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Doctoral Thesis

Three essays on human capital: investments, resilience, and spillovers

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To my family for their endless love,
support, and inspiration

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Declaration

- No part of this thesis has been submitted for another degree.
- Chapter 1 is co-authored with Professor Sonia Bhalotra, Professor Adeline Delavande, and Dr Joanna Maselko. The other chapters in this thesis are exclusively mine.
- Chapter 1 has been previously published in the ISER Working Paper Series (No. 2020-03, March 2020), and in the IZA Discussion Papers (No. 13056, March 2020). Chapter 2 has been previously published in the ISER Working Paper Series (No. 2020-16, December 2020).

Summary

This thesis contains three studies focusing on different dimensions of human capital: investment decisions, resilience, and spillovers.

Chapter 1 investigates the importance of subjective expectations of returns to and effort costs of maternal investments in newborns. We find heterogeneity across mothers in expected effort costs and expected returns for outcomes in the cognitive, socio-emotional, and health domains. While this contributes to explaining heterogeneity in investments, we find no significant differences in preferences for child developmental outcomes. The findings from simulating the impact of various policies on investments highlight the relevance of interventions designed to reduce perinatal fatigue alongside interventions that increase perceived returns to investments in children.

Chapter 2 exploits the expansion of a large-scale health insurance program in Mexico and variation in local rainfall levels to estimate whether the increase in healthcare coverage protected the educational attainment of primary school children in the event of adverse climatic shocks. Results show that the universalization of healthcare mitigated the negative effect of atypical rainfall on test scores, particularly in more marginalized and rural areas. An analysis of the mechanisms shows a reduced incidence of sickness among children, lower demand for their time, and higher stability in household consumption among program-eligible families exposed to rainfall shocks.

Chapter 3 explores whether parents benefit from bringing up and investing in children. I instrument sibship size by exploiting gender preferences among Chinese households and address the endogeneity of parental investments by leveraging an extension to the minimum compulsory schooling. In a context of low state welfare provision I find that while the quantity of children has a null direct effect on the physical, mental, or cognitive health of parents in later life, the reform-induced increase in daughters' education improved the physical and cognitive health of mothers, reducing the gender gap in health outcomes among older generations.

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Introduction

In recent decades, the world has seen a remarkable increase in the education level of its population. Nevertheless, the positive evolution in educational attainment contrast with recent evidence showing that more than one-half of children and adolescents worldwide perform poorly in cognitive assessments, 68% of whom are attending school (UIS, 2017). Studies have shown that gaps in children's intellectual, physical, and emotional development emerge early in life and widen over time (Cunha et al., 2006; Ermisch et al., 2012; World Bank, 2015). Hamadani et al. (2014) show that significant cognitive delays between children of different socio-economic backgrounds emerge as early as 7 months old, well before reaching school-age. Parents thus play a crucial role in the human capital acquired by their children, and understanding differences in parental behavior are key to explain what is being considered a global learning crisis.

In the model of parental investments developed by Becker and Tomes (1979, 1986), heterogeneity in parental investments arises either from difference in resource constraints or from differences in parental preferences over child development. The model therefore assumes that parents have perfect information as to how their investments influence child outcomes. In Chapter 1 we relax this assumption (as in Cunha et al., 2013), allowing that parents with similar resource constraints and preferences may choose different levels of investment in their children due to differences in subjective expectations (or beliefs) of the returns. In an important contribution to the literature, we also model the effort cost of investments directly, addressing a second limitation of traditional models of parental investments which interpret resource constraints as credit constraints, neglecting the relevance of mental and physical capacity.

To investigate the role of information frictions and perceived effort in parental investment behavior we collect data on expected returns and effort costs from more than 1,100 pregnant women in Pakistan. We focus on the perceived effect of exclusive breastfeeding and stimulation through play (essential aspects of parenting in the first months of life) on the cognitive, socio-emotional, and health outcomes. Although in general mothers report positive expected returns to maternal investments, there is substantial variation in their answers. Heterogeneity in effort cost is also present. Using a discrete choice model in which mothers decide whether to breastfeed and play, together with the expected returns and costs of the investments, we estimate the preference parameters for child developmental outcomes. The main finding is that differences in expected returns and effort costs across mothers contribute to explain differences in maternal investments in infants, but that differences in preferences for child developmental outcomes play a limited role. Policy simulations using the estimated structural parameters show that information campaigns targeting an increase in maternal expected returns would raise investments in children. Moreover, increasing expected returns while simultaneously lifting effort cost shows the strongest potential to foster maternal investments. The results evidence the potential role of information policies as well as interventions to reduce the mental and physical load on mothers to foster developmental outcomes in children.

While parents decide on the optimal investments in children based on resources, preferences, and expectations, shocks experienced during childhood can endanger children's developmental outcomes. The extent to which shocks affect children's human capital, however, depends on the ability and coping mechanisms families have access to.

In Chapter 2 I inspect how the experience of negative shocks impact children's performance in school when the capacity of households to endure them is increased. I define shocks as atypical rainfall levels and use the expansion of a large-scale pro-poor health insurance program in Mexico that sought to establish universal healthcare in the country (Seguro Popular). Combining information from a yearly national standardized test in primary education, the expansion in health coverage induced by the reform of the health system, and rainfall precipitation, Chapter 2 shows the ability of universal healthcare in protecting the cognitive development of children in the event of adverse environmental shocks. The main results show that while adverse rainfall shocks reduce mathematics and verbal attainment by 0.022 and 0.020 standard deviations respectively, a one standard deviation increase in healthcare coverage mitigates 55% and 52% of the negative effect. The estimated results are driven by schools located in more marginalized and rural areas. The finding adds on recent studies examining the extent to which different programs or interventions can mitigate the negative effect of climatic and other environmental shocks on human capital (Adhvaryu et al., 2019; Adhvaryu et al., 2018; Duque et al., 2019; Garg et al., 2017; Gunnsteinsson et al., 2019).

An inspection of the mechanisms at play shows that health insurance reduces the incidence of sickness among children from eligible families, decreases the demand for children's time, and protects households' consumption levels in the event of negative shocks. Chapter 2 highlights the potential role of universal healthcare in fostering human capital resilience, by protecting cognitive attainment from climatic shocks experienced during childhood. This is especially relevant given the large incidence of environmental shocks among the poor, and the push by the WHO for the expansion of universal healthcare as a major goal for health reform.

