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The Role of Maternal Cognitive Ability on Child Health

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Abstract

Little is known about the mechanisms through which mother's cognitive ability operates in enhancing her children's health. This paper analyzes how maternal returns to cognitive ability on children's height reflect contemporaneous endowments and childhood background of the mother. Results suggest that maternal returns to cognitive ability on child height are less likely to reflect observed mother's childhood endowments as measured by parental transmission of knowledge or school quality, but are more likely to be associated with learning to be a mother, and with a better capacity to take advantage of household and community available resources.

Resumen

El objetivo del artículo es estudiar los diversos mecanismos por medio de los cuales la habilidad cognitiva de la madre, como variable adicional de capital humano, incide en la salud de los hijos. Para ello, relajamos el supuesto de la literatura de concebir a la capacidad cognitiva como variable predeterminada y estudiamos en qué medida sus retornos en la procuración de la salud de los hijos se encuentran correlacionados con variables tradicionalmente no observadas, como lo son los antecedentes de infancia de la madre (educación de sus padres) y la disponibilidad y calidad de recursos comunitarios durante sus años de formación escolar. Los resultados muestran un importante retorno a la capacidad cognitiva de la madre en la procuración de salud de sus hijos, aun después de controlar por el nivel de escolaridad y talla de la madre, y por antecedentes maternos durante la infancia. Asimismo, los resultados muestran que la habilidad de razonamiento materna es un factor importante sobre la salud infantil cuando la madre experimenta la maternidad por primera vez. Nuestro análisis se basa en información de Matrices Progresivas de Raven, como medida de capacidad cognitiva, y en información antrópométrica (talla) infantil.

Introduction

It is generally agreed that investments in human resources play an important role in economic growth. There is a vast literature showing that education improves one's performance in the labor market and one's business, on the farm and even in the home by influencing children's outcomes. Like schooling, health is a form of human capital also correlated with improved functionality and productivity (Strauss and Thomas, 1998). But health is also a good for which there is no market, and is therefore produced within the household by reallocating (market and non-market) resources to the production of health. Given household (home and environmental- specific) endowments, child rearing technology, the way parents allocate family resources has a direct impact on child health. These decisions, in turn, affect not only the children's productivity at school and at their future jobs, but also influence their life expectancy. For example, malnutrition in early stages of life has been shown to be correlated with child mortality and child morbidity. Likewise, good health has been linked to improvements in cognitive ability and faster mental development. [Beaton, G.H., *et al.*, (1993), Bleichrodt and Born, (1994), and Wachs, T.D., (1995)].

The literature on child health and nutrition in a socioeconomic context has been analyzed by several authors. Schultz (1984) reviews the impact of household economic and community variables on child mortality; Wolfe and Behrman (1982), and Thomas and Strauss (1990) investigate the interdependence of child height and nutritional status with child survival; Barrera (1990) studies the role of maternal schooling in relation to public health programs in child health production; and Thomas (1990, 1994) investigates how household differences in resource allocations on child health reflect both technological differences in child rearing and differences in the parent's preferences. This literature suggests that mothers play a central role in household and child rearing activities. As a result, a mother's education has been commonly described as a key determinant of child health. At least four channels have been proposed through which maternal education enhances child health: a) it improves productivity of health inputs due to better knowledge and access to new information; b) it makes allocation of resources more efficient c) it increases the economic resources available to the family via her participation in economic activities, and d) as proxy of individual permanent income, education gives mothers bargaining power in decision making, shifting household preferences towards child human capital investments.

Some efforts have been made to separate the differential mechanisms through which a mother's human capital can impact health outcomes. Wolfe and Behrman (1987), and Behrman and Wolfe (1987) have analyzed the correlation of schooling returns to unobserved mother's childhood background, and intra-generation transmission of knowledge; Thomas, Strauss and M. Henriques (1990) have analyzed the effect of maternal capacity to process information on her children's health; and Bhargava and Fox-Kean, (2003) have studied the sensibility of maternal returns to schooling on child's nutrition when controlling for a measure of maternal cognitive ability as a predetermined variable.[1]

Little is known, however, about the mechanisms through which mother's cognitive ability operates in enhancing her children's health. As schooling and other measures of human capital, maternal cognitive ability is likely to be correlated with contemporaneous and background endowments that simultaneously drive her children's health. This paper tries to shed light on this issue by analyzing how maternal returns to cognitive ability on children's height reflect her childhood observed background in the form of a) parental intra-generation transmission of knowledge; and b) mother's childhood environment such as her community and school. We also question whether the mechanism through which maternal cognitive ability relates to the health of her children operates through contemporaneous child health determinants, such as maternal child rearing experience or household economic resources. Finally, we test whether returns to maternal reasoning are correlated to additional unobserved characteristics other than mother's childhood endowments.

Our results show that maternal cognitive ability can in fact improve her children's height, even after controlling for parental age, mother's and father's years of schooling and mother's height. We find that maternal cognitive ability estimates remain important when we include mother's parents years of schooling, whether she lived in an urban community during her primary years, and whether she attended to an elementary public school, as opposed to a private institution. These results suggest that cognitive ability returns to child health are less likely to reflect a mother's childhood background, such as the transmission of knowledge from her parents or her local childhood community environment. In line with the literature, we find household economic resources, —as measured by household total expenditure—, to be an important determinant of children's health. Controlling for household total expenditure, the effect of maternal cognitive ability on child's health falls by 10 percent, suggesting the possibility that cognitive ability enhances child's health investment by improving maternal capability of providing wealth to the household, perhaps by means of labor productivity and/or savings decisions. However, the fact that the effect of mother's cognitive ability remains significant suggests that cognitive ability

[1] Most studies which analyze the returns to reasoning ability on other dimensions such as individual labor productivity and cognitive achievement, also treat it as predetermined. [Alderman, Behrman, Ross and Sabot (1996) and Glewwe & Jacoby (1994)].

may also improve children's health by other means instead of simply facilitating the transfer of economic resources to the household.

