly correlated with the assets that were measured. Details of how these principal components are constructed are found in Maluccio, Murphy, and Yount (2005).

exogenous factors were responsible for variations in observed maternal G1 resources two years prior to the date at which the oldest G2 woman in our sample commenced school.

Table 2, column (2) reports the results of when maternal cognitive skills are treated as endogenous. We begin by noting that the Kleibergen-Paap LM statistic rejects the null that the model is under-identified at $p < 0.01$. Using the critical values presented by Stock and Yogo (2005, Table 5.1), with a Kleibergen-Paap Wald F test statistic (Kleibergen and Paap, 2006; Kleibergen, 2007) of 6.46 (or higher) we barely fail to reject at a 5 percent significance level the hypothesis that the instruments are weak, where weak in this case means having bias in the IV results that is larger than 20 percent of the bias in the OLS results. We do not reject the null that the over-identifying instruments are valid with a Hansen J test p-value of 0.85. Further, a heteroskedastic, robust version of Hausman's (1979) endogeneity test rejects the null of the exogeneity of mother's Raven's scores at $p < 0.01$. Finally, the C statistic test results for maternal grandparental resources fails to reject the null that this instrument is exogenous. We conclude that our instrument set is satisfactory.[12] Mindful of this, the striking finding in Table 2 column (2) is that, when we treat maternal cognitive skills as endogenous the point estimate of $\alpha_{K,\,G3}$ more than doubles, from 0.30 to 0.844. Failing to account for the endogeneity of maternal cognitive skills leads to a considerable underestimate of their impact on children's cognitive skills. Further, the effect size implied by the IV estimates is large. Moving a mother from the 25th percentile of maternal Raven's scores to the 75th percentile—an increase of 7 points on the Raven's tests—would increase a child's score by 5.9 points, a 32 percent increase relative to the mean.

Why do we observe such a large increase? Recall that in our specification of G3s cognitive skills, the disturbance term has three components: η_H , aspects of the dynasty which influence human capital formation and are common to all members of the dynasty; η_k , G3 child specific effects such as innate ability and motivation and a white noise disturbance term. We can think of the bias in the OLS estimates deriving from the omission of these characteristics. The magnitude of the bias can be written as:[13]

$$\alpha_{K,G3,\,UNBIASED} - \alpha_{K,G3,\,OLS} =$$

$$[\mathrm{cov}(\eta_H, K_{1,\,G2} \mid Z_{2,\,G2}) / \mathrm{var}(K_{1,\,G2})] + [\mathrm{cov}(\eta_K, K_{1,\,G2} \mid Z_{2,\,G2}) / \mathrm{var}(K_{1,\,G2})] \qquad (3)$$

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[12] Appendix Table 1 presents first stage regressions.

[13] Comments by Elizabeth Powers were especially useful in developing the ideas presented here.

We would expect the first term to be positive given our assumption of common dynastic effects. But by itself, this would imply that the OLS estimates are upward biased which is not what we observe here. One possibility is that the second term is negative because there is regression to the mean—offspring of atypically high performing mothers on the Raven's test are more likely to be closer to the average. Random measurement error would further bias downwards the estimate of $\alpha_{K,G3,\, OLS}$.

Table 3 reports further robustness checks. First, it could be argued that maternal G1 resources are correlated with the disturbance term in (2). For example, this would be true if these resources capture an ethic of hard work or determination, and this is both passed from G1 to G2 to G3 and such an intergenerationally transmitted ethic was correlated with the development of cognitive skills. Even though such a supposition is not supported by the results of the Hansen tests and the C statistic reported above, in column (1) we report the results of estimating equation (2) without G1 maternal resources as an instrument. While our test statistics for instrument relevance are slightly weaker, the parameter estimate is basically unchanged.

A feature of our empirical specification thus far has been a focus on the maternal side of the dynasty. What happens if we include paternal characteristics as additional controls? Note that we should not use paternal schooling as a control because it too could be correlated with the disturbance term. Instead, we include paternal age to capture, in a loose sense, the life-cycle position of the G2 household. We also include the attained grades of schooling of the G3s paternal grandparents. This can be thought of as a way of capturing cognitive skills of the paternal side of the dynasty. If this notion is correct, then we should see the parameter estimate for $\alpha_{K,G3}$ increase because we are directly capturing an additional component of the first term of equation (3). The coefficient on maternal cognitive skills in column (2) is in fact slightly higher (0.897 v 0.844), consistent with this argument.

We note the results of further robustness tests. To the extent that our estimates are biased, conditional on the validity of the excluded instruments they are biased toward the OLS estimate. However when we estimate using limited information maximum likelihood (LIML), as suggested by Stock and Yogo (2005), our results are unchanged (column 3). If we use a log-log specification, we can interpret our coefficients in terms of elasticities. When we do so, as shown in column (4), we obtain an elasticity of 0.780. A 10 percent increase in maternal Raven's scores increases children's Raven's scores by 7.8 percent. Our impact measure is also robust to the inclusion of the student/teacher ratios at the local primary schools attended by these children and if we use results from Raven's scores obtained from a subset of mothers who took this test in 1988 when they were aged 11-26 (not reported).

