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Parental Preferences and Allocations of Investments in Children's Learning and Health Within Families

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Abstract

Empirical evidence suggests that parental preferences may be important in determining investment allocations among their children. However, there is mixed or no evidence on a number of important related questions. Do parents invest more in better-endowed children, thus reinforcing differentials among their children? Or do they invest more in less-endowed children to compensate for their smaller endowments and reduce inequalities among their children? Does higher maternal education affect the preferences underlying parental decisions in investing among their children? What difference might such intrafamilial investments among children make? And what is the nature of these considerations in the very different context of developing countries?

This paper gives new empirical evidence related to these questions. We examine how parental investments affecting child education and health respond to initial endowment differences between twins within families, as represented by birth weight differences, and how parental preference tradeoffs and therefore parental investment strategies vary between families with different maternal education. Using the separable earnings-transfers model (Behrman, Pollak, & Taubman, 1982), we first illustrate that preference differences may make a considerable difference in the ratios of health and learning differentials between siblings – up to 30% in the simulations that we provide. Using a sample of 2,000 twins, collected in the 2012 wave of the Early Childhood Longitudinal Survey for Chile, we find that preferences are not at the extreme of pure

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compensatory investments to offset endowment inequalities among siblings nor at the extreme of pure reinforcement to favor the better-endowed child with no concern about inequality. Instead, they are neutral, so that parental investments do not change the inequality among children due to endowment differentials. We also find that there are not significant preference differences between families with low- and high-educated mothers. Our estimates are consistent with previous empirical evidence that finds that parents do not invest differentially within twins.

Keywords

Chile; parental preferences and within-family investments; child development; birth weight; weight; height; body mass index; cognitive and non-cognitive development

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Introduction

Empirical work from the last decade has emphasized the important role that early-life conditions and childhood development play in later life outcomes, especially in human capital formation. Cunha and Heckman (2007) developed a multistage process of skill formation whereby the existing stock of human capital of children complements parental investments in the process of subsequent capital formation. Parental investments are influenced by parental preferences, prices, production technology that links investments to outcomes and resource constraints, but also by parents' perceptions about the endowments of their children. Parents learn about the endowment of a child at birth (or soon after), and this influences their decisions about postnatal investments (Del Bono, Ermisch, & Francesconi, 2012).

Most of the empirical emphasis has been on differences *between* families in such investments. But there also may be important differences in investments *within* families that have been much less studied. Therefore, understanding parental preferences with respect to allocation of investments *among* children in the same family and the factors that drive the differences in these preferences *between* families is helpful for unraveling further the mechanisms underlying heterogeneity in human capital formation, and thereby in children's outcomes.

This study gives new empirical evidence on how parental intrafamilial investment strategies respond to initial endowment differences between siblings within a family and how the underlying parental preferences vary across families with different maternal educational levels. Specifically, this paper addresses the questions: How are parental investments in child education and health allocated among siblings within the same family? Do parents reinforce or compensate for initial endowment differences, as measured by birth weights, among their children? Does this reinforcement/compensation behavior vary across families with different maternal educational levels? Is inequality in learning and health outcomes between siblings affected much by the nature of parental preferences?

Scholars tend to agree that parents may not make equal investments among children in the family. They disagree, however, on the type of child who receives additional resources. Parents who adopt a *reinforcing strategy* invest more in high-endowment children, hence

leading to increased inequality in outcomes that depend on human capital (e.g., health, earnings) among children in the family. In contrast, parents who use a *compensating strategy* invest more in more-disadvantaged children; consequently, potential outcomes that depend on human capital among children are equalized to a degree. Parents may also adopt a *neutral strategy* in which they neither compensate or reinforce, hence disregarding initial endowments. Empirical studies have found that parental investments generally reinforce to a degree initial endowment differences (Aizer & Cunha, 2012; Behrman, Rosenzweig, & Taubman, 1994; Datar, Kilburn, & Loughran, 2010; Frijters, Johnston, Shah, & Shields, 2013); however, some studies also find evidence that parents adopt compensating behavior (Del Bono et al., 2012; Halla & Zweimüller, 2014). For an excellent review see Almond and Mazumder (2013).

Most of the previous studies on intrafamilial parental investments in early childhood have focused on siblings. However, even though siblings fixed-effects models control for common stable family characteristics, this strategy does not control for the possibility that children within the family differ in unobservable ways because singleton siblings are born at different times and parental characteristics at birth therefore are likely to differ and because there may be birth-order effects (Almond & Currie, 2011). Twins provide a better way to deal with the problem of unobservables including those that may vary as parents age. Twins fixed-effects estimates control for age-specific unobserved heterogeneity between children coming from the same family and for birth order.

Also, most of the previous research looks at developed countries. But realities in developing countries may be critically different. The lack of support that mothers receive in terms of maternity leave and postpartum care, combined with the huge quality gap between public and private schooling systems, can shape parental investment decisions and children's outcomes differently as compared to developed countries. Evidence looking at parental investment in early childhood from developing countries is scarce. Behrman (1988a) studied the intrahousehold allocation of nutrients between sons and daughters in rural India, with results suggesting a pro-male bias. This male preference is associated with caste rank; lower-ranked castes exhibit more male preference. Parents do consider equity and productivity, but the combination of limited inequality aversion and pro-male preferences, particularly for the lowest castes, may leave those children who are less-well endowed, close to the margin of survival. In Behrman (1988b) the focus was on birth order and seasonality. The evidence shown is that nutrients are allocated to children independent of their relative endowments, however, parents favor the older children and in the lean season inequality aversion is much less, and perhaps insignificant. Therefore, when food is scarcest, parents follow closer to a pure investment strategy, thereby exposing their more vulnerable children to greater malnutrition risk. Ayalew (2005) studied parental investment decisions in the face of differences in endowments among siblings in rural Ethiopia, finding that parents reinforce for learning inequalities and compensate for health inequalities. These findings provide useful evidence that parents in a developing context may behave differently when considering different outcomes, suggesting that maybe when parents are confronted with limited resources, they care about equality in terms of some outcomes, but they reinforce in others. However, these papers approach the within-family lens by looking at siblings, and not twins. Bharadwaj, Løken, and Neilson (2013) use a model of human capital