Since the literature on household decision-making suggests that the child rearing experience may be an important input in the health production function, by allowing parents to allocate household resources more efficiently [Strauss & Thomas (1995), Glewwe (1999)], the natural next step is to investigate the relationship between a mother's reasoning ability and child care experience on returns to child health. By fully interacting both mother's and child's characteristics, we compare the effect of maternal cognitive ability between first-born and not-firstborn children. Our results suggest that high maternal reasoning ability plays a more important role in improving the child's health when mothers experience motherhood for the first time, than when they have acquired experience with their subsequent children. These results hold only if we control for mother's fixed effects, which wipe out any remaining maternal unobserved characteristics. We conclude, therefore that returns to mother's cognitive ability are likely to be correlated with additional unobserved child's health determinants other than mother's observed childhood endowments.

II. Model

For simplicity, we define the household welfare as a function of each parent's preferences as dependent upon parental (observed and unobserved) characteristics, and on all household member's private and public consumption.[2] This allows us to explain any altruistic behavior and externalities in consumption that are essential in modeling why parents allocate resources in the provision of health to their children:

$$W = \left[U^m\left(X, H, u_m, u_f, \varepsilon_m, \varepsilon_f\right), U^f\left(X, H, u_m, u_f, \varepsilon_m, \varepsilon_f\right)\right] \qquad (1)$$

X represents a vector of market commodities, including leisure; H stands for all non-market goods produced at home, such as child's health investment; um and uf denote mother's and father's observed background characteristics such as age, and years of schooling; and ε_m and ε_f correspond to vectors of parental unobservable characteristics, such as tastes and cognitive ability.

2 We impose no a priori restriction on the household decision making mechanism.

The household welfare function is maximized, subject to the family budget constraint;[3]

$$PX = Y,$$
$$Y_i = E_j + ny_j \tag{2}$$

P is a vector of market prices excluding the price of leisure; and Y stand for household total income, as a linear combination of household earnings (E) and non-labor income (nyi). Earnings depend as usual, on individual's wage and on a time constraint.

The health of the children in the family does not depend merely on the parents' preferences in the allocation of resources. Other variables such as child biological factors, community characteristics and each parent's specific technology in raising children become important elements in determining the health status of the child. This is captured by a non-market commodity production function that summarizes any private and public inputs in the procurement of health:

$$H = H\left(X, X_n, \theta, \eta_p, \eta_c\right) \tag{3}$$

H depends on any market purchased (X) and non-market (Xn) inputs that are related to the health status of the child, such as food intake, utilization of health services and breast-feeding, respectively. We also incorporate a vector of child's characteristics (θ), such as age and gender, that controls for biological factors influencing the child's health. ηp is a vector of parental-specific characteristics that reflects child-rearing technology. ηp can be thought as parental age, years of schooling, cognitive ability and any other background endowments. ηc captures characteristics related to the environment that surrounds the household, such as community quantity and quality of public services, type of sewage, water facilities and garbage disposal services, public policy interventions such as health talks and vaccination campaigns, consumption goods prices, and regional climate.

The maximization process leads to aggregate market and non-market household commodity demands for each element of X and H, which includes child's health investments:

[3]For simplicity, we assume parental incomes to be the only source of family monetary resources.

$$X^* = G_x\left(P, y_m, y_f; u_m, u_f, \varepsilon_m, \varepsilon_f; \theta, \eta_p, \eta_c\right)$$

$$H^* = G_z\left(P, y_m, y_f; u_m, u_f, \varepsilon_m, \varepsilon_f; \theta, \eta_p, \eta_c\right) \qquad (4)$$

These reduced forms – including the demand for child health (such as child height) depend on a vector P of commodity prices, and on the set of observed and unobserved household and community characteristics that reflect parental preferences and child rearing technology in the allocation of resources within the household. Section IV of the paper deals with the empirical strategy that estimates the child's health as a component of H*.[4] We turn next to the description of the data.

III. Data

The data analyzed in this study comes from The Mexican Family Life Survey 2002 (MxFLS-1), a multi-purpose household survey that is representative at the national, urban-rural and regional level and was carried out from April to July 2002. The survey was designed by the Centro de Investigación y Docencia Económicas (CIDE), and the Universidad Iberoamericana, but adopts the methodology and protocols followed in the Indonesian Family Life Surveys. The survey was fielded by The Mexican National Institute of Statistics, Geography and Informatics, the equivalent of the U.S. Bureau of the Census. Free access of MxFLS-1 data and documentation is available at www.cide.edu or www.uia.mx. Since this survey is new and relatively unknown, a brief summary of it follows.

The multi-dimensional characteristic of the survey enabled the collection of detailed demographic, socioeconomic and health information about all individuals in the household. MxFLS-1 gathers, in one single database, detailed information on:

Household level data

The survey includes information on expenditure including self-sufficiency by the household; agricultural land ownership and detailed information about each plot; non-agricultural businesses, non-labor income; asset ownership (wealth), saving decisions, formal and informal credit, debts; household

[4] In this context, H* corresponds to a vector of household aggregate health demand including child's health.

economic shocks, such as loss dwelling, crop, and/or home business, severe illness or death of a household member; as well as information on crime and victimization suffered at the house, business or plot. It also provides detailed data about every event; total nonlabor household income, dwelling characteristics, living arrangements and environmental shocks such as floods, suffered by the household/community. This information is gathered from one single respondent.

Individual level data

Information from every member of the household is collected on the following matters: retrospective data on schooling; retrospective histories of migration, marriage, births and deaths of children, labor force participation, labor income of adults; monetary and in kind transfers, time allocation of adults and children, credits and loans, human capital investment levels and decision-making; socio-demographic and geographic information of the individuals that conform the extended family (including non co-resident parents and siblings), individual health status both objective and subjective of all members in the household (own perception; habits and functioning indicators; chronic diseases; morbidity, anthropometric outcomes; hemoglobin levels; as well as demand for health services), reproductive health of all women in the household in fertile age and the use of contraception.