Table 4 considers whether the relationship between maternal and child Raven's scores differs across children and their households. This shows no difference in the impact on boys' and girls' scores (columns 1 and 2). There is a larger impact on older children, see columns 3 and 4 and on higher order children (columns 5 and 6).[14]

4.2 Vocabulary Scores

We now turn to an assessment of the impact of maternal reading and vocabulary skills on a second dimension of children's cognitive skills, vocabulary. The outcome is the child's (G3's) scores on the Spanish version of the Peabody Picture Vocabulary Test (*Test de Vocabulario en Imagenes Peabody* or TVIP). While the Raven test was implemented to children 5-12y old, TVIP was implemented to children 3-12 years old, raising the sample size from 577 to 646.

Figure 4 shows mean raw TVIP scores for G3s by age and sex. These rise as children become older but at a diminishing rate. Boys at all ages do better than girls. Additionally, observed TVIP scores are standardized by dividing through by the age-specific sample mean which allows differences in average score by sex of the child to be compared. This difference is statistically significant at 5 percent ($p=0.038$) and the magnitude of the difference is 2.6 points, or two and a half correct answers. In addition, Figure 5 shows the density distributions of child's TVIP scores by the level of maternal SIA score (whether maternal SIA score is above or below the sample mean, 34 points). The distribution of the TVIP score for those children whose mother reached a high SIA score (above the mean) is, as expected, shifted to the right. The Kolmogorov-Smirnov test rejects equality of the distributions ($p<0.001$). Figure 6 is a scattergram of TVIP scores for children and SIA scores of their mothers. Superimposed on this is a line of predicted values for children's scores derived from regressing child's TVIP scores on mother's SIA scores, showing a positive correlation between these. The Pearsonian correlation coefficient is 0.448 and is statistically significant at 1 percent.

Basic results are reported in Table 5 using specifications analogous to those used in Table 2. OLS results show a positive, statistically significant association between maternal

[14] There may be a story here about how your mother's skills become more important as you get older; and that mothers with greater cognitive skills can manage interactions with multiple children more effectively.

reading/vocabulary scores and their children's vocabulary. Column (2) shows instrumental variable regressions where maternal SIA score is treated as endogenous. We can reject the null that model is under-identified at $p < 0.01$. Using the critical values presented by Stock and Yogo (2005, Table 5.1), with a Kleibergen-Paap Wald F test statistic (Kleibergen and Paap, 2006; Kleibergen, 2007) of 6.46 (or higher) we reject at a 5 percent significance level the hypothesis that the instruments are weak, where weak in this case means having bias in the IV results that is larger than 20 percent of the bias in the OLS results. We do not reject the null that the over-identifying instruments are valid and the heteroskedastic robust version of Hausman's (1979) endogeneity test rejects the null of the exogeneity of mother's Raven's scores at $p < 0.01$. Again we conclude that our instrument set is satisfactory.[15] Mindful of this, the striking finding in Table 2 column (2) is that, when we treat maternal cognitive skills as endogenous the point estimate of $\alpha_{K,\ G3}$ more than doubles, from 0.33 to 0.776. Failing to account for the endogeneity of maternal reading/vocabulary skills leads to a considerable underestimation of their impact on children's vocabulary. Table 6, replicating the robustness checks performed for the scores on Raven's Progressive Matrices, shows that these findings are unchanged when we exclude maternal grandparent wealth or paternal covariates or school quality. The log-log specification tells us that a 10 percent increase in maternal reading and vocabulary scores increases those of her children by 5 percent. There is some suggestion in these data that there is a larger effect for boys relative to girls and once again we observe larger impacts for older children, see Table 7 for details.

4.3 Assessing the Impact of Paternal Cognitive Skills

Lastly, we use a similar methodology to assess the impact of paternal cognitive skills on the cognitive skills of their children. The OLS estimates reported in columns (1) of Tables 8 and 9 show similar associations to those observed for mothers in Tables 2 and 5. When we instrument for paternal cognitive skills, we again observe an increase in the magnitude of $\alpha_{K,G3}$. However, the increase is considerably smaller than for mothers. For example, we obtain a point estimate of 0.348 for the impact of fathers' Ravens scores compared to a point estimate of 0.844 for mothers. One possible explanation for this is that fathers are absent for long periods of time during the day; for example there are a significant number of males who commute to wage jobs outside of

[15] Appendix Table 1 presents first stage regressions.

these villages. With considerably less contact with their children, it is perhaps not surprising that the impact of their cognitive skills is lower than mothers.

5. Summary

This paper examines ECD outcomes and their association with family characteristics, investments and environmental factors. We are particularly interested in the intergenerational transmission of cognitive abilities. Given the strong causal links between cognitive abilities and economic productivity in adulthood, the intergenerational transmission of these abilities represents an important pathway by which economic advantage or poverty is perpetuated over time. Associational studies on this topic cannot be considered causal given that the cognitive abilities of different generations reflect, in part, unobservable factors such as the genetic heritability of such abilities which are common across generations. We examine the causal relationship between parental cognitive abilities and ECD outcomes of their offspring using a rich data set from rural Guatemala that can account for such unobservable factors. Accounting for these unobservables doubles the estimated impact on the cognitive skills of their children. We find that a 10 percent increase in maternal Raven's scores increases children's Raven's scores by 7.8 percent. A 10 percent increase in maternal reading and vocabulary skills increases children's score on the TVIP by five percent. These results are robust to a wide set of controls. Effects are larger for older children and the impact of maternal cognitive skills is larger than for paternal skills.