accumulation in which parental investments respond to initial endowments. An interesting feature of this paper is that the authors compare the behavior of parents with singleton siblings versus parents with twins. They find that investments are compensatory regarding initial health endowments with siblings, but with twins, parents do not invest differentially. Except for using sibling data, the methodological perspective of this paper resembles the one that we adopt in this study. However, Bharadwaj et al. (2013) look at parental investments and outcomes of the children later in life --specifically they look at investments of parents in the schooling context and outcomes in standardized school tests.

Some authors have hypothesized that parental intrafamilial investment varies due to cultural parenting practices and family socioeconomic status rather than intentionally reinforcing or compensating for endowments (Lynch & Brooks, 2013). This narrative suggests that parental intrafamilial investment strategies are not tied to cost-benefit calculations on the part of parents, but are instead a product of socio-demographic characteristics and structural constraints (Lynch & Brooks, 2013). However, until recently, most of the empirical evidence has not given much consideration to this approach. But some recent evidence suggests that parental intrafamilial investment responses may vary with family socioeconomic status. Restrepo (2016) analyzed how parental investments respond to low birth weight, and found important differences in investment responses by maternal education; high school dropouts reinforce and high-educated mothers compensate. Hsin (2012) used a sibling fixed-effect model and also looked at differential investment by mother's education, specifically looking at maternal time investments. The author concluded that less-educated mothers devote more total time and more educationally-oriented time to the children with higher birth weight, whereas better-educated mothers devote more total and more educationally-oriented time to lower birth weight children. Grätz and Torche (2016) found a different result. Using as an endowment measure early cognitive ability, they found that advantaged parents provide more cognitive stimulation to higher-ability children, while less disadvantaged parents do not respond to ability differences. An interesting result of this paper is that there is no differential response between advantaged and disadvantaged parents to birth weight. This evidence of differential parental investment responses for different outcomes highlights the value of further research on such possibilities in other contexts.

Therefore, exploring heterogeneity in parental preferences underlying different intrafamilial investments affecting diverse children's outcomes and comparing between different levels of maternal education within a developing country context is an important contribution to the literature on preferences underlying intra-household allocations for several reasons. First, families from developing countries face different constraints than those from the developed world, that could end up shaping preferences for the type of investments they prioritize. Second, the knowledge and importance that public opinion gives to different child outcomes could also be different between contexts, determining how parents define their preferences in terms of investments. Both of these aspects could have important implications on inequality in children's later-life outcomes. Also, given the large inequality in many developing countries, the childrearing process could be very different for children from upper-class families than for children from low-class families. There is a huge gap in such families' access to private and public health and schooling systems that, since conception, can determine the future of the child. Furthermore, families with lower maternal education

could be willing to implement a strategy to reduce risk, and invest more in more-endowed children to make sure at least one child will be successful, or, alternatively, reinforcing behavior could occur because there is less effort in investing in highly-endowed children.

In sum, the mixed evidence, the lack of studies using twins data particularly for developing contexts, and the limited concern for the relation between maternal education and preferences all point to the need for further research on preferences underlying differential parental intrafamilial investment strategies within families from developing countries. In this paper we contribute to the literature on early childhood health and learning, adding new evidence on intra-household preference models of parental intrafamilial investments using twins data from Chile and examining how parental preferences underlying parental investment strategies vary between families with different maternal education.

Theoretical Framework

The paper uses an adaptation of the general preference model developed in Behrman et al. (1982). The original model is a constrained welfare (or utility) maximization model, where parental preferences play a central role in determining the distribution of educational attainments and earnings among children. Earnings are assumed to be the sole determinant of an adult's economic well-being. Expected lifetime earnings are determined by an individual's genetic endowments and education, and parental expenditures on education increase a child's expected lifetime earnings but at a diminishing rate. In the adapted version of the model used here, parents maximize the learning and health developmental outcomes of their children O_i (instead of earnings), subject to a logarithmic production function that depends on endowments G_i and parental investments S_i and subject to a budget constraint associated with the cost of these investments.

In the separable earnings-bequest model developed in Behrman et al. (1982) the parameters that determine whether parents adopt a compensating, reinforcing, or neutral intrafamilial investment strategy depend on parents' aversion to inequality and on the properties of the earnings function (in our case cognitive, language, motor, socio-emotional, height, weight and BMI functions). In this paper we use a Constant Elasticity of Substitution (CES) welfare function as it provides a convenient functional specification that allows the full range of inequality aversion regarding the distribution of outcomes among the family's children; from the case of linear indifference curves (zero inequality aversion or extreme reinforcement), through the Cobb-Douglas case (unitary inequality aversion or neutrality), to the fixed-coefficient case (pure inequality aversion or extreme compensation). Also, we treat parental investments and genetic endowments as the only inputs in the production functions, which, given the young ages of the children, is a credible assumption.

We first estimate the parameters of the parental welfare function for learning and health developmental outcomes assuming that all families in our sample have the same welfare function. However, since we want to look at possible differences in preferences between families as they relate to maternal education, we subsequently relax this assumption and investigate parental welfare preferences differentiating families between low and high education of the mother. Maternal education is a particular important indicator of possible

family differences given the dominant roles of most mothers in raising children and the perceived role of education in affecting preferences (Oreopoulos & Salvanes, 2009). Maternal education also is the indicator most commonly used in the previous literature (see introduction).