While most of the research in economics focuses on the returns to children from parental investments, little is known on whether parents benefit from the human capital of their children.

Becker's seminal 1960 paper argues that parents obtain utility from both the quantity and the quality of their children. The trade-off in fertility choice (Becker and Lewis, 1973), by which parents must choose between how many children to have and how much to invest on them, inspired models of parental utility maximization to examine the relationship between returns to human capital and fertility decisions (Becker et al., 1990; Galor, 2012; Galor and Weil, 2000; Hazan and Berdugo, 2002, among others). Assessing whether parents benefit from the quantity and quality of their children could be useful to better understand the evolution of fertility choices and parental investments in children. For instance, previous empirical work has shown a positive relationship between the value of child labor and fertility levels (Ager and Herz, 2019; Caldwell, 1976) and between the returns to education and investments in children (Attanasio et al., 2019a; Boneva and Rauh, 2018; Chiswick, 1988). Different from previous work on parental utility maximization, In Chapter 3 I inspect returns to parents from the quantity and the quality of their children in the form of measurable health outcomes in later life.

I exploit son preference among Chinese households and the quasi-random assignment of the firstborn's gender to instrument for fertility levels, and an extension to the minimum compulsory schooling to instrument for children's education. I focus on the effect of fertility choices on indices of parental physical, mental, and cognitive health among a representative sample of Chinese residents aged 45 and older. The findings show that while fertility does not have any statistically significant direct long-term effect on parental health, the reform-induced increase in daughters' education improved mothers' physical health by 0.14 standard deviations (two-thirds of the gender gap in physical health), and increased parental cognitive achievement by 0.16 standard deviations (29% of the cognitive premium from primary school completion) - an effect driven by the sample of mothers.

The findings in Chapter 3 suggest an underestimation in previous studies of the effect of policies promoting higher education among girls as a means to reduce gender inequality, as they typically fail to account for the positive externalities accruing to their mothers. Assessing the return to offspring quantity and quality is not only critical to understanding fertility behavior and parental investments in children, but also to evaluate potential externalities accruing to parents from policies promoting reduced fertility levels, banning child labor, or expanding compulsory schooling as a means to increase children's human capital. The results show that both children and parents' human capital can improve from reduced fertility levels and higher investments in children, and add to the literature on the intergenerational transmission of poverty by showing how low levels of human capital among children in large families could also negatively affect their parents in the long-run. To the best of my knowledge, this is the first study that attempts to disentangle the relative return from offspring's quantity and quality.

Chapter 1

Maternal Investments in Children: The Role of Expected Effort and Returns

1.1 Introduction

Gaps in children's intellectual, physical, and emotional development by family-level deprivation emerge early in childhood and tend to widen over time (Cunha et al., 2006; Ermisch et al., 2012; World Bank, 2015). It is estimated that at least half of the variation across individuals in lifetime earnings arises from attributes determined by age 18 (Cunha et al., 2005; Huggett et al., 2011; Keane and Wolpin, 1997). Early childhood developmental outcomes are shaped by a combination of neurological, physiological, and environmental factors, including nutrition, stress, and the responsivity and stimulation offered by parents and other caregivers. Parents thus play a crucial role, and differences in parental behaviours must be an important facet of the emergence of unequal capabilities in children.

In the model of parental investments pioneered by Becker and Tomes (1979, 1986), heterogeneity in parental investments arises either from differences in resource constraints or from differences in parental preferences over child development. As it can be difficult to modify preferences, this has led to a tradition of seeking to ameliorate childhood inequalities through cash transfers. However, the evidence that untargeted income transfers to poor families boost child outcomes is ambiguous (Caucutt and Lochner, 2020; Heckman and Mosso, 2014).

We contribute to recent research highlighting the potential relevance of two additional constraints on parental investments – information frictions and effort costs. The Beckerian model assumes that parents have perfect information on how their investments influence child outcomes (henceforth, expected returns). As in Cunha et al. (2013), we relax this assumption, allowing that parents with similar preferences and resource constraints may choose different levels of investment in their children because they have different subjective expectations (or beliefs) of the returns. If this is the case, interventions that offer information to mothers may redress early gaps in development. However, even if mothers update their beliefs about returns to their investments in children, effort costs may constrain investment. Effort costs may arise, for instance, from postnatal fatigue, depression, or the cognitive load associated with poverty (Mullainathan and Shafir, 2013; Putnam, 2016), and failing to address these constraints may limit the effectiveness of a range of early childhood interventions. In an important contribution to the literature, we model effort cost directly, addressing a second limitation of traditional models of parental investments which interpret resource constraints as credit constraints, neglecting the relevance of mental and physical capacity.

To investigate the role of information and effort costs, we elicit baseline data on expected returns and effort costs from a sample of more than 1,100 pregnant women in rural and peri-urban Pakistan and measure investments when their children are three months old. In particular, we elicit probabilistic beliefs about investment returns in terms of child development in various domains: cognitive (language and learning well at school), socio-emotional (playing with other children), and health (diarrhea, the leading cause of death among infants and children in Pakistan). We use visual aids following the approach developed by Delavande and Kohler (2009) and reviewed in Delavande (2014). We elicit expected effort costs by asking mothers how tiring they anticipate the activities of breastfeeding and play to be. We focus on exclusive breastfeeding and guided play as these are essential aspects of parenting and attachment-creation in the first months of life. Moreover, parenting and attachment have been argued to be among the most critical family-level factors influencing human capital and social mobility (Heckman and Mosso, 2014).[1]

The expectations and cost data we elicit are well-behaved. For example, the vast majority of respondents respect the basic properties of probabilities when answering the questions. In general, mothers report positive expected returns to maternal investments. They expect exclusive breastfeeding to have its highest impact on children's health (with, on average, a 39 pp expected reduction in the likelihood that the child will experience diarrhea), while they expect guided play to have its highest impact on cognition (with, on average, an increase of 35 pp in the expectation that the child will learn well at school). There is, however, substantial variation in expected returns. Expected costs also vary across mothers, with around 39% of them reporting that they expect to find breastfeeding to be tiring, and 35% saying they expect that playing with the child will be tiring. Heterogeneity in both expected returns and effort costs exhibits a gradient in socio-economic status (measured by education and wealth). We also find that expected effort costs for both investments are higher among women who are depressed in pregnancy, but we find no significant association of depression with expected returns.