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Table 1. Descriptive Statistics Matrices

	Mean	**Standard Deviation**
Child's Raven score, Series A	7.91	1.76
Child's Raven score, Series AB	5.92	2.73
Child's Raven score, Series B	4.59	2.21
Child's Raven score (*A plus AB plus B*)	18.43	5.90
Child's Spanish vocabulary score TVIP *	90.99	16.05
Mother's Raven score	16.17	5.21
Mother's SIA score *	34.09	21.64
Child age (years)	8.63	2.04
1 if child is 7 (%)	17.16	
1 if child is 8 (%)	14.90	
1 if child is 9 (%)	15.08	
1 if child is 10 (%)	12.82	
1 if child is 11 (%)	15.25	
1 if child is 12 (%)	8.32	
Child sex (1 if boy) %	49.22	
Mother's age (years)	35.36	4.05
1 if mother born in San Juan %	26.17	
1 if mother born in Conacaste %	26.34	
1 if mother born in Espiritu Santo %	24.78	
1 if mother born in Santo Domingo %	22.70	

Sample size is 577 children

* Sample size is 646 children due to the inclusion of children 3y and 4y old for the vocabulary score

Table 2. Basic Results for Determinants of Child's Raven's Progressive Matrices Scores

	(1) OLS	(2) IV
Mothers' Raven's score ($K_{1,\ G2}$) (2002)	0.300***	0.844***
	(0.0409)	(0.185)
=1 if 7 y old	1.256*	0.968
	(0.548)	(0.734)
=1 if 8 y old	2.685***	2.227**
	(0.558)	(0.691)
=1 if 9 y old	4.492***	4.220***
	(0.493)	(0.616)
=1 if 10 y old	8.159***	7.876***
	(0.654)	(0.719)
=1 if 11 y old	8.130***	7.985***
	(0.661)	(0.738)
=1 if 12 y old	10.41***	10.10***
	(0.790)	(0.941)
Boy	0.963**	1.061*
	(0.359)	(0.434)
Mother's age, y	0.0605	0.0994
	(0.0538)	(0.0703)
=1 if mother born in San Juan	-0.867	-1.957*
	(0.609)	(0.813)
=1 if mother born in Conacaste	-0.930	-2.611**
	(0.622)	(0.905)
=1 if mother born in Espiritu Santo	-0.327	-1.243
	(0.601)	(0.800)
F test	41.70***	30.66***
Kleibergen-Paap LM statistic Chi^2 p-value		0.002
Kleibergen-Paap Wald F statistic		6.131
Hansen J test Chi^2 p-value		0.846
Endogeneity test Chi^2 p-value		0.002
C statistic test Chi^2 p-value		0.644

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Sample size is 577. Standard errors (in parentheses) are robust to heteroscedasticity and clustered at maternal level (346 clusters). Instruments used in column (2) are maternal grandparental wealth index, an indicator variable that takes value 1 if the maternal grandmother lived with her grandparents when <12y and an indicator variable that takes value 1 if maternal grandmother's mother remarried when <12y. Column (2) uses a two-step efficient generalized method of moments (GMM) estimator. Critical values for Kleibergen-Paap Wald F test statistic (Kleibergen and Paap 2006; Kleibergen 2007) at the 5 percent significance level is 6.46 for rejecting the null hypothesis of weak instruments, where weak means having bias in the IV results that is larger than 20 percent of the bias in the OLS results. C statistic tests for exogeneity of suspect instrument: maternal grandparental wealth index. Omitted categories for child sex and age are girl and 5y-6y, respectively, and Santo Domingo for mother's village of origin.

Table 3. Determinants of Child's Raven's Progressive Matrices Scores, Robustness Tests

	(1) IV (excludes maternal grandparent wealth)	(2) IV with paternal covariates	(3) IV with paternal covariates (LIML)	(4) IV with paternal covariates and school quality	(5) IV with paternal covariates (log-log)
Mothers' Raven's score ($K_{1, G2}$)	0.800***	0.897***	0.910***	0.887***	
	(0.201)	(0.209)	(0.218)	(0.204)	
Primary school student/teacher ratio, child				-0.327*	
				(0.133)	
Log Mothers' Raven's score					0.780***
					(0.184)
F test	31.89***	23.83***	23.02***	22.99***	24.94***
Kleibergen-Paap LM statistic Chi^2 p-value	0.006	0.003	0.003	0.003	0.003
Kleibergen-Paap Wald F statistic	6.233	5.944	5.944	5.955	6.236
Hansen J test Chi^2 p-value	0.715	0.849	0.852	0.810	0.817
Endogeneity test Chi^2 p-value	0.014	0.001	0.001	0.001	0.002

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Sample size is 577. Second stage controls used in Table 2 are included but not reported here; also see Table 2 notes for construction of standard errors and instruments. Column (1) does not use maternal grandparental wealth index as an instrument. Columns (1), (2), (4) and (5) use a two-step efficient generalized method of moments (GMM) estimator while column (3) use the limited-information maximum likelihood (LIML) estimator.