Since the well-being of individuals also depends on their environment (community infrastructure and services and quality of the services offered), MxFLS-1 also conducted fieldwork activities at the community level parallel to the household interviews. MxFLS baseline included the use of a locality/community questionnaire, to embody qualitative and quantitative information at the community level with regards to schools, health services, and socioeconomic past and present infrastructure characteristics. Interviews were conducted in every community of MxFLS-1 respondents with the community leaders and personnel in charge of health institutions and schools. The following information was gathered: history, economic and physical infrastructure of the locality (for example, wages, availability of public services, existence of roads, natural disasters, crimes), as well as a price module collecting local prices and availability of food, medicine and basic goods.

The MxFLS-1 sample consists of approximately 8,400 households. For this study we select all children less than 18 years of age who can be linked to their biological father or mother living in the household. The total number of observations in this sub-sample is 13,871 children. Descriptive statistics can be found in table 1.

While the child-age distribution in our sample is relatively homogeneous, 27 percent of the children are first born. The height z-scores of the different child-age categories present an inverted U-shape with the age of the child, suggesting that children in our data are smaller compared to children in the standard (US) when born, but catch up as toddlers and deviate again during adolescence.

Mothers in our sample are on average 35 years old, 153 centimeters tall and their Raven Z-score distribution is relatively skewed to the right. Mothers usually entered primary school at the age of 6.5, while 26 percent of them report having failed a grade in elementary school. On average, a mother's years of schooling is 6, although 9 percent are illiterate and close to 20 percent exhibit more than 10 years of education. However, their mothers and fathers --the child's maternal grandparents--, had only 3 and 2.6 years of schooling, respectively. Sixty percent of the children's mothers currently live in urban areas, in contrast to only 22 percent that lived in urban areas when they were 12. This suggests there has been a vital migration to the cities over time.

IV. Empirical Strategy and Findings

In the estimation of the determinants of child health, mother's human capital has proven to be an important variable in leading to estimates of what has been denominated returns to schooling in the procurement of health. These returns have often been overstated by the exclusion of unobserved characteristics of the mother, which are very hard to find in one single source, leading to biased estimates of the impact of maternal years of education. Therefore, we start our empirical analysis by assessing the importance of other measures of human capital, such as mother's height and maternal cognitive ability as child's health determinants in addition to years of schooling. We begin with standard parental characteristics as determinants of child health, gradually adding other variables to understand the contribution of each one to the child's height. In each step, we model returns to schooling using a semi-parametric approach to correctly capture the marginal contribution of additional variables of human capital on child's health, in the event of nonlinearitites.[5]

In line with the literature, OLS results of table 2 (column 1) show increasing returns to mother's years of education on child's height.[6] In fact, height increases by 0.21 percent if the mother attended some level of

[5]The additional variables of human capital enter linearly into our model since adopting a flexible form in years of schooling is sufficient to control for the presence of nonlinearities in parental human capital.
[6] See, for example, surveys by Cochrane, Leslie, and O'Hara (1982) and Behrman and Deolalikar (1988).

elementary school. However, if she finished high school or higher levels of education, the height of the child increases by 0.50 percent relative to a child whose mother is illiterate. Moreover, mother's years of schooling estimates are about 40 percent higher than father's returns on schooling. Nevertheless, like other measures of human capital, schooling is correlated with unobserved individual characteristics, such as mother's background- that affected both mother's schooling achievement in the past and continues to influence her children's health. We add to our specification mother's height, which reflects not only biological and mother's genetic factors passed to her children, but also reflects early investments in the health of the mother that are usually correlated with childhood household human capital and economic resources. Consequently, the inclusion of this additional control results in lower returns to schooling, indicating that indeed, when all else is constant, taller mothers have healthier –or taller-- children, (column 2).

We next raise the question of whether maternal cognitive ability provides additional health comfort to her children once we control for household traditional human capital variables. Ceteris paribus, a mother with higher reasoning ability may be in a better position to process relevant information in the procurement of her children's health. For example, Bhargava and Fox-Kean, (2003) find a positive correlation between maternal cognitive ability and child's nutrition. Likewise, cognitive ability may allow her to reduce the learning cost of new motherhood, and allow her to learn faster from child rearing experience in general when it comes to procure her children's health. Returns to cognitive ability have also been studied in the context of labor markets (Alderman, Behrman, et al., 1996); and as a determinant of individual cognitive achievement (Glewwe, 1994; Knight and Sabot, 1990).[7] Nonetheless, the socioeconomic literature on returns to cognitive ability has treated individual reasoning aptitude as predetermined, making difficult to understand the mechanisms through which people's returns to cognitive skills operate.

To obtain a measure of reasoning ability, MxFLS-1 administered Raven's (1956, 1993) Color Progressive Matrices test, an instrument which requires no literacy skills and involves the matching of patterns. This test was administered to all household members between 5 and 65 years of age. We use the test score of adult females biologically linked to children in the household, as our measure of mother's cognitive ability. For this study individual maternal Raven test scores were normalized as a percentage deviation from MxFLS-1's Raven test score mean to obtain a continuous distribution of maternal cognitive ability with mean 0 and variance 1 that is not truncated at either tail. [Table 1].

[7] Cognitive ability has also been studied in non-economic analyses (e.g. Nokes, et al. 1992).