In our model parents maximize a CES welfare function of the form:

$$W^O(O_1, \dots, O_n) = \sum_{i=1}^n a(O_i)^c \quad (1)$$

subject to a double logarithmic learning/health production function

$$\log O_i = \alpha_g \log G_i + \sum_{s=1}^m \alpha_{ms} \log S_{mi} = \alpha_g \log G_i + \alpha_s \log S_i \quad (2)$$

and the budget constraint

$$P_S \sum_{i=1}^n S_i = R^O \quad (3)$$

where O_i is the expected test score or health measure of the i th child, G_i is the child's endowment at birth, S_i is the aggregate parental investments in the i th child (the weighted sum of the m individual investments S_{mi} in that child), and n is the number of children in the family. In the budget constraint, P_S is the price per unit of aggregate investment in children in the family and R^O is the total value of resources devoted to children. Solving for the equilibrium ratios of aggregate investments and outcomes from the first-order conditions yields:

$$\log \frac{S_i}{S_j} = \frac{\alpha_g c}{1 - \alpha_s c} \log \frac{G_i}{G_j} \quad (4)$$

$$\log \frac{O_i}{O_j} = \frac{\alpha_g}{1 - \alpha_s c} \log \frac{G_i}{G_j} \quad (5)$$

The sign and significance of the coefficient c gives the curvature of parental preferences, and, thus, whether they are reinforcing, compensatory or neutral. If $c=1$, parents have no aversion to inequality and do not care about the distribution of test scores or health outcomes among their children. If $1 > c$, parents have some concern about inequality but if $1 > c > 0$ they still invest so as to reinforce endowment differences among their children. If $c = 0$ (the log-linear or Cobb-Douglas case) parents are neutral and balance their preferences for equality

against the trade-off the developmental outcome production functions and budget constraint offer them. If $0 < c$ parents compensate by investing more in the less-endowed child. Table 1 summarizes the different cases.

We use relation (4) to estimate the parameter c , related to the curvature of parental preferences that reflects their concern about equity versus productivity of their investments in their children. In this relation, the left- side is the logarithm of the ratio between the two children for the aggregate parental investments in each child. To get these aggregate parental investments in each child, we first estimated the production function in relation (2) using three ($=m$) different measures of parental investments in each child. Using the weights estimated in this procedure (α_{mS}), we combined the three parental investments into one aggregate investment, which we then used to estimate relation (4). For more details, see Methodological Appendix. The next step was to get the value of the parameter c from the coefficient of the ratio of endowments obtained in the estimation of relation (4). For this step, we used the additional assumption of constant returns to scale in the production function so that $\alpha_g + \alpha_s = 1$. Hence, we used the estimation of α_g that we obtained from the production function (2), which allows us to estimate c . We do this for eight different learning and health developmental outcomes. The estimations that explore different preferences by maternal educational level also include an interactive dummy term between maternal educational level and the logarithm of each investment. Given the positive production function parameters, α_g and α_s , the compound coefficient from relation (4) will be significantly different than $-\infty$ (or a very big negative number such as negative 0.1^{12}) if there is not pure compensation but some concern about productivity in addition to strong concern about inequality, negative if the parameter c is negative, not significantly different from zero if the parameter c is not significantly different from zero, significantly positive if the parameter c is significantly positive, and not significantly different from 1.0 if there is extreme reinforcement and no concern about inequality. Therefore, we use the estimates of relation (4) to establish whether the parameter c is significantly different from $-\infty$, significantly negative, not significantly different from zero, significantly positive or not significantly different from 1.0.

Relation (5) is useful to provide a sense of how much the ratio of the outcomes between the twins might vary with changes in the values of the parameter c and in the production function parameter α_g . In Table 2 we show that, given the ratio of endowments (in this table 1.3, which is at the 90th percentile for the birth weight data in our sample) and given values of c and α_g , the ratios of outcomes between the twins may vary considerably. For $c = 1$ (extreme reinforcement), the outcome for the better endowed twin is 130% of the outcome of the less well-endowed twin. For $c = -\infty$ (extreme compensation), the ratio of outcomes is equal to 1 so that there is no difference between twins in the outcomes. For values of $c=0$ (neutrality), the ratio in the outcomes varies according to parameters of the production function, ranging from 105.4% to 123.4% for the three examples in Table 2.

Note that maternal education may have effects on parental investment through shifting the budget constraint through R^0 or by altering the production function parameters in relation (2), both of which may affect interfamilial differences in investments in children. But those possibilities are not what we are investigating in our estimates of the direct effect of

maternal education on parental preferences through the within-family allocations. Or, to put it differently, we are examining the effects of maternal education on preferences related to *within*-family allocations controlling for (with the within-twins estimates) all family characteristics including family resources.

For this study, we used birth weight as the measure of endowment. Birth weight is of relevance, not only because it is a measure of prenatal exposures and proxies for health status at birth, but also has been used in other studies as a measure of endowments at birth that can be observed readily by parents (Torche & Conley, 2016). Birth weight is an important marker of individual health and human capital endowments at the beginning of life, which is predictive of later development. Birth weight has two proximate determinants: gestational age and intrauterine fetal growth. Twins do not vary in gestational age, so the only source of variation in birth weight in twin comparisons is differences in fetal growth. Within-twin pair comparison is based on the assumption that the birth weight discrepancy between twins emerges basically from random differences in access to nutritional intakes resulting, for example, from position in the uterus or umbilical cord attachment to the placenta (Torche & Conley, 2016).