Table 4. Determinants of Child's Raven's Progressive Matrices Scores, Disaggregations

	(1) Boys	(2) Girls	(3) Children (5-8 y)	(4) Children (9-12 y)	(5) First born children	(6) Higher order children
Mothers' Raven's score ($K_{1,G2}$)	0.801**	0.717***	0.552**	1.348***	0.555	0.885***
	(0.246)	(0.204)	(0.214)	(0.329)	(0.301)	(0.224)
Observations	284	293	280	297	113	464
F test	15.36***	14.48***	3.27***	5.02***	7.56***	19.73***
Kleibergen-Paap LM statistic Chi^2 p-value	0.009	0.004	0.019	0.012	0.015	0.016
Kleibergen-Paap Wald F statistic	6.223	5.489	3.962	5.220	3.769	3.958
Hansen J test Chi^2 p-value	0.557	0.127	0.676	0.647	0.164	0.189

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Second stage controls used in Table 2 are included but not reported here; also see Table 2 notes for construction of standard errors and instruments.

Table 5. Determinants of Child's Spanish Vocabulary Score TVIP (Test de Vocabulario en Imágenes Peabody)

	(1) OLS	(2) IV
Mother's SIA score ($K_{1, G2}$) (2002)	0.333***	0.776***
	(0.033)	(0.164)
=1 if 5 y old	-2.833	-4.584
	(2.414)	(2.913)
=1 if 6 y old	0.567	-1.047
	(2.469)	(2.976)
=1 if 7 y old	2.815	0.794
	(2.059)	(2.677)
=1 if 8 y old	2.643	3.139
	(1.827)	(2.476)
=1 if 9 y old	1.884	0.113
	(1.954)	(2.617)
=1 if 10 y old	3.987	1.811
	(2.244)	(2.818)
=1 if 11 y old	-0.911	-1.533
	(2.173)	(2.621)
=1 if 12 y old	-1.074	-2.798
	(2.600)	(3.160)
Boy	2.484*	2.025
	(1.211)	(1.366)
Mother's age, y	0.109	0.261
	(0.168)	(0.224)
=1 if mother born in San Juan	-3.305	-2.830
	(1.993)	(2.726)
=1 if mother born in Conacaste	0.313	1.768
	(1.862)	(2.509)
=1 if mother born in Espiritu Santo	-0.847	1.504
	(1.948)	(2.721)
F test	9.916***	3.102***
Kleibergen-Paap LM statistic Chi^2 p-value		0.0005
Kleibergen-Paap Wald F statistic		6.970
Hansen J test Chi^2 p-value		0.640
Endogeneity test Chi^2 p-value		0.0008
C statistic test Chi^2 p-value		0.884

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Sample size is 646. Standard errors (in parentheses) are robust to heteroskedasticity and clustered at maternal level (353 clusters). Column (2) uses a two-step efficient generalized method of moments (GMM) estimator, see Table 2 notes for instruments. C statistic tests for exogeneity of suspect instrument: maternal grandparental wealth index. Omitted categories for child sex and age are girl and 3y-4y, respectively, and Santo Domingo for mother's village of origin.

Table 6. Determinants of Child's Spanish Vocabulary Score TVIP, Robustness Tests

	(1) IV (excludes maternal grandparent wealth)	(2) IV with paternal covariates	(3) IV with paternal covariates (LIML)	(4) IV with paternal covariates and school quality	(5) IV with paternal covariates (log-log)
Mother's SIA score (2002) ($K_{1, G2}$)	0.782***	0.789***	0.787***	0.694***	
	(0.171)	(0.189)	(0.204)	(159)	
Primary school student/teacher ratio, child				0.059	
				(0.387)	
Log Mothers' SIA score					0.501***
					(0.120)
Observations	646	646	646	601	518
N clusters	353	353	353	344	288
F test	2.972***	3.167***	2.970***	3.260***	2.955***
Kleibergen-Paap LM statistic Chi^2 p-value	0.0003	0.002	0.002	0.001	0.005
Kleibergen-Paap Wald F statistic	9.578	5.811	5.811	7.080	4.534
Hansen J test Chi^2 p-value	0.359	0.603	0.612	0.422	0.158
Endogeneity test Chi^2 p-value	0.001	0.001	0.001	0.007	0.002

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Sample size is 646 except for column (4) due to missing values on child's school quality. Second stage controls used in Table 5 are included but not reported here; also see Table 2 notes for construction of standard errors and instruments. Column (1) does not use maternal grandparental wealth index as an instrument. Columns (1), (2), (4) and (5) use a two-step efficient generalized method of moments (GMM) estimator while column (3) use the limited-information maximum likelihood (LIML) estimator.

Table 7. Determinants of Child's Spanish Vocabulary Score TVIP, Disaggregations

	(1) Boys	(2) Girls	(3) Children (3-7 y)	(4) Children (8-12 y)	(5) First born children	(6) Higher order children
Mother's SIA score (2002)	0.784**	0.565***	0.664**	0.823***	0.837	0.661***
	(0.304)	(0.157)	(0.269)	(0.168)	(0.434)	(0.183)
Observations	327	319	284	362	116	530
F test	2.072**	2.865***	3.116***	3.366***	1.630	2.627***
Kleibergen-Paap LM statistic Chi^2 p-value	0.037	0.0005	0.045	0.002	0.161	0.007
Kleibergen-Paap Wald F statistic	3.674	7.198	3.038	6.918	1.458	4.789
Hansen J test Chi^2 p-value	0.251	0.321	0.376	0.869	0.734	0.409

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Second stage controls used in Table 5 are included but not reported here; also see Table 5 notes for construction of standard errors and instruments.