To see the effect of this variable alone, column (3) of table 2 displays the results when mother's Raven z-score is included, but not mother's height. Like before, returns to schooling decrease, suggesting that schooling effects confound typically unobserved characteristics such as the mother's reasoning ability to procure health. This variable is statistically significant. Column (4) displays the results when both the mother's height and cognitive ability are included. As expected, returns to schooling diminish even more than in previous specifications, indicating the relevance of including other parental characteristics when estimating schooling returns to health. Nevertheless, maternal height estimates are robust to the inclusion of mother's cognitive ability suggesting little correlation between the two variables. In contrast, mother's returns to reasoning ability on child health decrease by 40 percent. However, after controlling for mother's height and years of education, cognitive ability remains highly significant and accounts for one forth of the returns to schooling, suggesting that maternal cognitive ability is indeed an important variable in children's long-run health outcomes.

Our results have been drawn from a sample of children between 0 to 17 years old, where child age splines with seven knots serve as controls for differences in biological transitions of health as the child develops.[8] Nevertheless, our estimates of returns to cognitive ability –and to schooling-- may be biased if returns to maternal human capital on child health differ by the age of the child, Barrera (1999). For example younger children, to meet their needs, turn to be more dependent on the mother relative to older children. In paralell younger children have underdeveloped immune systems and are relatively more vulnerable to infections and diseases compared to older children. This makes young children particularly sensitive to the proper choice and efficient use of health inputs. The last two columns of table 2 check for the presence of these nonlinearities by directly testing the possibility that maternal cognitive ability may be relatively more important for younger children as opposed to older children. To achieve this, column (5) replicates the specification of column (4) but restricts the sample to children between 0 to 9 years of age; column (6) restricts the analysis to children between 10 to 17 year old. In line with Barrera (1990) , comparissons between columns (5) and (6) estimates suggest that maternal returns to schooling are greater for younger children, particularly when the mother reports some level of primary education as opposed to being iliterate. In contrast, the returns to mother's cogntivie ability on child's height do not statistically differ across age groups, suggesting that most of the nonlinearities in the returns of maternal human capital on child health are more likely to be explained by mother's schooling and less though maternal cognitive ability.

[8] The child age splines have their knots at 0 to 3 years, 4 to 6 years, 7 to 9 years, 10 to 12 years, 13 to 15 years, and 16 to 17 years of age.

Testing some mechanisms through which Maternal reasoning ability may operate

Cognitive ability may reflect innate individual reasoning capacity. However, an individual's cognitive ability may well capture part of his childhood human capital endowment --such as parental transmission of knowledge and/or school quality, among other factors--, and may also be affected by an individual's past experiences. Understanding how maternal cognitive ability impacts child health investment decisions has important policy implications. The design of social programs may have little impact on this matter, if maternal cognitive ability is mainly innate. Nevertheless, the role of social programs becomes important if reasoning ability mainly reflects school quality; or parents-to- mother transmission of knowledge and inheritance of good health practices.

In this section we investigate some means through which maternal reasoning ability enhances her offspring's health. We begin our analysis by exploring the relationship between maternal cognitive ability and some variables that reflect her human capital endowment. Table 3 shows OLS estimates on mother's Raven z-score. Results show that mother's age is not an important factor in explaining her performance on the Raven test, once years of schooling are taken into account. In contrast, there is an increasing correlation between years of schooling and the Raven z-score. Whether this reflects causality of schooling on cognitive ability, or cognitive ability affecting years of schooling, is unclear.

MxFLS-1 collects extensive information on non-co-resident relatives, regardless of their place of residence and independent of whether they are currently alive. We use years of schooling of the mother's parents as proxies of maternal background household resources. Estimates of mother's parent's years of schooling [Column (2)], suggests that mother's background endowment in the form of parental human capital is an important factor in determining her reasoning ability, despite controlling for mother's years of schooling. The non- significance of the estimates of whether mother's parent lives in the household may suggest that parental human capital has a higher impact on her reasoning ability during childhood than through a permanent mother-parent relationship in adulthood. Our results also show a higher relationship of mother's mother years of schooling than of mother's fathers on her cognitive ability. Mother's height is also positively correlated with mother's reasoning ability after controlling for all our set of background variables.

Using individual retrospective information on migration and school attendance gathered in MxFLS-1, we are able to construct two proxy variables about the maternal childhood environment: a) whether she lived in an urban community during the primary school years --between 0 to 12 years old--; and

b) whether she studied in a public primary school as opposed to a private institution. The significant estimate of the categorical variable that indicates if the mother lived in an urban area when 0-12 years old, suggests that possibly more resourceful environment during childhood is positively related to better cognitive ability in adulthood, even after controlling for individual and parental years of schooling (column 3), and current household resources, as expressed by household total expenditure (column 4).

The analysis of table 3 suggests that maternal cognitive ability is not independent of her childhood background characteristics. This maternal background endowment may also influence current household decisions on her children's health. Our next step, therefore, is to investigate to what extent the path through which maternal cognitive reasoning ability operates on child's height is associated with her background. Table 4 column (1) replicates the parsimonious specification of column (4) of table 2 and shows the estimates of interest, to facilitate comparison. Columns (2) through (6) (table 4) investigate the sensitivity of the effect of maternal cognitive ability on child's height if mother's childhood endowment information is gradually added to the specification.

Results in column (2) indicate that grandmother's schooling is weakly but positively associated with grandchildren's health, while grandfather's schooling has no effect. Both effects are jointly not significant given that we are controlling for mother's height, schooling and cognitive ability. These results are corroborated in column (3) when additional covariates for whether the grandparents reside in the same dwelling are included. The idea of including these variables relates to the possible impact on the child's well-being if the grandparents, that co-reside with him/her, dedicated time and resources to their grandchildren. The coefficients of mother's returns to schooling do not change in either of the specifications, nor do the returns to mother's cognitive ability on child's height.