Data

The data used in this paper comes from the *Encuesta Longitudinal de la Primera Infancia* (ELPI), a Chilean nationwide representative survey of infants and young children. This face-to-face survey gathered two types of information: a socio-demographic survey applied to all mothers; and a battery of tests for evaluating cognitive, socio-emotional and anthropometric development in children and their mothers.

The sample for the 2010 wave was randomly drawn from official administrative birth records of children born between January 2006 and August 2009. The sample size was 15,000. The second wave was conducted in 2012. The target population in 2012 was the children interviewed in 2010 and an additional 3,000 children who were born between September 2009 and December 2011. In the 2012 wave, a sampling of twins was added. We use this part of the sample for this paper. The cross-sectional sample of twins, that was only taken in the 2012 wave, includes 2,046 observations. The ELPI is a public and anonymous data base so it is no subject to IRB approval.

For the measurement of children's outcomes, we considered different dimensions: *learning and developmental outcomes*, namely, cognitive, language, motor and socio-emotional skills and *health and nutritional outcomes*, namely weight, height and body mass index (BMI). This decision was made based on previous research that has shown that parents could behave differently in terms of health and learning investments, therefore generating different results for their children (Ayalew 2005). To measure cognitive, language, motor and socio-emotional skills, we use a developmental test score called the Test of Learning and Child Development (TADI). This is a rating scale for children from 3 months to 6 years, designed and standardized in Chile. TADI evaluates four dimensions: cognitive, language, motor and socio-emotional, each of which is a separate scale, allowing the evaluation of development and learning globally. We use test scores, since they are reliable measures of children's

development and also important predictors of future academic outcomes. The three health outcome variables that we explore are weight, height and body mass index (BMI). Weight has been considered as an indicator of the short-run health status of children mainly because it is highly sensitive to short-term changes in nutrients intakes and morbidity, providing a good measure in this framework of parental investments affecting outcomes. Height is an important indicator of chronic early-life health and nutritional status, with substantial associations with outcomes over the life cycle (Hoddinott et al., 2013; Victora et al., 2008). The body mass index is a measure of body weight for a specified height and it has been used in multiple studies as a measure of health because it provides a measure of body fatness, which is a function of a wide variety of dietary and non-dietary inputs controlled by parents. Also, it is correlated with diseases later in life. These three outcomes provide us with a fairly full picture of children's health status.

Weight was measured using digital floor weight scales and height was measured using tape measures. The interviewers were trained with a strict protocol on how to use the scales and tapes to get accurate measures of the mothers and children's weight and height. Interviewers were provided with a field-work manual with the instructions and corresponding pictures. The protocols for weight and height measures were different depending on the age of the children. For the weight measure, children between 2 and 5 years old were asked to stand on the scales, without shoes, and using light clothes (removing jackets or big sweaters). For children aged less than 2 years, the protocol was done in two steps. First the mother was asked to stand on the scales, without shoes and using light clothes. Once the interviewer had a weight measure for the mother, she had to take the child in her arms, and stand on the scale again. The measure of the child weight was obtained by subtracting from the last measure the mother's weight. For the height measure, children between 2 and 5 years old were measured standing next to a wall and for children under 2 years old, the measurement was made on the floor or on the top of a table, with the help of the mother. The BMI was calculated using these measures, with the WHO standards.

For parental investments we use three different measures. The first measures the time that mothers spend with their children doing different activities like reading books, singing, going to the park, teaching names of animals or colors, etc. Maternal time investments are important components of the investments parents make towards their children's human capital development (Hsin, 2012). Also this measure reflects early stimulation that parents can do to improve early child development. The variable used was constructed using the set of questions in Appendix B1 and we build a continuous variable using the average of time spent in each activity with each child. The second parental investment variable came from a selection of questions from the Home Observation for the Measurement of the Environment (HOME). This instrument enables reporting on the educational quality of the home environment and emotional and verbal responses from the mother towards the child. The questionnaire is answered two times (one for each twin) by the interviewer while he/she is in the household doing the other evaluations. Since the home environment is the same for both twins, we build the scale only using the emotional and verbal responses that vary between twins. There is evidence of the importance of these kinds of variables in the development of pre-academic skills. The scale developed represents the percentage of positive answers out of the total answers. Appendix B2 shows the questions selected from each scale to build the

indicators used in the analyses. We choose investments from mothers rather than fathers for two reasons. First, the HOME observation scale was applied during the interview with the mother, so in order to be consistent with our other investment variables we choose mothers. Second, the missing values from the paternal investments are considerably greater than for maternal investments. The third parental investment is related to children's food consumption and it is a simple count of the weekly healthy food consumption of the children (water, milk, fruits and vegetables). Table 3 shows means and percentage distributions for our sample of twins.

An important requirement for estimating equation (4) is that there is sufficient within twinship-pair variation in the child outcomes, parental investments and in the endowments to identify their effects. Table 4 shows the degree of variation within twinship-pairs in all the variables used in the estimates. The fourth column of Table 4 shows the number of twin-pairs that have variation, and columns 5 and 6 show the mean and standard deviation of these within twin-pairs differences. In terms of variation within twinship-pairs, the smallest percentage is for the measure of average consumption of healthy food, with 11.8%. In terms of the developmental and health measures approximately 80% of the pairs have differences. These within twinship-pair variations are sufficient to allow us to estimate the models. We also present in Appendix B3 four graphs to illustrate the patterns of outcome differences between twins as related to birth weight differences and average birth weight between twins, in the underlying data; basically, these graphs suggest that the outcome differences do not vary systematically with the birth weight differences and average birth weights.