[1]Fitzsimons and Vera-Hernández (2013) identify a positive causal impact of breastfeeding on cognitive development, and several other studies have associated breastfeeding with attachment (e.g., Britton et al., 2006). Attanasio et al. (2020) identify impacts of structured play on cognitive development among toddlers.

We use the data on investments as well as the expected returns and costs measured before any investment is made, to estimate preference parameters for child developmental outcomes and effort costs using a discrete choice model in which mothers decide whether to breastfeed and play. Our main finding is that differences across mothers in expected returns and expected effort costs contribute to differences in maternal investments, but that differences in preferences for child developmental outcomes play a limited role. Learning well at school appears to be the most important development outcome determining early childhood investment.[2] The estimated elasticities with respect to returns are about 4 to 5 times larger than in studies investigating the elasticities of education choices with respect to expected earnings (Arcidiacono, 2004; Delavande and Zafar, 2019; Wiswall and Zafar, 2015). There are no previous estimates of the elasticity of maternal investment with respect to perceived costs.

We use the structural parameters to simulate the impact of alternative policies that raise expected returns or lift effort costs. In line with previous research, we find that an information policy that increases mothers' expected returns raises both investments. Information interventions are inexpensive relative to resource interventions (like cash transfers or school construction), and issues of parental responses such as crowd-out do not arise. In a departure from previous research, we also demonstrate, for the case of guided play, that eliminating effort costs leads to a significant increase in stimulation. Investment in play increases by 12% (3.8 pp from a baseline of 31%) in a simulation in which effort costs are set to zero – a magnitude that happens to be the same as that which results from raising expected returns by the interquartile range of the returns distribution. Increasing expected returns while at the same time lifting effort cost shows the strongest potential to foster maternal investments, with

[2] At baseline we also elicit preferences by asking women how much they care about each development outcome that we analyze. A larger fraction of women say they care about the child learning well at school than for the other developmental outcomes. When we estimate our model with all developmental outcomes together, then learning wins the horse race.

a large increase in play of 25% under the scenarios specified above.[3] In an alternative simulation, we investigate the effect of treating depression by setting an indicator for whether the mother is depressed to zero and replacing the expected returns and costs reported by depressed mothers with the averages from the non-depressed sample. This results in an increase in investment in play of 8%, consistent with our finding that depression exacerbates effort costs.[4] Our results indicate a potential role for information policies as well as interventions that act to lighten the mental and physical load on new mothers, such as mothers groups or depression treatments, as a way to foster child development.

Following recognition of the identification problem that arises because many combinations of preferences and expectations yield the same choice (Delavande, 2008; Manski, 2004; Savage, 1954), a number of recent studies combine expectations data with choice data to better understand forward-looking decisions (Arcidiacono et al., 2012; Attanasio and Kaufmann, 2014; Delavande, 2008; Delavande and Kohler, 2016; Delavande and Zafar, 2019; Giustinelli, 2016; R. Stinebrickner and Stinebrickner, 2012, 2014a, 2014b; Wiswall and Zafar, 2018).[5] With some recent exceptions discussed next, this research has not studied the role of parental expectations in determining parental investment in children. Dizon-Ross (2019) differs from us in eliciting parental beliefs about the child's academic performance and providing information on actual school grades rather than on expected returns to investing in children. Attanasio et al. (2019a), Attanasio et al. (2019b), Boneva and Rauh (2018) and Cunha

[3] This combined intervention is also effective at reducing differences in investment across mothers with high vs low ends education and wealth and the difference between mothers who were and were not depressed in pregnancy.

[4] The data show that mothers who are depressed in pregnancy are 9.7 and 8 percentage points more likely to say that they expect breastfeeding and playing with their child will be tiring. In line with this, the data also show that women who are depressed in pregnancy are less likely to make both investments at 3 months.

[5] An alternative approach to the direct use of expectations data is to rely on stated choices for multiple hypothetical scenarios as in Adams-Prassl and Andrew (2019). This approach delivers the population average of beliefs vs preferences by comparing parent responses to certain vs uncertain choices. It is therefore not appropriate when one wants individual-specific expectations to associate them with choices.

et al. (2013, 2019) are similar to us in eliciting beliefs about returns to parental investments but, in contrast to us, they do not elicit effort costs. Our approach also differs from these studies in eliciting perceived returns in the health, cognitive and socio-emotional domains. With the exception of Biroli et al. (2018) who investigate parental beliefs about the returns to diet and exercise among children age 5-18 in the UK, related studies have focused on cognitive, education, or earnings returns.

Although to our knowledge the effort costs of mothers in making early postnatal investments have not been directly measured or incorporated before in models of maternal investments, a number of recent papers show that non-pecuniary factors or psychic costs influence (own) education decisions (Boneva and Rauh, 2019; Cunha et al., 2005; Delavande and Zafar, 2019; Eisenhauer et al., 2015; Navarro and Zhou, 2016). From a methodological perspective, if expected returns and effort costs are correlated, then omitting costs in the choice model will tend to bias estimates of the importance of preferences (see also the discussion in Wiswall and Zafar, 2015). From a substantive perspective, non-pecuniary costs for maternal investments, which include physical and mental constraints, may render simple tasks such as breastfeeding or interacting with a child burdensome. Physically, it can take a mother a year or more to recuperate from pregnancy and replenish stocks of vital nutrients (DaVanzo and Pebley, 1993). Mental constraints may arise from perinatal depression, which is estimated to affect 10 percent of women in high-income countries and 20 percent in low and middle-income countries. The condition often goes undiagnosed and hence untreated (Gelaye et al., 2016), and is associated with stress and fatigue (Cohen et al., 1982; Den Hartog et al., 2003). Effort costs may similarly be elevated on account of the burdens of poverty. Recent work shows that the stress of poverty can enhance cognitive load and trigger tunnelling in decision-making (Mani et al., 2013; Schilbach et al., 2016).