In column (4) we add additional background covariates. We include an indicator if the mother lived in an urban area up to when she was 12 years old and whether she studied in a public primary school. With both variables we intend to reflect at least partly the environmental resources she was exposed to when she was growing up as well as serve as a measure of the possible quality of schooling. Having studied in a public elementary institution as opposed to a private school provides no additional improvement in the child's height and maternal cognitive ability remains unchanged. The estimate of having lived in an urban community during elementary school does have a positive impact on child's health. The coefficient is twice the size than that of the returns of maternal cognitive ability. Both environmental background variables are jointly significant and their inclusion reduces the returns to schooling by 50 percent. Nevertheless, the impact of maternal cognitive ability on her children's height remains significant and continues to be highly statistically important.

However, it is possible that as of the date of the interview, mothers who lived in urban areas when young continue to live in urban areas so that the urban dummy variable confounds the effect of childhood background infrastructure and current community resources. For this reason, specification in column (4) further controls for whether the mother and her children currently live in an urban setting. The impact of having lived in an urban area as a child completely disappears after this control is included. However the coefficient of returns to mother's reasoning ability remains extraordinarily robust.

All results related to background characteristics suggest that they do not eliminate the impact of mother's cognitive ability on child's height. Cognitive ability apparently is yet another form of human capital that determines the health of the child in an important way independently of observed mother's childhood background and years of schooling.

It follows that we must investigate if the relationship between the cognitive ability of the mother with the health of their children is associated with mechanisms of intermediation of daily living. For example, these mechanisms could be related to exploiting the mothers experience as a mother with subsequent children; a better capacity to take advantage of available resources in the community towards the procurement of the health of their children (in terms of infrastructure, social programs); or through the possibility of attracting more wealth to the household in the form of higher long-term income. The following section investigates this possibility.

Returns of maternal cognitive ability as means of enhancing household economic resources

Another way in which cognitive ability might have an impact is through wealth since higher human capital is related to higher labor productivity, higher earnings, and thus higher wealth, and higher wealth to a better holding of health. We thus further investigate whether economic resources brought to the household can explain in part the path through which the cognitive ability of the mother affects her children's health. Column (5) of table 4 controls for household total expenditure. In line with the literature, household expenditure is positive and highly correlated with children's health.[9] Yet its inclusion has no effect on mother's returns to schooling and a small one on her Raven's score.

It is possible, however, that more cognitive mothers are in a better position to exploit economic resources and health infrastructure at the

[9]The coefficient of the logarithm of household total expenditure is smaller in magnitude than the estimates reported in other studies that do not control for ability and background variables. When we exclude these controls, the coefficient increases to 0.13 with a standard error of 0.019.

community level to improve the health of their children. To explore this possibility, column (6) further controls for community fixed effects. When we add community controls, the estimates of mother cognitive ability declines by 40 percent, suggesting that more cognitive mothers are likely to have a better capacity to take advantage of community available resources when looking after their children.

Community Fixed Effects (CFE), however, do not purge for unobservables at the household or mother's level that are simultaneously correlated with the level of cognitive ability and children's height. If, for example, migration decisions to larger cities – with incidentally better health infrastructure--are more attractive to individuals with higher human capital, then saying that 40 percent of the cognitive ability operates through a better capacity to take advantage of community resources, would clearly be an overstatement. On the other hand, CFE returns to cognitive ability on child's health may be biased downward if higher cognitive ability is associated with higher individual labor productivity (Alderman, Behrman, et. al., 1996), and therefore, with a higher opportunity cost of the mother to devote time to child rearing activities.[10] Unfortunately we do not have convincing identifying instruments to correctly estimate the direct effect of mother's cognitive ability on child's height. Nevertheless, if we fully interact the mother's cognitive ability with her children characteristics, we obtain sufficient heterogeneity within the household, and are able to control for mother's fixed effects (MFE) –which wipe out any unobserved heterogeneity at the mother's level-- to identify the indirect returns to cognitive ability on child health.

Returns of maternal cognitive ability as means of reducing child care learning costs of new motherhood

Ceteris paribus, mothers with higher cognitive ability may shorten their learning curve with respect to child care information acquisition in new motherhood, and consequently augment their firstborn child's health relative to firstborns of mothers with less cognitive ability. Using individual fertility and birth histories of females in reproductive ages, we construct an indicator variable that takes the value of one for every child in our sample who we identify as first-born and is a household member. Next, in order to test the new motherhood learning hypothesis, we proceed to fully interact our basic model with this indicator. We restrict our sample to mothers with at least two children living in the household, one of which is recorded as first-born. Table 5 summarizes the results. For the benefit of briefness we only present estimates of the returns to mother's schooling, height and to cognitive ability

[10] These arguments, of course, applies to all our other measures of maternal human capital.

on first-born and later-born child's height. All the covariates from table 2 column (4) --and their interactions with the firstborn indicator-- are suppressed from the table.

Results suggest no differential effects between first-borns and other children in mother's returns to height and years of schooling on child's health. Nevertheless, maternal cognitive ability seems to play a more important role on the first-born child's health than on subsequent children. Whether the differences in returns to reasoning ability are explained by a better capacity of learning how to be a mother, or whether they reflect an increase in mother's role in househol decision making in early motherhood via a shift in bargaining power, is yet unresolved.[11] Moreover, the result, only holds at a 10 percent significance level once we control for mother's unobserved characteristics, [table 5, column (4)], suggesting that mother's returns to cognitive ability on child health are likely to be downward biased in the presence of unobserved heterogeneity.

[11] Thomas (1994) suggests that the effect of parental human capital on household resource allocation may reflect differences in powers as well as differences in parental child rearing technology.

Conclusions

The empirical literature on child health indicates that the mother's human capital plays a central role in children's health outcomes. Some efforts have been made to separate the differential mechanisms through which mother's human capital impacts health outcomes. Nevertheless, little is known on how important the mother's cognitive ability is in determining her children's health. This paper differs from the socioeconomic literature that treats individual cognitive ability as a predetermined, and investigates possible mechanisms through which mother's reasoning ability operates in procuring her children's health. Our results suggest that mother's return to cognitive ability on child health are less likely to reflect observed mother's childhood endowments by means of parental transmission of knowledge or school quality, but more likely to be associated with a better capacity to take advantage of household and community resources. We also find that that high maternal reasoning ability plays a more important role in improving child's health when mothers experience motherhood for the first time. These results only hold if we control for maternal fixed effects. We conclude, therefore that returns to mother's cognitive ability are likely to be correlated to additional unobserved child's health determinants different to mother's observed childhood endowments.