Finally, we characterize, in Appendix B4, the completeness of coverage of the data. For the twins pairs with birth weight data, the percentages of missing data range from 0% to 1.6% for the parental investments and from 2.9% to 16.2% for the child outcomes, higher than 8% only for BMI. Logit estimates for being missing as a function of birthweight, twins' sex and maternal education indicate that there is no systematic correlation between these characteristics and the probability of missing data. Thus, the percentages of missing data are fairly small and are weakly related to observed family characteristics, which are controlled in the within-family estimates, so biases due to missing observations are not a major concern.

Results

In this section we explore the within-family parental preferences for the whole sample of families with twins and subdivided by maternal education differences. We define high-educated mothers as those who have more than 12 grades of schooling attainment, while low-educated mothers are defined as those with 12 or less grades of schooling. We chose this division because the 12 grades schooling marker in Chile is a meaningful distinction since it is the end of high school. Dividing the sample this way, we have about 75% of the observations in the low-educated group and the remaining 25% in the high-educated group.

The first set of results show the estimates of the production function in relation (2), from which we estimated the proportional weights for the aggregate parental investment. Table 5 shows for each of the outcomes, the estimation of the production function with inputs

including birth weight and the three measures of parental investments. Table 6 shows similar estimates, but adds interactions of the investments with the high/low maternal education variable. The estimation of the production function shows that, for all outcomes, birth weight, as the measure of endowment, significantly explains some of the variation of the test score and health measures. Also, for almost all outcomes, the time that mothers spend with the children is a significant predictor of the children's outcomes. Finally, mothers having high education changed some of the production function parameters significantly, in all but one case by increasing them so that for a given production input the outcome was greater. The coefficients from the parental investments, Activities, Home and Healthy Food, were combined and used to compute the aggregate parental investment.

Table 7 shows the estimations of relation (4). Tables 8 and 9 also show estimates of relation (4), but considering high- and low-educated mothers separately. The dependent variable in these estimations is the ratio between twins of the aggregate investment obtained from the production function. As noted the coefficient estimate for this relation relates to the parental preference parameter for each sample.

The estimated parental preferences in the developmental sub-dimensions of the TADI test score and the health outcomes, for the overall sample and differentiating between high- and low-educated mothers, was computed using the elements of the previous results (Appendix C1 shows the results). For the overall sample, all the parameters are between 0 and 1, but not statistically significantly different from zero (from the significance of the coefficient in estimations shown in Table 7), which means that parental preferences are neutral. The overall set of parental investments decisions is not made according to differential endowments between the children; they do not reinforce the better-endowed child or compensate the lower-endowed child. Also, there is no difference between low- and high-educated mothers, none of these coefficients are statistically significantly different from zero (from the significance of the coefficient in estimations shown in Tables 8 and 9), which means that parental preferences are neutral for both high- and low-educated mothers. However, all of them are significantly different from $-\infty$ --which means that there is not extreme compensation with no concern about productivity and significantly different from 1.0 --which means there is not extreme reinforcement with no concern about inequality.

Conclusion

Parental preferences about differential investments among their children are studied using four dimensions of children's development test scores (cognitive, language, motor and socio-emotional skills) and three health outcomes (weight, height and body mass index) for a Chilean twins sample. We demonstrate that the ratios of outcomes between children may vary considerably depending on the nature of parental preferences. The estimates indicate that parents have neutral preferences, whether the mothers are high- or low-educated. When parental preferences are neutral, the implication is that if endowments are unequal, then the resulting outcomes associated with those endowments are equally unequal, perpetuating the inequality between the children. Therefore, those inequalities that are present at birth will be maintained through childhood. This inequality is greater than that that would have occurred

if parental preferences were of the extreme compensatory type, but much less than that that would have occurred if parental preferences were of the extreme reinforcing type.

Comparing the results with previous research, we conclude that our results are different from those from developed countries, which show that parental investments generally reinforce or compensate to a degree initial endowments differences (Almond & Mazumder, 2013) and different from some of the evidence from developing contexts that reports that in certain circumstances, for example scarcity, there is an investment strategy from the parents (Behrman, 1988b) or that in other contexts, like Ethiopia (Ayalew, 2005) parents reinforce for some inequalities and compensate for others. Our estimates are consistent with the empirical evidence from Chile Bharadwaj et al. (2013) that finds that parents do not invest differentially within twins. Also, this result is consistent with Grätz and Torche (2016) also for Chile, that finds that there is no differential response between advantaged and disadvantaged parents to birth weight. Thus, there are reasons to think that this parental behavior needs to be studied in each specific context, since the circumstances will affect the differential parental intrafamilial investments, therefore the consequences on inequalities in children's outcomes.

A few important caveats are worth mentioning. First, the model does not consider the role of child preferences; this means for example that, if parents are trying to invest equally in the children but one of them is rejecting the investment, then we could be interpreting the result as the parents investing more in one child than the other, when it is the child who is not responding to the investment. To account for this kind of behavior we would need data that allowed us to understand children's responses, but this is out of the scope of the data available for this paper. Second, a key assumption of this model is that parents can completely differentiate some investments to different children. However, one alternative hypothesis is that parental investments have *public good* dimensions or have spillover effects. Since twins have the same age, many of the investments that parents undertake may affect both children. The implication of the public good dimension is that compensating (reinforcing) behavior will take longer to reduce (increase) the gap in the outcomes (Bharadwaj et al., 2013). These public good effects could be different for twins than siblings, but since we have only a sample of twins we cannot explore this possibility. Additionally, it is important to keep in mind that this research only focuses on families with two or more children, and, moreover, only on families with twins, though the estimation strategy controls for family characteristics including ways in which families with twins might be different from other families.