Our study is one of the few to analyze the role of maternal subjective expectations of returns and costs in the context of child development in a developing country.[6] There is an ongoing global learning crisis affecting the developing world as well as poor families in developed countries, with an estimated 39 percent of the world's children under age five failing to attain their cognitive potential (e.g., Grantham-McGregor et al., 2007; UNESCO, 2014). In line with the finding that parental beliefs about the returns to investment are downward biased among parents of low socio-economic status (Cunha et al., 2013), it seems plausible that returns are underestimated in many developing countries (Attanasio et al., 2019b). Similarly, perceived costs are likely to be higher in low-income settings, where constraints on time and energy are tighter. For these reasons, the returns to interventions that lead people to update beliefs on returns, or that reduce effort costs, are likely to be higher in developing countries.

Our finding that maternal depression elevates the perceived costs of play with the infant child contributes to an emerging literature on depression and economic decision-making. In the US and Pakistani context, respectively, Ronda (2016) and Baranov et al. (2020) find that depression hinders maternal investments. Both studies suggest that effort cost may be important but cannot test for this directly due to lack of data on this cost. De Quidt and Haushofer (2016) formulate a theoretical model in which depression leads to an individual having downward biased beliefs about returns to their effort (i.e., their productivity), as a result of which they supply less effort. As far as we know, their hypothesis has not been tested – we provide the first empirical test of an association of expected returns with depression. Our findings tie in with their overall conclusion that depression can lead to lower investments but, for the case of maternal investments in children, our evidence is not consistent with depression biasing beliefs downward but, rather, with depression elevating perceived effort costs.

[6] Attanasio et al. (2019b) elicit subjective expectations in Colombia.

The rest of this paper unfolds as follows. Section 1.2 introduces our model of early-life investments. Section 1.3 describes our data collection framework and our measures of maternal beliefs, costs, and investments. Section 1.4 provides descriptive evidence on the different variables feeding the model, and Section 1.5 specifies the empirical model and reviews the estimates. Section 1.6 carries out a series of robustness checks to assess the sensitivity of the assumptions and specifications. Section 1.7 provides results from policy simulations targeting an increase in maternal investments in early-life. Finally, section 1.8 offers some concluding remarks.

1.2 A simple static model of early-life maternal investments

Here we set out a simple model of maternal investments that motivates the data collection and empirical analysis. Consider a mother i who has recently given birth to a child. For simplicity, we assume here that the newborn is the only (first) child in the household, but we relax this assumption in the estimation. The mother's utility depends on household consumption c_i, and on three dimensions of her child's human capital in early (preschool) childhood (health h_i, cognitive ability a_i, and socio-emotional development s_i) as well as one dimension of development during later childhood (learning well at school l_i). The mother can engage in two different binary investments in the preschool period, breastfeeding e_{i1} and stimulating her child through play e_{i2}. These investments may impose an effort or psychic cost on the mother and produce a return in terms of the child's development. Since we measure investments at a very young age (3 months) in a low-income setting with virtually no female labor force participation, we abstract from monetary investments. For tractability, we assume that the utility function is additively separable, and logarithmic in consumption.

The mother's utility is given by:

$$U_i(c_i, h_i, a_i, s_i, l_i, e_{i1}, e_{i2}) = \alpha ln(c_i) + u_{hi}(h_i) + u_{ai}(a_i) + u_{si}(s_i) + u_{li}(l_i) - C(e_{i1}, e_{i2}) + \varepsilon_{ei} \quad (1.1)$$

where α is the utility value of log consumption, $u_{ji}(j)$ is the utility associated with the child's human capital outcome j ($j \in h_i, a_i, s_i, l_i$), $C(e_{i1}, e_{i2})$ is the effort cost of engaging in the different investments (e_{i1}, e_{i2}), which we will simply call cost from now on, and ε_{ei} is a random term which is individual and investment-specific, and unobservable to the econometrician. To reflect the scarcity of well-functioning credit markets in rural Pakistan, we assume there is no borrowing or lending so that mothers will consume their household earnings y_i.

A key feature of the model is that mothers face uncertainty about the child's future human capital outcomes at the time of choosing the investment levels as well as about the actual cost they will incur.[7] Although each combination of investment levels (e_{i1}, e_{i2}) is associated with an objective probability for the realization of the developmental outcomes (i.e. there is a technology of skills production), the individual mother possesses subjective beliefs $P_i(j|e_{i1}, e_{i2})$ about the realization of a child's human capital outcome j ($j \in h_i, a_i, s_i, l_i$) when engaging in (e_{i1}, e_{i2}) and, similarly, expectations about the cost she will incur $E_i[C(e_{i1}, e_{i2})]$. The mother's problem is, therefore, to choose investment levels (e_{i1}, e_{i2}) that maximize her subjective expected utility:

[7] For instance, breastfeeding or guided play may take a longer or shorter time than anticipated, they may be demanded by the child at unexpected times (that elevate the cost of providing them), and they may cause more or less fatigue or stress depending on the day.

$$EU_i(y_i, P_i, E_i(C), e_{i1}, e_{i2}) = \alpha ln(y_i) + P_i(h_i|e_{i1}, e_{i2})u_{hi}(h_i) + \\ P_i(a_i|e_{i1}, e_{i2})u_{ai}(a_i) + P_i(s_i|e_{i1}, e_{i2})u_{si}(s_i) + \\ P_i(l_i|e_{i1}, e_{i2})u_{li}(l_i) - E_i[C(e_{i1}, e_{i2})] + \varepsilon_{ei} \quad (1.2)$$

Using data on maternal investments, and data on expected returns and costs measured prior to the investment decision, our empirical analysis seeks to make inference (up to scale) on the parameters of the mother's utility function. This will illuminate whether variation in investments observed across children originates from variation in expectations about returns, expectations about costs, or preferences.