Table 8. Determinants of Raven's Progressive Matrices Scores, Inclusion of Fathers' Raven's Scores

	(1) OLS	(2) IV
Fathers' Raven's score (2002)	0.261***	0.348**
	(0.032)	(0.131)
Observations	472	472
N clusters	273	273
F test	42.26***	35.34***
Kleibergen-Paap LM statistic Chi^2 p-value		0.0006
Kleibergen-Paap Wald F statistic		6.965
Hansen J test Chi^2 p-value		0.007
Endogeneity test Chi^2 p-value		0.537
C statistic test Chi^2 p-value		0.396

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 9. Determinants of Child's Spanish Vocabulary Score TVIP (Test de Vocabulario en Imágenes Peabody), Inclusion of Fathers' Scores

	(1) OLS	(2) IV
Father's SIA score (2002)	0.306***	0.499***
	(0.034)	(0.118)
Observations	567	567
N clusters	292	292
F test	10.60***	3.639***
Kleibergen-Paap LM statistic Chi^2 p-value		0.00002
Kleibergen-Paap Wald F statistic		10.21
Hansen J test Chi^2 p-value		0.110
Endogeneity test Chi^2 p-value		0.111
C statistic test Chi^2 p-value		0.089

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix Table 1: First-Stage Regressions for Columns (2) in Tables (2) and (5), Respectively

	(1) Raven	(2) TVIP
Grandparental wealth index	0.764**	2.705
	(0.358)	(1.761)
= 1 if the maternal grandmother lived with her grandparents when <12y	1.487*	9.198***
	(0.809)	(2.983)
= 1 if maternal grandmother's mother remarried when <12y	2.816**	9.228*
	(1.211)	(5.189)
Observations	577	646
F test of excluded instruments p value	0.0005	0.0001

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors (in parentheses) are robust to heteroskedasticity and clustered at maternal level. Controls included in second stage regressions on Tables 2 and 5 were also included here but not reported.