Despite these caveats, we have contributed to the literature on the nature of parental preferences that may affect substantially outcomes among children in the family and on how parental preferences determine investments among their children, investments that have important long-run implications for the children's learning and health over their lives. Although more research needs to be directed towards a comprehensive understanding of the consequences and heterogeneity of parental investments among their children; our estimates are an effort in this direction and this paper adds to the meager previous literature on this topic for developing countries.

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Appendix B1

Question in Survey of Parental Investments						
In the last 7 days, how often the mother/father did the following activities with the child:		Never	1-3 times	4-6 times	Every day	Not apply
1	Read or look at books with the child	1	2	3	4	5
2	Tell stories to the child	1	2	3	4	5
3	Sing to/with the child	1	2	3	4	5
4	Go to the park or playground with the child	1	2	3	4	5
5	Go to museum, zoo, library with the child	1	2	3	4	5
6	Spent time with the child talking or painting	1	2	3	4	5
7	Invite the child to participate in household activities	1	2	3	4	5
8	Take the child to the grocery store	1	2	3	4	5
9	Share a meal (breakfast, lunch or dinner) with the child	1	2	3	4	5
10	Teach animals or sounds of animals to the child	1	2	3	4	5
11	Teach colors to the child	1	2	3	4	5
12	Go visit friends or family with the child	1	2	3	4	5
13	Teach numbers to the child	1	2	3	4	5
14	Teach letters to the child	1	2	3	4	5

Appendix B2

Question selected from HOME 1 (6 to 36 months)		Yes	No
1	The mother speaks to the child at least twice during the visit.	1	0
2	The mother praises the qualities of the child at least twice during the interview.	1	0
3	You can see the mother kissing or cuddling the child, at least once during the visit.	1	0
4	The mother shows some positive emotional response to praise towards the child performed by the interviewer.	1	0
5	The mother responds quickly to the needs and vocalizations of the child.	1	0
6	The mother does not yell at the child during the visit.	1	0
7	The mother does not express hospitality towards the child.	1	0
8	The mother does not hit the child during the visit.	1	0
9	The mother does not scold or criticizes the child during the visit.	1	0
10	The mother tends to keep the child within visual range and look at it often.	1	0
11	The mother speaks to the child as she answered the survey.	1	0
12	The mother knows a lot about the child, is good informant.	1	0
13	The mother subjected the child to a constant and rapid overstimulation; the child is overwhelmed.	1	0

Question selected from HOME 1 (6 to 36 months)		
	Yes	No
14 The mother signals to the child when going out of the room.	1	0
15 The mother notes and identifies interesting things in the environment to the child.	1	0
Question selected from HOME 2 (37 months – onwards)		
	Yes	No
1 The mother speaks to the child at least twice during the visit.	1	0
2 The mother verbally answer questions or requests of the child.	1	0
3 The mother usually replied verbally to the child when he/she communicates with her.	1	0
4 The mother praises the qualities of the child at least twice during the interview.	1	0
5 The mother gives kisses, caresses and hugs the child during the visit	1	0
6 The mother helps the child to demonstrate some of its achievements during the visit.	1	0
7 The mother does not scolds, abrogate or yells at the child during the visit.	1	0
8 The mother does not make use of physical coercion during the visit (send him to the room, stop at a corner, etc.).	1	0
9 The mother does not hit the child during the visit.	1	0
10 The mother knows a lot about the child, is good informant.	1	0

Appendix B3

Appendix B4

Table B4 – 1: Missing data

Twin pairs with birth weight data % with missing data	
Parental Investments	
Maternal Time (Activities)	0.0
Home (Adapted version)	1.6
Healthy food	0.0
Outcomes	
TADI Cognitive Test Score	4.15
TADI Language Test Score	3.51
TADI Motor Test Score	2.87
TADI Socio-Emotional Test Score	2.87
Weight (kg)	7.26
Height (cm)	7.61
Body Mass Index	16.20

Table B4 – 2: Logit Outcomes with Missing Data

	TADI Cognitive	TADI Language	TADI Motor	TADI Socioemotional	Weight	Height
Birth weight twin i	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	0.001* (0.000)	0.001* (0.000)
Birth weight twin j	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	-0.000 (0.000)	-0.001*** (0.000)
Male	-0.056 (0.324)	0.029 (0.350)	0.044 (0.384)	0.044 (0.384)	-0.321 (0.256)	-0.454* (0.255)
Maternal schooling	-0.015 (0.053)	-0.068 (0.057)	-0.026 (0.063)	-0.026 (0.063)	-0.011 (0.042)	-0.008 (0.041)
Constant	-2.908*** (1.121)	-2.759** (1.210)	-3.373** (1.339)	-3.373** (1.339)	-2.902*** (0.888)	-0.829 (0.795)
Observations	999	999	999	999	999	999

Appendix C1

Table C1 - 1: Parental Preferences

Outcome	Parental Preferences	Parental Preferences Low-Educated	Parental Preferences High-Educated
TADI Total	0.076	0.079	0.310
TADI Cognitive	0.087	0.092	0.265
TADI Language	0.091	0.089	0.626
TADI Motor	0.060	0.062	0.138
TADI Socioemotional	0.055	0.069	0.377
Weight	0.005	0.022	-0.159
Height	0.058	0.119	-0.511
BMI	0.626	0.103	-0.871

Methodological Appendix for Estimating Aggregate Investments in Children

Step 1: Estimation of the production function in relation (2) using three (=m) different measures of parental investments in each child

$$\log O_i = \alpha_g \log G_i + \sum_{s=1}^m \alpha_{ms} \log S_{mi} = \alpha_g \log G_i + \alpha_s \log S_i \quad (2)$$

We first estimated a OLS regression for each outcome O_i (TADI Total, Cognitive, Language, Motor, Socioemotional and Weight, Height and BMI) using birth weight to represent endowments and three different investment variables: activities, home and healthy food (more description of these is in the Data section). All the variables are in logarithms with an error term added to each regression because of random shocks or measurement error in the dependent variables.