We acknowledge that this simple model abstracts from potentially important considerations. First, the maximisation problem (1.2) is assumed to be made without any constraints. The investments we focus on when the child is age 3 months do not carry a direct monetary cost, and foregone earnings are not relevant in our sample as female labour force participation is essentially inexistent.[8] As such, credit constraints will not directly restrict investments in our set-up but we will nevertheless allow effort cost to depend on household wealth or income. We also allow investments to be influenced by time constraints. We already account for this, in part, by introducing expected effort costs. However, in specification checks, we will produce separate estimates for households in which the mother is more vs less likely to be time-constrained to assess if the results are different. Second, assuming separability in the utility function implies that the utility a mother receives from any one developmental outcome is independent from the utility she receives from others. This makes elicitation of subjective expectations more tractable and allows us to capture "first-

[8]Only 6% of mothers responded they normally work. Although women's labour force participation is in general low in this region, recall that the women in our sample are pregnant and baseline and three months post-partum at follow-up.

order" effects in a context where we still know very little. Third, the model abstracts from endowment effects. This is a realistic assumption in our rural setting, as birth weight is typically not measured, and healthcare workers do not monitor child health with any known metric or provide scaled feedback.[9] Despite these caveats, the model captures the main trade-offs that a mother faces in her decision-making process and can be estimated with the expected return and cost data we collected without making restrictive assumptions on the mother's knowledge about the production function for skills and on the effort cost that the investments entail.

1.3 Study design

1.3.1 Sample

The data were collected as part of a longitudinal cohort study called Bachpan (which means childhood in Urdu) in rural and peri-urban Pakistan in 2016-2017. The data were collected electronically using tablets, uploaded daily to the main server, and checked weekly for inconsistencies. Although not used in our analysis, the study incorporated a cluster-randomized control trial addressing perinatal depression with a cognitive behavioural therapy approach. As a result, the study over-sampled depressed women. A description of the data is available in Sikander et al. (2015) and Turner et al. (2016). In total, 1154 pregnant women were recruited in 40 clusters, 570 of whom were screened positive for a depressive disorder, and enrolled in the depression trial, with around half in each of the intervention and control arms. The remaining 584 women were not depressed in pregnancy. Baseline data were collected when mothers were in their third trimester of pregnancy, the time of recruitment into the study. At that time, women had not yet received any form of treatment for

[9]Note also that to account for endowments, one would need to elicit expectations conditional on various endowments level, which implies that the number of questions increases n-fold for n endowment levels as, for instance, in Cunha et al. (2013) and Boneva and Rauh (2018), and increases survey time as well as respondents' burden.

depression. Depression was assessed using the patient health questionnaire (PHQ-9), which queries a series of symptoms of depression (see Data Appendix B for a detailed list of all items evaluated). The intervention was a positive thinking therapy focusing on the mother's personal health, her interactions with the child, and with others (Atif et al., 2017). We do not use the trial-induced variation because the expected returns and effort cost data were collected at baseline.[10]

We use two different samples for our analyses. We elicited expected returns and costs of early-life investments for all women in the baseline data (depressed and not depressed and irrespective of their treatment arm allocation), and these are the data used to describe expected returns and costs. This first sample includes 1,090 women given an item non-response rate of 5.6% on the questions pertaining to expected returns and cost. Maternal investments were measured in a follow-up survey carried out when the children were 3 months old. For the main analysis modelling investments (section 1.5), we exclude mothers in the intervention arm. This is to be conservative and address the possibility that the depression intervention had a direct effect on parenting behaviour, but we investigate the sensitivity of our results to this restriction.[11] This second sample consists of 626 women. The smaller sample size at the 3-month survey reflects a 23% attrition rate between waves (including 8% of miscarriage/stillbirth, 1% of women not surveyed due to child's illness, and 14% of women not surveyed for other reason which we know is primarily because many mothers in these communities go to live with their own mother soon after giving birth).

Given that the trial oversampled women with depression, we use two different sets of weights to account for the regional prevalence of maternal depression, which was 30%. We first weight observations at baseline to account for the difference between

[10](Sikander et al., 2019) found no treatment effect on symptom severity or remission from perinatal depression at 6 months after childbirth, but they found that the intervention was beneficial on some other metrics of severity and disability.

[11]We nonetheless do not find any significant association of the depression intervention on actual maternal investments at month 3.

the real prevalence of maternal depression and the share of depressed mothers in our sample, and we construct a second weight variable to account for the exclusion of mothers receiving the intervention when examining the link between maternal beliefs and investments at 3 months.[12] Nevertheless, we confirm that our results are insensitive to the inclusion of treated mothers in the model estimation and to using weights.

Tables 1.1a and 1.1b provide descriptive statistics for (1) the original unweighted sample; (2) the baseline weighted sample which we will be using to describe elicited expectations over returns and costs; and (3) the 3-month weighted follow-up sample which we use to measure maternal investments. Mothers in our sample are 26 years old on average, with a mean parity of 2.5 children including the current pregnancy, and about 30% of them are pregnant with their first child. They have, on average, about 8 years of completed education, around 33% of them have 5 or fewer years of education, and their labour force participation rate is very low, at 6%. The difference between the weighted and unweighted samples is primarily in depression levels (since the weights are designed to map the 30% depression prevalence of the study area) and in variables known to be associated with the incidence of maternal depression- namely education, wealth and parity.[13] There are no statistically significant differences in variable means between the weighted samples at baseline and 3 months. Appendix Table A.1 presents descriptive characteristics by attrition status. Column (1) presents characteristics for women who are included in the 3-month sample and column 2 for women who are not. Reassuringly, demographic characteristics and expected returns and effort costs are similar across the two groups, so it does not seem that at 3 months we have a selected sample of the women at baseline.

[12]The weights are constructed by post-stratification. In our sample, the two strata considered are depressed and non-depressed. Each weight is constructed by adjusting the observations in each stratum such that with independence of the sample used, the weighted prevalence of depression in the sample matches the overall depression rate in the study region.

[13]The Data Appendix B details the construction of the wealth measure.

1.3.2 Expected returns, effort costs and maternal investments

Measuring expectations. We elicit maternal beliefs on the productivity of early-life investments using visual aids, as is commonly done in developing countries (Delavande, 2014; Delavande and Kohler, 2009). In particular, we used a card with bars numbered from 0 to 10. Each bar is made up of equal-sized blocks (e.g., 1 block for 1, 3 blocks for 3) and we explain that one block means one chance out of ten. Data Appendix B details the survey design. We started with a preamble intended to explain the notion of a probability, followed by a question designed to test whether women had understood the concept.