Figure 1: Average Child's Raven Score by Child's Sex and Age

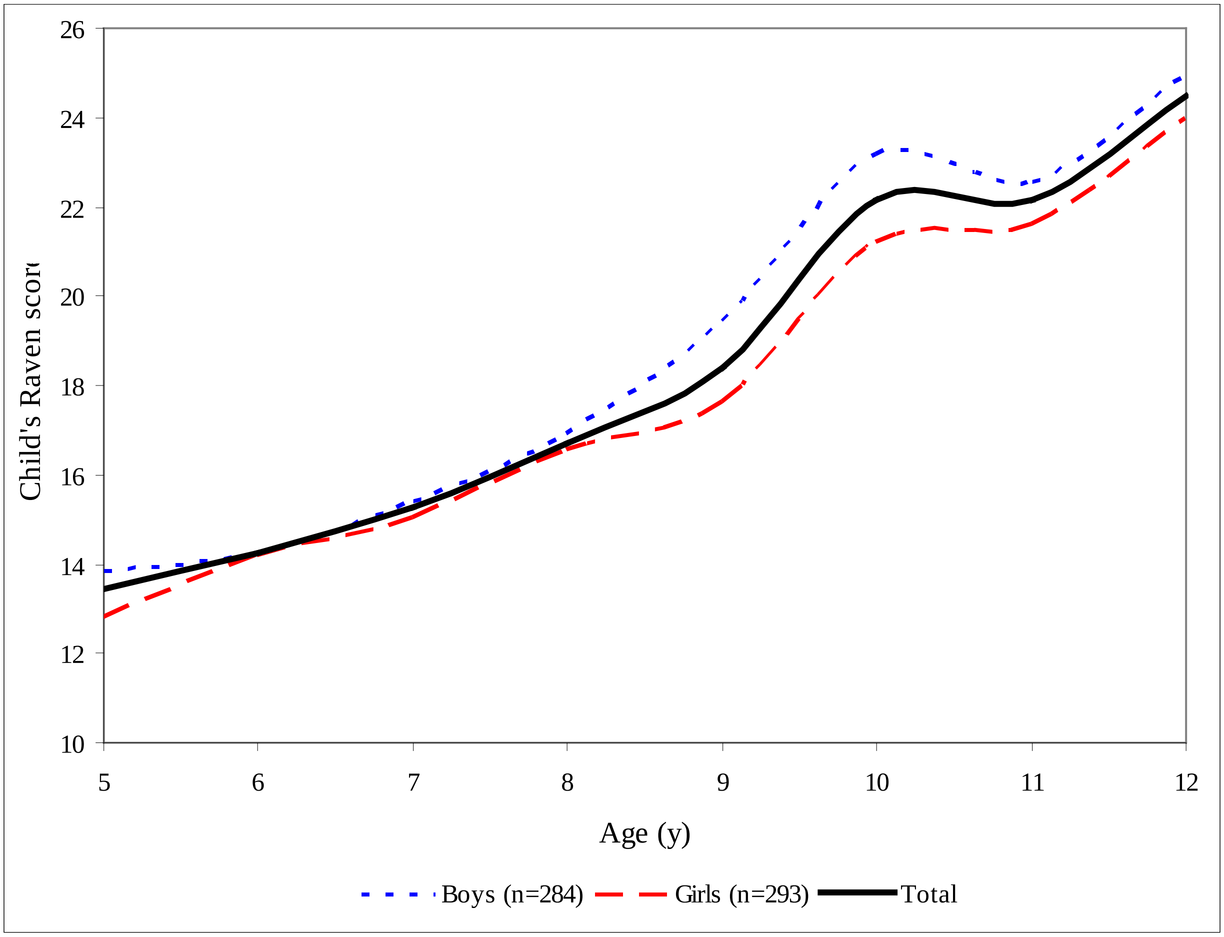

Figure 2. Distribution of Child's Raven Score by Mother's Raven Score

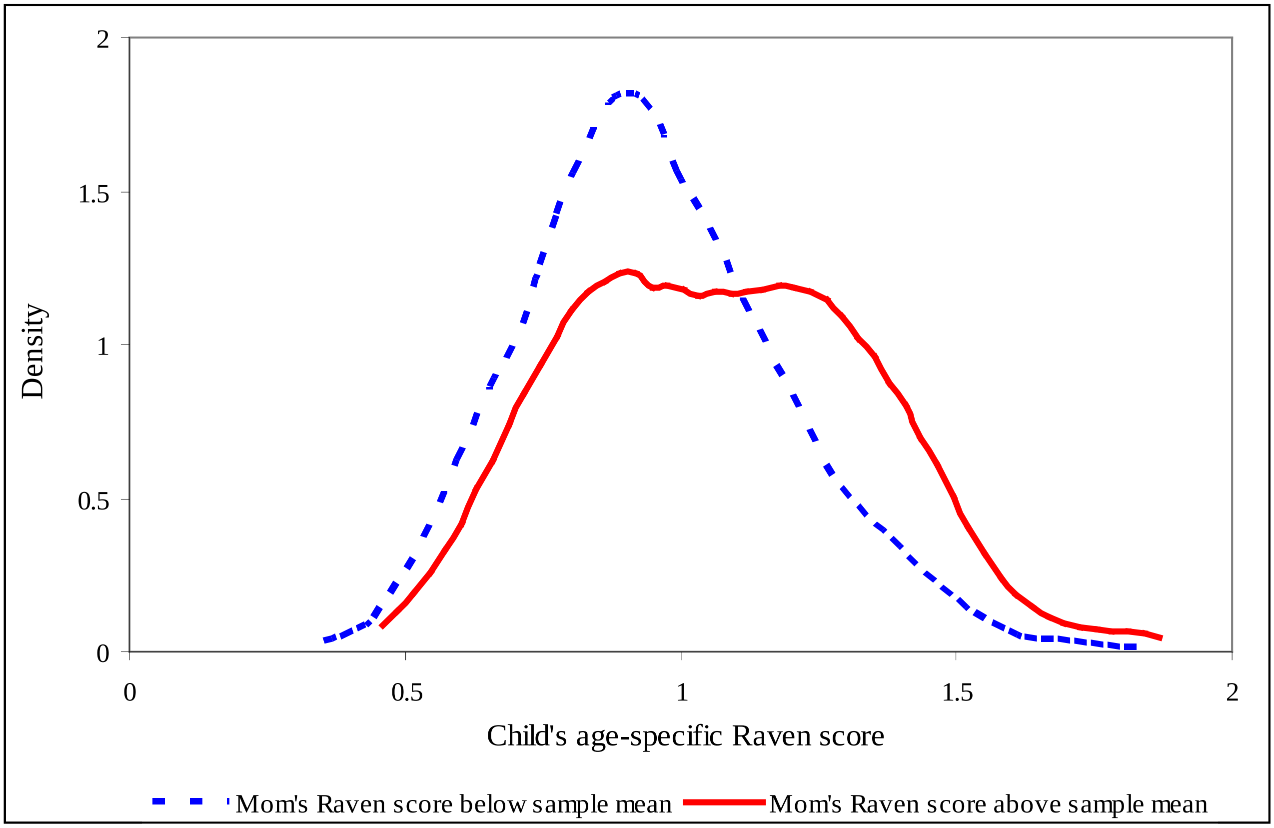