References

Alderman, H., Behrman, J.R., Ross, D.R, R. Sabot, 1996, The Returns to Endogenous Human Capital in Pakistan's Rural Wage Labour Market. Oxford Bulletin of Economics and Statistics 58, 1, 29-55.

Barrera, A., 1990, The Role of Maternal Schooling and its Interaction with Public Health Programs in Child Health Production. Journal of Development Economics 32, 69-91.

Beaton, G. H., Martorell, R., L'Abbe, K. A., Edmonston, B., McCabe, G., Ross, A. C., Harvey, B., 1993. Effectiveness of Vitamin A Supplementation in the Control of Young Child Morbidity and Mortality in Developing Countries. ACC/SCN State-of-the-Art Nutrition Policy Discussion Paper No. 13, United Nations.

Behrman J.R., Deolalikar, A., 1988, Health and Nutrition. In: Hollis Chenery, T.N. Srinivasan. (Eds)., Handbook of Development Economics, Elsevier Science Publishers, Amsterdam/New York, pp. 631-711.

Behrman J.R., Wolfe B.L., 1987, Women Schooling and Children's Health: Are the Effects Robust with Adult Sibling Control for the Women's Childhood Background? Journal of Health Economics 6, 3, 239-54.

Bhargava, A., Fox-Kean, M., 2003, The effects of maternal education versus cognitive test scores on child nutrition in Kenya. Economics and Human Biology 3, 1, 309-319.

Bleichrodt, N., Born, MA., 1994, Meta-analysis of research on iodine and its relationship to cognitive development. In: Stanbury, J.B. (Ed.), The damaged brain of iodine deficiency. New York, Cognizant Communication Corporation, pp. 195-200.

Cochrane, S., Leslie, J., O'Hara, D., 1982, Parental education and child health: Intracountry evidence. Health Policy and Education 2, 213-250.

Glewwe, P., 1994. Are Rates of Return to Schooling Estimated form Wage Data Relevant Guides for Government Investments in Education? Evidence form a Developing Country. LSMS Working Paper No. 76. World Bank. Washington, D.C.

Glewwe, P., Jacoby, H., 1994, Student Achievement and Schooling Choice in Low Income Countries: Evidence from Ghana. Journal of Human Resources 29, 842-64.

Glewwe, P., 1999, Why Does Mother's Schooling Raise Child Health in Developing Countries? Evidence from Morocco. Journal of Human Resources 34, 1, 124-159.

Knight, J.B., Sabot, R.H., 1990, Educational Productivity and Inequality: The East African Natural Experiment. Oxford University Press, New York.

Nokes, C., Grantham-McGregor, S.M., Sawyer, A.W., Cooper, E.S., Robinson, B.A., Bundy, D.A.P., 1992, Moderate to Heavy Infections of

Trichuris trichiura Affect Cognitive Function in Jamaican School Children? Parasitology 104, 539-47.

Raven, J.C., 1956, Guide to the Coloured Progressive Matrices (Sets A, Ab, B). Lewis, London.

Raven J.C., Court J.H., 1993, Test de Matrices Progresivas. Escalas Coloreada, General y Avanzada. Paidos Iberica, Eds. ISBN: 9501260607.

Schultz, T.P., 1984, Studying the impact of household economic and community variables on child mortality. In: Henry Mosley, Lincoln Chen. (Eds.), Child survival: Strategies for Research, Population and Development Review, Supplement to Vol. 10, pp. 215-235.

Strauss, J., Thomas, D., 1995, Human resources: empirical modeling of household and family decisions. In Behrman, J. and Srinivasan T.N.(Eds.), Handbook of Development Economics, Vol. 3ª. North-Holland, Amsterdam, pp.1883-2023.

Strauss, J., Thomas, D., 1998, Health, Nutrition, and Economic Development. Journal of Economic Literature 36, 2, 766-817.

Thomas, D., 1990, Intra-household Resource Allocation: An Inferential Approach. Journal of Human Resources 25, 4, 635-664.

Thomas D., 1994, Like Father Like Son; Like Mother, Like Daughter: Parental Resources and Child Height. Journal of Human Resources 29, 950-988.

Thomas, D., Strauss, J., 1990. Prices, Infrastructure, Household Charasteristics And Child Height Series. Papers Number 602. Yale, Economic Growth Center.

Thomas, D., Strauss, J., Henriques M., 1990, How Does Mother's Education Affect Child Height? Journal of Human Resources XXVI-2, 183-211.

Wachs, T. D., 1995, Relation of mild-to-moderate malnutrition to human development: Correlational studies. Journal of Nutrition 125, 2245S-2254S.

Wolfe, B.L., Behrman, J.R., 1982, Determinants of Child Mortality, Health, and Nutrition in a Developing Country. Journal of Development Economics 11, 163-193.

Wolfe, B.L., Behrman, J.R., 1987, Women's Schooling and Children Health: Are the Effects Robust with Adult Sibling Control for the Women's Childhood Background?, Journal of Health Economics 6, 3, 239 – 254.