We then directly elicited probabilities for whether a child will reach specified developmental milestones conditional on high vs low levels of maternal investment.[14] These questions were framed with reference to a mother and child in the community rather than with reference to the respondent and her child. As such, we expect the responses to capture beliefs about each woman's expectations of the technology of skills formation in her community. The questions focus on two key investments (exclusive breastfeeding and guided play) and four child developmental outcomes: experiencing frequent diarrhea (health), putting 2-3 words together in speaking by age 2 (cognitive ability); playing happily with other children by age 3 (socio-emotional development) and learning well at school. The high and low levels of maternal investment were specified as exclusive breastfeeding for 6 months versus not doing this, and playing

[14]Cunha et al. (2019) discusses two ways to measure maternal subjective expectations. The first relies on asking mothers the likelihood that a milestone will be reached like we do. The second asks mothers to report what they think the youngest and oldest age is at which a child will reach a milestone, which requires additional steps to transform answers into probabilities. This is also the method adopted in Attanasio et al. (2019b) in Colombia. In Cunha et al. (2019), the probabilities elicited using the first method appear uncorrelated with the difficulty of the milestone considered but both methods yield measures of beliefs that behave sensibly, for instance, being correlated with investments as measured by the HOME score. We used probabilistic beliefs as they have worked well in many different low-income settings (see Delavande (2014) for a review). Moreover, even in developed countries, individuals tend to have difficulties with providing a minimum and a maximum, as shown by the low response rate in Dominitz and Manski (2011). Finally, beliefs elicited with the format we use can be analysed without making any assumptions on maternal beliefs about the shape of the production function for skills.

frequently with the child to help her learn new things versus playing rarely. For example, the questions were phrased as:

In your view, what is the likelihood that a child will put 2-3 words together in speaking by the age of 2 years:

(i) If the mother plays with the child frequently to help them learn new things?

(ii) If the mother rarely plays with the child to help them learn new things?

Importantly, the questions were asked in pregnancy before any investments were made to avoid any feedback from investments to beliefs.

Effort cost. We elicited expected effort costs associated with making the investments by asking mothers at baseline (before birth) to report on a Likert scale how tiring they expected it would be to breastfeed or to play with a baby (see Data Appendix B).

Measuring maternal investments. During the 3-month follow-up interviews, we measured the two maternal early-life investments for which we had gathered data on beliefs regarding returns and costs. To measure exclusive breastfeeding, mothers were asked about all the nutrients given to their child in the last 24 hours (see Data Appendix B for a complete list of all the nutrients evaluated and Appendix Table A.2 for a detailed summary of feeding practices in our study area). Mothers are considered as exclusively breastfeeding if they are giving only breast milk. While 93% of mothers are breastfeeding their 3-month old baby, only 49% are exclusively breastfeeding (Table 1.1c). Guided play is a question collected within the Infant-Toddler Home Observation Measurement of the Environment (HOME) inventory questionnaire designed for children aged 0-3 (Cox et al., 2002) asking the mother whether she guides the child during play. See Data Appendix B for details. We focused on this particular question as it matches very closely the investment portrayed in the expectation questions. Using this variable, 33% of mothers were guiding during play with their 3-month old baby. We conduct robustness checks replacing the chosen play question with multiple alternative items from the HOME inventory in Section 1.6.

Why early infancy. As our focus on very early infancy is an important feature, we briefly elaborate its rationale here. The velocity of physical and cognitive growth is higher in infancy than at any later period in life and there is considerable developmental plasticity, making the newborn child particularly sensitive to environmental influences including nutrition and stimulation, the two investments that we analyze (Almond et al., 2018; D. J. Barker, 1990, 1995; Bateson et al., 2004). In a context similar to ours (Bangladesh), Hamadani et al. (2014) show that significant cognitive delays between children of different socio-economic backgrounds are apparent as early as 7 months old, motivating the need to investigate differences in parental investments in the very first months of a child's life. Once differences in initial conditions develop, they tend to be "self-productive" and to exhibit dynamic complementarity with subsequent investments, as a result of which inequalities widen with age (Cunha and Heckman, 2007). As a result, infancy is a critical period for investment (Heckman and Kautz, 2014). Our focus on early infancy also facilitates a cleaner analysis by limiting the agency of the child (the relevance of which is discussed, for instance, in Heckman and Mosso, 2014), allowing us to isolate determinants of maternal investment from data on mother's expectations and effort cost.

1.4 Description of investments, expected returns and effort costs

1.4.1 Heterogeneity in investments

We estimate conditional associations of maternal investments with baseline values of the mother's education, wealth, and depression status using linear regression (Appendix Table A.3). Exclusive breastfeeding does not vary with any of these characteristics, but play does. Mothers who are asset poor or depressed in pregnancy are significantly less likely to guide their 3-month old baby during play, possibly indicating that time and energy constraints are more likely to bind in these cases.

Our analysis focuses on joint investments, allowing that women either make both investments, neither or one and not the other. In our sample, 36% of mothers make neither investment, 32% breastfeed but do not guide play, 15% do not breastfeed but guide play, and only 18% make both investments when the child is age 3 months (Table 1.1c). We observe a wealth and depression gradient in indicators of joint investments (Table 1.2). We find that 20% of mothers with wealth above the sample median, in contrast to 15% with wealth below the median make both investments, while 33% of wealthier mothers compared with 39% of less wealthy mothers make neither investment. Similarly, 20% of non-depressed mothers in contrast to 11% of depressed mothers make both investments, while 34% of non-depressed mothers and 41% of depressed mothers make neither investment (Appendix Figure A.1).

1.4.2 Expected returns to maternal investments and effort cost

Subjective expectations data. We describe the expectations in more detail before discussing data quality considerations. The individual subjective probabilities for the two maternal investment scenarios and the four developmental outcomes are displayed in Figures 1.1a and 1.1b. The figures reveal considerable heterogeneity in expectations, with probabilities taking all values between 0 and 1. The modal answer is 1 in the high-investment scenario and 0.5 in the low-investment scenario (with the exception of the case of returns to breastfeeding in terms of lower diarrhea). Figures 1.2a and 1.2b transform the data into *expected returns* (i.e., difference in expected outcomes between the high and low investment cases). Three behavioural tendencies emerge from these figures: (*i*) On average, women perceive positive returns to both investments: 74 to 82% of women report higher chances of positive child developmental outcomes with the investment than without[15] – and the expected returns are large, varying between 16 pp (for playing-diarrhea) and 39 pp (for breastfeeding-diarrhea). (*ii*) Breastfeeding is expected to have the largest impact on child health (an average 39 pp expected reduction in the likelihood that the child will experience diarrhea), relative to no breastfeeding. On the other hand, playing is expected to be most effective in influencing learning (with an average increase of 35 pp that the child will learn well at school) and cognitive outcomes (with an average increase of 33 pp that the child will put 2-3 in speaking words by age 2). These differences are all statistically significant at conventional levels.[16] Playing is expected to have only a limited impact on health – notice the large heaping in Figure 1.2b, indicating that 22% expect a zero return. (*iii*) There is substantial heterogeneity in expected returns. For instance, the expected return from breastfeeding on diarrhea is 20 pp in the bottom quartile and 60 pp in the upper quartile. Similarly, the expected return from playing on learning is 10 pp in the bottom quartile and 60 pp in the upper quartile.