Figure 3: Association between Child's Raven Score and Mother's Raven Score

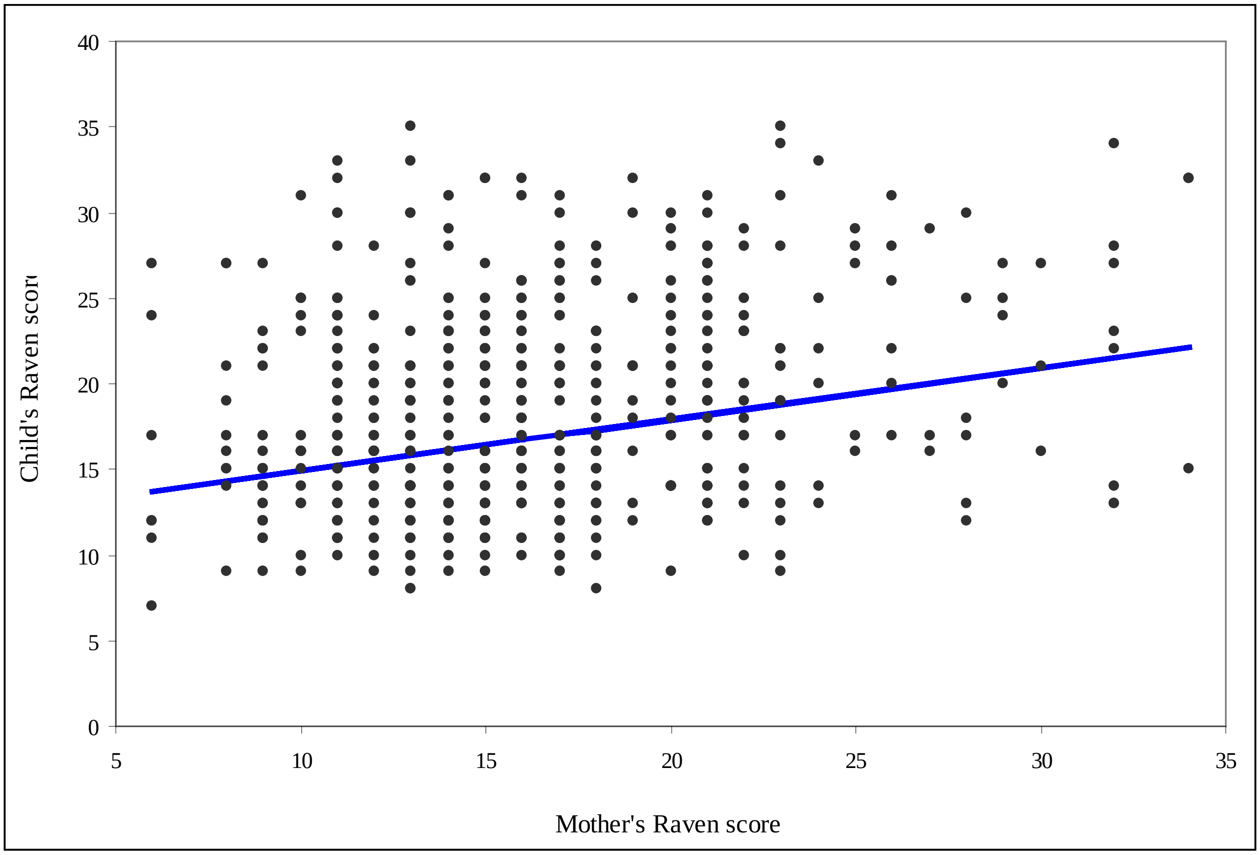

Figure 4. Average Child's TVIP Score by Child's Sex and Age