TABLE 1 Descriptive Statistics

Child´s characteristics	**mean**	**st. dev**
Male	0.50	0.50
Age distribution		
0 – 3 years old	0.19	0.39
4 - 6 " "	0.15	0.36
7 - 9 " "	0.17	0.37
10-12 " "	0.18	0.38
13-15 " "	0.17	0.38
16-17 " "	0.14	0.35
First born child	0.27	0.43
Height Z- score		
0 – 3 years old	-0.63	1.30
4 - 6 " "	-0.54	1.16
7 - 9 " "	-0.43	1.10
10-12 " "	-0.62	1.09
13-15 " "	-0.83	0.97
16-17 " "	-1.30	0.85
Mother´s characteristics		
Age	35.62	8.23
Height (cm)	153.17	6.44
Cognitive ability test		
Raven Z-score *	0.00	1.00
10th pctile Raven Z-score	-1.19	-
25th " "	-0.83	-
50th " "	-0.11	-
75th " "	0.61	-
90th " "	1.33	-
Years of schooling		
0	0.09	0.29
1 to 6	0.48	0.50
7 to 9	0.23	0.42
10 or more	0.20	0.40
Currently lives in urban community	0.58	0.49
Mother´s background		
Studied in public primary school	0.98	0.16
Lived in urban area when 0 – 12 years old	0.22	0.42
Mother's parents		
Schooling of the mother´s mother (years)	2.33	2.54
Schooling of the mother´s father (years)	2.65	2.62
Mother´s mother is a hhold member	0.09	0.28
Mother´s father is a hhold member	0.05	0.22
Household characteristics		
ln (total hhold monthly expenditure)	8.26	0.77
Number of observations	13,871	

Notes: *standardized over the sample mean. Source: MxFLS-1.

TABLE 2 Effect of Mother´s Cognitive Ability on Child´s Height for Age Z-Scores

Child´s characteristics	(1)	(2)	(3)	(4)	(5)	(6)
male	-0.04	-0.03	-0.03	-0.02	-0.11	0.07
	(0.02)*	(0.02)	(0.02)*	(0.02)	(0.03)***	(0.02)***
Age spline						
from 0 to 3 years	0.09	0.09	0.09	0.09	0.09	-
	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	
from 4 to 6 years	-0.01	-0.01	0.00	-0.01	-0.01	-
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	
from 7 to 9 years	0.04	0.03	0.04	0.03	0.03	-
	(0.01)***	(0.01)**	(0.01)***	(0.01)**	(0.01)**	
from 10 to 12 years	-0.10	-0.09	-0.10	-0.09	-	-0.09
	(0.01)***	(0.01)***	(0.01)***	(0.01)***		(0.02)***
from 13 to 15 years	-0.07	-0.09	-0.08	-0.09	-	-0.09
	(0.01)***	(0.01)***	(0.01)***	(0.01)***		(0.01)***
from 16 to 17 years	-0.18	-0.18	-0.18	-0.18	-	-0.18
	(0.01)***	(0.01)***	(0.01)***	(0.01)***		(0.01)***
Mother´s characteristics						
mother´s age	0.01	0.01	0.01	0.01	0.14	0.01
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.07)*	(0.002)***
mother´s years of schooling						
1 to 6	0.21	0.14	0.18	0.13	0.27	0.12
	(0.05)***	(0.04)***	(0.05)***	(0.04)***	(0.08)***	(0.04)***
7 to 9	0.48	0.27	0.40	0.23	0.33	0.20
	(0.06)***	(0.05)***	(0.06)***	(0.05)***	(0.08)***	(0.05)***
10 or more	0.54	0.33	0.44	0.28	0.01	0.22
	(0.06)***	(0.05)***	(0.06)***	(0.05)***	(0.002)***	(0.06)***
F-joint sig. mother´s schooling	48.63	20.02	31.12	13.86	8.84	6.47
	[0.00]***	[0.00]***	[0.00]***	[0.00]***	[0.00]***	[0.00]***
mother´s height	-	0.06	-	0.06	0.06	0.06
		(0.002)***		(0.002)***	(0.003)***	(0.002)***
mother´s raven z-score	-	-	0.08	0.04	0.03	0.05
			(0.01)***	(0.01)***	(0.02)*	(0.01)***
Father´s years of schooling						
1 to 6	0.14	0.10	0.12	0.09	0.16	0.05
	(0.07)**	(0.06)*	(0.07)*	(0.06)	-(0.10)	(0.06)
7 to 9	0.31	0.22	0.28	0.20	0.25	0.19
	(0.07)***	(0.06)***	(0.07)***	(0.06)***	(0.10)**	(0.06)***
10 or more	0.31	0.18	0.27	0.16	0.22	0.14
	(0.07)***	(0.06)***	(0.07)***	(0.06)**	(0.10)**	(0.07)**
F-joint sig. father schooling	12.64	6.96	10.25	6.14	2.97	5.30
	[0.00]***	[0.00]***	[0.00]***	[0.00]***	[0.03]**	[0.00]***
Number of observations	13,629	13,629	13,629	13,629	7,027	6,602
R-squared	0.10	0.21	0.11	0.21	0.15	0.26

Notes: Regressions with robust std. errors with clustering at the mother´s level. Standardized errors in parenthesis. [p-values] bellow F-test values for joint significance. Source: MxFLS-1.