[15] An exception is that only 55% of mothers estimate a positive return to playing in terms of reduced incidence of diarrhea. We may have expected most mothers to report zero returns from playing on diarrhea but we see in Figure 1.2b that only 22% did. However, debriefing during the pilot revealed that several respondents reported that playing with the child would, by increasing their time together, enable the mother to spot early signs of diarrhea and act on them quickly.

[16] The difference between the expected return on learning and the expected return on speaking from playing frequently with the child is not statistically significant if calculated as an unpaired sample mean difference, but it is at the 5% level using a paired t-test.

We investigated if the heterogeneity in expected returns is correlated with demographic and socio-economic characteristics of the mother. Simple regressions are in Tables 1.3a and 1.3b, and the corresponding distributions in Appendix Figure A.2. There is an education gradient for most investment-outcome pairs and a wealth gradient for some, in line with the finding of Cunha et al. (2013, 2019) that women of low socio-economic status tend to have downward biased beliefs.[17]

There is no evidence in our sample that depression modifies beliefs, in contrast to the priors set out in De Quidt and Haushofer (2016).[18] We might expect higher parity mothers to have different beliefs than those expecting their first child as they may have had the opportunity to learn from previous children, although this will matter less if they also learn from their peers. However, we find that beliefs of first-time mothers are in general not systematically different from those of more experienced mothers.

We observe that 19% of women report a zero return for at least one investment-outcome pair, which is a plausible answer. More educated mothers are less likely to report four or more zero returns (column 3, Table A.5). A lot of the heterogeneity in expectations is left unexplained by mother characteristics (R-square in Tables 1.3a and 1.3b is always below 0.05). This is typically the case with expectations data, even in other domains.

Data quality considerations. We conduct several validity checks to assess the quality of the expectations data. We started our expectations module with a test

[17]The education gradient is essentially a difference between mothers with no education (15% of the sample) vs some education. For example, mothers with any education at all expect that exclusively breastfeeding for 6 months reduces the probability that a child experiences diarrhea by 8.5pp more than women with no education (column 4, Table 1.3a). Wealth is measured as an index of asset ownership.

[18]We use a binary measure of maternal depression based on each of the SCID and the PHQ-9 following the psychometric literature. There is no gradient even if we use different cut-off of the depression score (Appendix Tables A.4a and A.4b). This may be due to the fact that women answer questions about the technology of skills in their community. But we find similar results when using beliefs about own child and own investment elicited when the child is 36 months in questions related to school readiness and ability to share.

question asking about the likelihood of a woman in their community going to the market (a) in the next 2 days and (b) in the next 2 weeks. The distribution of respondent answers to these questions is displayed in Appendix Figure A.3. The figure shows a clear shift of the distribution to the right when the time horizon increases, highlighting that women recognize that the probability of going to the market is higher the longer the time span. Only 3.3% of respondents violated the monotonicity property of probabilities by reporting a strictly larger likelihood for the shorter time horizon, which is similar to what has been found in other developing country contexts, and at the lower end compared to other surveys in developed countries (Delavande and Kohler, 2009; Delavande et al., 2017).

In addition, item non-response is overall low, at 5.6%. We also investigate the extent to which an individual woman provides the same answer to the series of probabilistic questions, as this might indicate that she is paying limited attention to the questions. Figure A.4 shows the distribution of repeated values of beliefs for the high and low investment levels for the same woman. Only about 10% of women provided four or more repeat combinations of answers in the probabilistic questions out of the eight outcome-investment combinations, and about 20% did not repeat any combinations, which is reassuring.

We would not expect women to report negative returns, as this would suggest that breastfeeding or playing with the child are detrimental to child development indicators, but 22% report more than one negative return. Investigating the characteristics of women who reported negative expected returns, we find they are more likely to have no education and wealth below the median.[19] We will investigate how the model estimates change if we exclude women who report negative returns (see section 1.6).

There are no reliable estimates of the parameters of the actual production function

[19] Among women with no education and wealth below the median, 31% and 28% respectively report more than one negative return, compared to 21% and 16% of women with more than 10 years of education and SES above the median respectively, see Column 4 of Appendix table A.5 for a more detailed picture.

for skills in this context. However, the beliefs data are consistent with the benchmark provided by the Pakistan 2012-2013 Demographic Health Survey (DHS) and data presented in Cunha et al. (2020) for a US sample. The DHS shows that the proportion of children that experienced diarrhea in the two weeks prior to the interview was 25-33% (depending on the child's age), which is similar to the average expected likelihood of frequent diarrhea in our sample when the mother exclusively breastfeeds (25%), or guides play (35%) (Table 1.1b and Appendix Table A.6). Cunha et al. (2020) documents that 72% of children in a US sample spoke partial sentences by the age of 2, comparing well with 70-74% in our sample for the high investment scenario. Women in the US sample expect an 82% chance of a 2-year old speaking a 3-word sentence with high investment and high endowment, which is comparable to our sample. Expectations in the low investment and low endowment scenario in the US sample are also very similar to the expectations under low investments in our sample, at 46%. Although crude, these comparisons suggest that the subjective expectations of sample women are broadly in line with outcome realizations.

Overall, women appear comfortable reporting probabilistic beliefs using the 10 bar scorecard; the vast majority respects basic probabilities properties; we find a socio-economic gradient in expected returns to early-life investments as has been found in other settings (e.g., Boneva and Rauh, 2018; Cunha et al., 2013); and average probabilities of reaching specific milestones are consistent with the available evidence. Moreover, very few women repeat their answers. This gives us confidence in using the expected return data in our empirical analysis.