Step 2: Using the weights estimated in this procedure ($\alpha_m S$), we combined the three parental investments into one aggregate investment, which we then used to estimate relation (4)

To compute the left-side variables of relation (4) we first calculated the following weighted sum:

$$\log S_i = \alpha_1 * \log S_{1i} + \alpha_2 * \log S_{2i} + \alpha_3 * \log S_{3i}$$

The estimated coefficients were used for the weights for each investment. Hence, each of the alphas is the coefficient from the previous estimation and was multiplied by the respective investment variable. We compute this for each outcome and for each twin. Then we divide this value for twin i by that for twin j , and take the logarithm of that ratio, which yields the left-side variable in relation (4).

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Research highlights

- New evidence on intra-household preference models of parental investments.
- The model explores children's health and educational outcomes.
- Adds to limited evidence on intra-household preferences in developing countries.
- Explores parental preferences by maternal educational level.
- Parents are neutral, neither reinforcing nor compensating endowment differences.

Table 1

Relation of c to parental concern about inequality and parental investment strategies.

Value	Interpretation
$c = -\infty$	Parents have extreme compensatory preferences with only concern about inequality.
$c < 0$	Parents have compensating preferences and invest more in the less-endowed child.
$c = 0$	Parents have neutral preferences and invest equally in the children, regardless of the different endowments.
$1 > c > 0$	Parents have reinforcing preferences and invest more in the more-endowed child.
$c = 1$	Parents have extreme reinforcement preferences with no concern about inequality.

Table 2
Ratio of the outcomes for different values of parameters c and α_g

Outcome Ratio (for Endowment Ratio = 1.3)					
c values	$-\infty$	-0.5	0	0.5	1
α_g values					
0.20	1.000	1.038	1.054	1.091	1.300
0.50	1.000	1.111	1.140	1.191	1.300
0.80	1.000	1.210	1.234	1.263	1.300

Table 3
Means and percentage distributions of the sample

	Twins				
	Obs.	Mean	SD	Min	Max
Parental Investments					
Maternal Time (Activities)	2166	44.3	20.0	0	98
Home (Adapted version)	2163	0.9	0.2	0	1
Healthy food	2166	23.8	3.8	0	35
Outcomes					
TADI Cognitive Test Score	2126	33.0	13.4	2	52
TADI Language Test Score	2138	33.0	11.2	1	47
TADI Motor Test Score	2130	34.3	13.5	4	55
TADI Socio-Emotional Test Score	2138	37.8	12.2	8	56
Weight (kg)	2094	16.7	4.7	6.9	38.9
Height (cm)	2087	98.7	13.8	66	135
Body Mass Index	1983	16.9	1.7	12.02	22.23
Mother characteristics					
Schooling attainment [grades]	2148	11.7	3.1	0	25
Age	2152	32.0	6.8	16	49
Child characteristics					
Sex child [1=boy] %	2184	51.1	-		
Age child [months]	2184	45.2	20.4	8	84
Birth weight [gr.]	2017	2397.2	545.7	688	4850

Table 4
Variation within Twin-Pair Parental Investments and Outcomes

	Pair Obs.	Mean	Std. Dev	Pairs with Variation	Mean Abs. Variation	Std. Dev Abs. Variation
Parental Investments						
Maternal time (Activities)	1083	1.62	5.24	248	7.11	9.01
Home (Adapted version)	1074	0.09	0.13	529	0.18	0.15
Healthy food	1083	0.60	2.18	128	5.10	4.15
Outcomes						
TADI Cognitive Test Score	1049	2.58	2.96	852	3.17	2.99
TADI Language Test Score	1054	2.61	3.03	847	3.24	3.06
TADI Motor Test Score	1061	2.21	2.54	809	2.90	2.55
TADI Socio-Emotional Test Score	1061	2.75	3.30	861	3.38	3.36
Weight [kg]	1018	1.19	1.41	960	1.26	1.42
Height [cm]	1014	1.93	2.30	792	2.47	2.33
Body Mass Index	940	0.98	0.93	915	1.01	0.93
Endowment						
Birth weight [gr.]	1004	261.99	251.02	969	271.45	250.44

Table 5

Production Function Estimates

	TADI Total	TADI Cognitive	TADI Language	TADI Motor	TADI Socioemotional	Weight	Height	BMI
Birth weight	0.075 *** (0.012)	0.082 *** (0.019)	0.069 *** (0.015)	0.096 *** (0.018)	0.067 *** (0.013)	0.127 *** (0.012)	0.033 *** (0.005)	0.058 *** (0.009)
Activities	0.057 *** (0.006)	0.070 *** (0.009)	0.063 *** (0.007)	0.072 *** (0.009)	0.035 *** (0.006)	0.015 *** (0.006)	0.010 *** (0.002)	-0.005 (0.004)
HOME	0.022 ** (0.010)	0.032 ** (0.015)	0.032 *** (0.012)	0.007 (0.014)	0.015 (0.010)	0.003 (0.009)	-0.002 (0.004)	0.005 (0.007)
Healthy Food	0.036 ** (0.017)	0.033 (0.027)	0.035 (0.021)	0.033 (0.025)	0.045 ** (0.018)	0.022 (0.017)	0.011 * (0.006)	0.005 (0.012)
Constant	1.733 *** (0.111)	1.443 *** (0.171)	1.669 *** (0.136)	1.506 *** (0.162)	2.084 *** (0.116)	1.107 *** (0.106)	3.944 *** (0.041)	2.418 *** (0.081)
Observations	1,938	1,926	1,932	1,938	1,938	1,906	1,901	1,807

Note: Standard errors in parentheses.