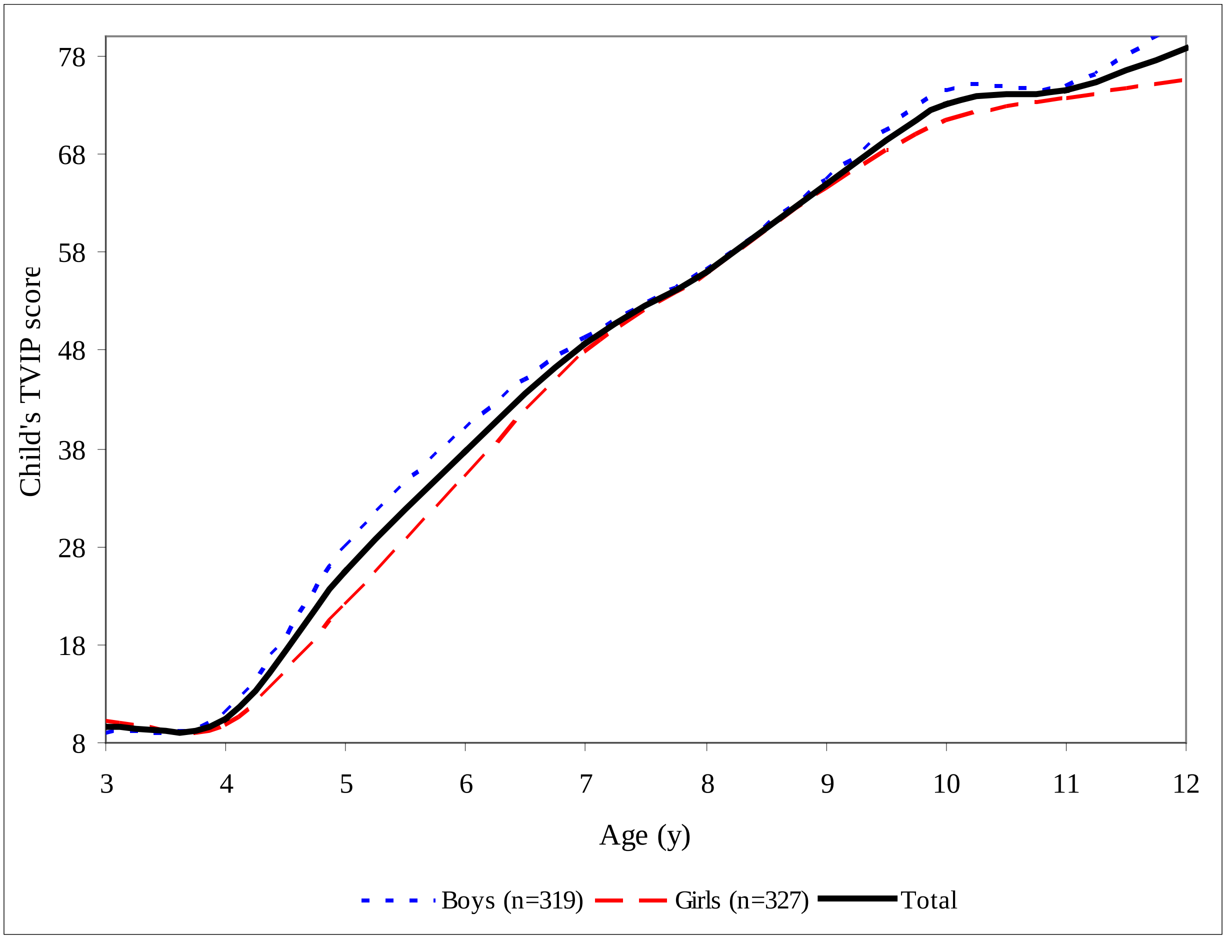

Figure 5. Distribution of Child's TVIP Score by Mother's SIA score

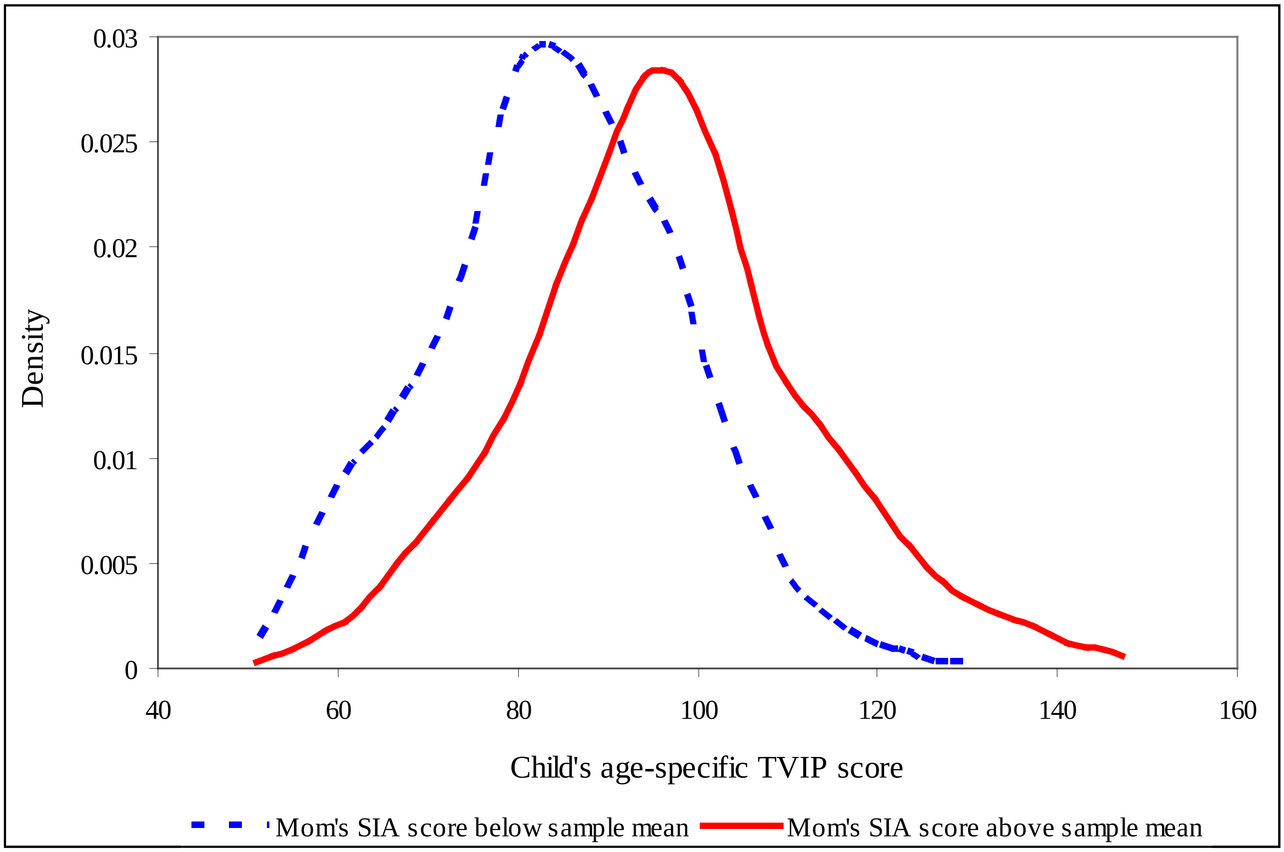

Figure 6. Association between Child's TVIP Score and Mother's SIA Score