TABLE 3 Effect of Mother´s Human Capital on her Cognitive Ability Raven Z-Score

	(1)	(2)	(3)	(4)
mother´s age	-0.00004	0.001	0.004	0.002
	(0.001)	(0.001)	(0.001)***	(0.002)
mother´s years of schooling				
1 to 6	0.40	0.40	0.24	0.21
	(0.05)***	(0.05)***	(0.05)***	(0.05)***
7 to 9	0.84	0.83	0.63	0.57
	(0.05)***	(0.05)***	(0.05)***	(0.05)***
10 or more	1.29	1.22	0.98	0.89
	(0.05)***	(0.06)***	(0.06)***	(0.06)***
F-joint sig. mother´s schooling	240.07	194.71	184.73	134.55
	[0.00]***	[0.00]***	[0.00]***	[0.00]***
mother´s height	0.02	-	0.01	0.01
	(0.003)***		(0.002)***	(0.002)***
Mother´s background				
mother´s parents				
years of schooling of mother´s mother	-	0.03	0.02	0.02
		(0.01)***	(0.01)***	(0.01)***
years of schooling of mother´s father	-	0.01	0.01	0.01
		(0.01)***	(0.01)***	(0.01)***
F-joint sig. parents´ schooling	-	31.77	17.06	13.68
		[0.00]***	[0.00]***	[0.00]***
Mother´s mother is a hhold member	-	-0.05	-0.05	-0.04
		(0.05)	(0.05)	(0.05)
Mother´s father is a hhold member	-	-0.01	0.00	-0.01
		(0.06)	(0.06)	(0.06)
F-joint sig. parents hhold members	-	1.38	0.74	0.87
		[0.26]	[0.48]	[0.42]
mother lived in urban area when 0 - 12 years old	-	-	0.20	0.18
			(0.03)***	(0.03)***
mother studied in public primary school	-	-	-0.08	-0.04
			(0.07)	(0.07)
F-joint sig. urban-public	-	-	22.28	15.70
			[0.00]***	[0.00]***
Household wealth				
ln (total hhold monthly expn)	-	-	-	0.11
				(0.02)***
Number of observations	6,087	6,087	6,087	6,019
R-squared	0.19	0.19	0.21	0.22

Notes: Regressions with robust std. errors with clustering at the community level. Standardized errors in parenthesis. [p- values] bellow F-test values for joint significance. Source: MxFLS-1

TABLE 4 Effect of Mother´s Cognitive Ability and Childhood Background on Child´s Height for Age Z-Score

	(1)	(2)	(3)	(4)	(5)	(6) CFE
mother´s years of schooling						
1 to 6	0.13	0.12	0.08	0.07	0.07	0.02
	(0.04)***	(0.04)***	(0.05)	(0.05)	(0.05)	(0.05)
7 to 9	0.23	0.23	0.17	0.15	0.14	0.08
	(0.05)***	(0.05)***	(0.06)***	(0.06)***	(0.06)***	(0.05)
10 or more	0.28	0.27	0.22	0.20	0.18	0.14
	(0.05)***	(0.05)***	(0.06)***	(0.06)***	(0.06)***	(0.06)**
F-joint sig. mother´s schooling	13.86	12.04	7.75	6.34	4.91	4.13
	[0.00]***	[0.00]***	[0.00]***	[0.0000]***	[0.00]***	[0.01]***
mother´s height	0.06	0.06	0.06	0.06	0.06	0.05
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
mother´s raven Z-score	0.04	0.04	0.03	0.03	0.03	0.02
	(0.02)***	(0.02)***	(0.01)***	(0.01)***	(0.01)***	(0.01)*
Mother´s background						
mother´s parents						
years of schooling of mother´s mother	-	0.01	0.01	0.01	0.01	0.004
		(0.01)*	(0.01)*	(0.01)	(0.01)	(0.01)
years of schooling of mother´s father	-	-0.003	-0.003	-0.004	-0.01	-0.002
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
F-joint sig. parents´ schooling	-	1.59	1.41	1.26	1.14	0.24
		[0.20]	[0.20]	[0.28]	[0.32]	[0.80]
Mother´s mother is a hhold member	-	0.07	0.06	0.07	0.06	0.07
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Mother´s father is a hhold member	-	-0.10	-0.10	-0.10	-0.11	-0.13
		(0.06)*	(0.06)*	(0.06)*	(0.06)*	(0.06)*
mother lived in urban area when 0 - 12 years old	-	-	0.06	0.03	0.04	0.02
			(0.0271)**	(0.03)	(0.03)	(0.03)
mother studied in public primary school	-	-	0.12	0.12	0.09	0.11
			(0.09)	(0.09)	(0.09)	(0.09)
F-joint sig. urban-public	-	-	3.25	1.51	1.21	0.94
			[0.04]	[0.22]	[0.30]	[0.40]
mother currently lives in urban community	-	-	-	0.07	0.07	-
				(0.03)***	(0.03)***	
Hhold wealth						
ln (total hhold monthly expenditure)	-	-	-	-	0.04	0.02
					(0.02)***	(0.02)
Number of observations	13,629	13,629	13,629	13,479	13,346	13,346
R-squared	0.21	0.21	0.21	0.21	0.21	0.25

Notes: Regressions with robust std. errors with clustering at the mother´s level. Regressions include controls for spline of child´s age (0 to 3, 4 to 6, 7 to 9, 10 to 12, 13 to 15 and 16 to 17 years), child´s gender, father´s yrs of schooling in categorical variables (1 to 6, 7 to 9, 10 or more). Source: MxFLS-1.

TABLE 5
Effect of Mother´s Cognitive Ability on Child´s Height for Age Z-Score by Birth Order

	(1) First born	(2) Other children	(3) OLS diff	(4) Mother´s FE diff
Mother´s years of schooling				
1 to 6	0.25	0.14	0.11	0.11
	[0.01]***	[0.09]*	[0.38]	[0.45]
7 to 9	0.27	0.26	0.01	0.03
	[0.01]***	[0.003]***	[0.96]	[0.82]
10 or more	0.32	0.26	0.06	0.13
	[0.003]***	[0.01]**	[0.64]	[0.41]
F-joint sig. mother´s schooling	3.14	3.98	1.03	0.66
	[0.03]***	[0.01]***	[0.38]	[0.58]
mother´s raven Z-score	-0.01	0.001	-0.01	0.06
	[0.02]***	[0.98]	[0.07]*	[0.07]*
mother´s height	0.07	0.06	0.01	0.001
	[0.00]***	[0.00]***	[0.23]	[0.85]
Number of observations	6870	6870	6870	6870
R-squared	0.21	0.21	0.21	0.60

Notes:
Robust std. errors with clustering at the mother´s level. Regression model full interacted with first born child indicator variable. [p-values] under coefficients. Sample restricted to mothers with at least one first born child living in the household. Source: MxFLS-1.