***
p<0.01,

**
p<0.05,

*
p<0.1.

All the variables shown in the Table are in logarithms. Other controls not shown are: child age and gender.

Table 6

Production Function by Maternal Education

	TADI Total	TADI Cognitive	TADI Language	TADI Motor	TADI Socioemotional	Weight	Height	BMI
Birth weight	0.075 *** (0.012)	0.081 *** (0.019)	0.068 *** (0.015)	0.095 *** (0.018)	0.066 *** (0.013)	0.128 *** (0.012)	0.033 *** (0.005)	0.058 *** (0.009)
Activities	0.052 *** (0.006)	0.060 *** (0.010)	0.055 *** (0.008)	0.067 *** (0.009)	0.036 *** (0.007)	0.013 ** (0.006)	0.009 *** (0.002)	-0.004 (0.005)
HOME	0.013 (0.010)	0.025 (0.016)	0.021 * (0.013)	-0.001 (0.015)	0.003 (0.011)	0.006 (0.010)	-0.002 (0.004)	0.008 (0.007)
Healthy Food	0.039 ** (0.018)	0.041 (0.028)	0.042 ** (0.021)	0.037 (0.026)	0.040 ** (0.018)	0.023 (0.017)	0.011 * (0.006)	0.004 (0.013)
Activities * High Educ.	0.030 * (0.016)	0.052 ** (0.024)	0.053 *** (0.019)	0.030 (0.023)	-0.004 (0.016)	0.005 (0.015)	0.001 (0.006)	-0.011 (0.011)
Home * High Educ.	0.054 ** (0.027)	0.037 (0.041)	0.072 ** (0.032)	0.049 (0.039)	0.071 ** (0.028)	-0.029 (0.026)	-0.002 (0.011)	-0.027 (0.022)
Healthy Food * High. Educ.	-0.027 (0.019)	-0.050 * (0.029)	-0.056 ** (0.023)	-0.028 (0.027)	0.014 (0.019)	-0.002 (0.018)	-0.000 (0.007)	0.013 (0.014)
Constant	1.741 *** (0.111)	1.442 *** (0.171)	1.674 *** (0.136)	1.513 *** (0.162)	2.100 *** (0.116)	1.102 *** (0.106)	3.944 *** (0.041)	2.417 *** (0.081)
Observations	1,938	1,926	1,932	1,938	1,938	1,906	1,901	1,807

Note: Standard errors in parentheses.

***
p<0.01,

**
p<0.05,

*
p<0.1.

All the variables shown in the Table are in logarithms. Other controls not shown are: child age and gender.

Table 7

First-Order Condition (Eq. 4)

	TADI Total	TADI Cognitive	TADI Language	TADI Motor	TADI Socioemotional	Weight	Height	BMI
	Log ratio of Aggregate Parental Investments (twin i / twin j)							
Log ratio of birth weight (twin i / twin j)	0.006 (0.011)	0.008 (0.013)	0.007 (0.013)	0.006 (0.010)	0.004 (0.009)	0.001 (0.008)	0.002 (0.008)	0.089 (0.185)
Constant	-0.001 (0.002)	-0.002 (0.002)	-0.001 (0.002)	-0.001 (0.002)	0.000 (0.001)	0.001 (0.001)	0.001 (0.001)	0.015 (0.030)
Observations	948	936	943	948	948	917	914	789

Note: Standard errors in parentheses. Estimates are significantly different from - ∞ and from 1.0, but not significantly different from 0.0.

Table 8

First-Order Condition (Eq. 4) for High-Educated Mothers

	TADI Total	TADI Cognitive	TADI Language	TADI Motor	TADI Socioemotional	Weight	Height	BMI
Log Ratio of Aggregate Parental Investments (twin i / twin j)								
Log ratio of birth weight (twin i / twin j)	0.032 (0.055)	0.028 (0.051)	0.103 (0.094)	0.015 (0.040)	0.038 (0.072)	-0.018 (0.029)	-0.011 (0.020)	-0.028 (0.566)
Constant	-0.004 (0.008)	-0.006 (0.008)	-0.010 (0.014)	-0.003 (0.006)	-0.000 (0.011)	0.002 (0.004)	0.002 (0.003)	0.082 (0.081)
Observations	206	203	206	206	206	199	199	156

Note: Standard errors in parentheses. Estimates are significantly different from - ∞ and from 1.0, but not significantly different from 0.0.

Table 9

First-Order Condition (Eq. 4) for Low-Educated Mothers

	TADI Total	TADI Cognitive	TADI Language	TADI Motor	TADI Socioemotional	Weight	Height	BMI
Log Ratio of Aggregate Parental Investments (twin i / twin j)								
Log ratio of birth weight (twin i / twin j)	0.006 (0.010)	0.008 (0.012)	0.007 (0.011)	0.006 (0.010)	0.005 (0.008)	0.003 (0.010)	0.004 (0.008)	0.007 (0.224)
Constant	-0.000 (0.002)	-0.001 (0.002)	-0.001 (0.002)	-0.000 (0.002)	0.000 (0.001)	0.001 (0.002)	0.001 (0.001)	0.022 (0.037)
Observations	741	732	736	741	741	718	714	635

Note: Standard errors in parentheses. Estimates are significantly different from - ∞ and from 1.0, but not significantly different from 0.0.