Expected effort costs of maternal investments. Using a binary indicator of whether the mother reports that the investment is either sometimes or most of the time tiring, we observe that 39% report that breastfeeding is tiring, and 35% report that playing with the child is tiring, see Figure 1.3 and Table 1.1b. Investigating heterogeneity in expected effort costs in Table 1.4 and Appendix Table A.7, we find that more educated mothers are less likely to expect breastfeeding and playing to be tiring. For example, mothers with 6-10 years of education are 13 pp less likely to expect to feel tired from breastfeeding compared to mothers with no education and 21 pp less likely to expect to be tired from playing. The education gradient in breastfeeding is attenuated when controlling for wealth, but the education gradient in playing persists. There is a significant wealth gradient in the expected costs of investment, steeper than for expected returns. Importantly, there is a significant gradient in costs by maternal depression. Depressed mothers are 9.7 pp and 8 pp more likely to expect that breastfeeding and playing, respectively, will be tiring. Also, consistent with intuition, older mothers are more likely to expect playing to be tiring.

We find a tendency for a positive association between expected returns and costs, even after controlling for mothers' characteristics (see Appendix Table A.8). This finding goes against the idea that mothers who anticipate higher returns for an investment internalize the cost of the investment and do not view it as costly. This underlines the importance of collecting effort costs data alongside expected returns data because omitting costs might lead us to over-estimate the role played by expected returns.

1.5 Empirical results

1.5.1 Identification and empirical specification

We seek to estimate the parameters of the utility function described in Section 1.2 using the data described in Sections 1.3 and 1.4. Recall that the mother's problem is to choose the investment levels (e_{i1}, e_{i2}) that maximize her subjective expected utility given in equation (1.2). Therefore, the probability that mother i chooses investment levels $(e_{i1} = j_1, e_{i2} = j_2)$ conditional on household income y_i, expected returns P_i and cost $E_i(C)$ is given by:

$$Pr(e_{i1} = j_1, e_{i2} = j_2 | y_i, P_i, E_i(C)) = \\ Pr\Big[EU_i(y_i, P_i, E_i(C), j_1, j_2) > EU_i(y_i, P_i, E_i(C), t_1, t_2), \\ \forall\ (t_1, t_2) \neq (j_1, j_2)\Big] \quad (1.3)$$

Because of survey time and complexity limitations, we were forced to ask a limited set of questions. We therefore need to make some additional assumptions in order to be able to estimate equation (1.3). We first assume that the mother gets utility level ω_j if the child reaches the milestone for outcome j, and zero otherwise. I.e., $u_{aj}(a_j) = \omega_j I[a_j > \bar{a}_j]$, where $\bar{a}_j$ is a certain level of the outcomes considered (**Assumption 1**). Developmental thresholds are set at the level defined by our belief elicitation questions.[20] Second, although we are making inference using the expected probability distribution of joint investments $P_i(a_i|e_{i1}, e_{i2})$, women were asked their expected returns from individual investments, i.e., $P_i(a_i|e_{i1})$ and $P_i(a_i|e_{i2})$. We assume the mother sets the other investment at the modal value of the investments in the community (i.e., no playing and no exclusive breastfeeding). This assumption is motivated by the fact that the vast majority of respondents report the mode of their distribution of beliefs when asked for a point estimate (Delavande and Rohwedder, 2011) (**Assumption 2**). Our baseline specification assumes that there is no subjective complementarity between the investments, i.e. $P_i(a_i|e_{i1}, e_{i2}) = max(P_i(a_i|e_{i1}), P_i(a_i|e_{i2}))$ (**Assumption 3**), but we test the sensitivity of our results to this assumption in Section 1.6.

We also make some parametric assumptions for the specification of costs as follows

[20] Recall that the milestones are: not experiencing diarrhea frequently, the ability of putting 2-3 words together in speaking by age 2, the chances of playing happily with other children by age 3, and the ability to learn well at school.

(**Assumption 4**):

$$E_i C(e_{i1}, e_{i2}) = \delta_1 I(e_{i1} = 1) \cdot I_i(e_1 \; is \; costly) + \delta_2 I(e_{i2} = 1) \cdot I_i(e_2 \; is \; costly) + \beta_{e1,e2} X_i$$

Where $I(e = 1)$ is a binary indicator function equal to 1 if mother i engages in investment e and $I_i(e \; is \; costly)$ is a binary indicator function equal to 1 if mother i expects investment e to be costly. This means, for example, that mother i expects to incur the cost δ_1 of breastfeeding if she breastfeeds and expects breastfeeding to be tiring. Similarly for the cost δ_2 of playing. Mothers who report that breastfeeding or playing is not tiring have a cost of zero. To capture systematic differences in investments by mothers' characteristics, we also show results that include characteristics X_i in the cost function: the mother's age, education, parity, husband's education, a household-assets wealth index, the gender of the newborn, and baseline depression status.

Assuming the random terms ε_{ei} to be independent for every individual i and investment level $e = (e_{i1}, e_{i2})$ and with a Type I extreme value distribution (**Assumption 5**), we estimate equation (1.3) using a multinomial logit model where the four choices are: (*1*) neither breastfeed nor play with the child, (*2*) breastfeed but not play, (*3*) play but not breastfeed, and (*4*) both breastfeed and play. Using the elicited expected returns and costs data, we make inference on the structural parameters $\omega_j, \delta_j, \beta_{e1,e2}$. The preference parameters ω_j are identified (up to scale) using the variation in expected returns across choices and mothers, while the cost parameters δ_j are identified using the variation in expected effort costs across choices and mothers. While the multinomial logit model has been widely used for the modeling of multiple choices, its assumptions could prove demanding for our specification of joint investments. We address this concern by also estimating a mixed logit model that relaxes the

Independence of Irrelevant Alternatives (IIA) assumption.

1.5.2 Baseline estimates

The estimates of the multinomial logit model are displayed in Table 1.5, and they are consistent with mothers valuing child developmental outcomes. We first show results assuming that mothers only value one of the four developmental outcomes (one at a time), and then we present estimates allowing all developmental outcomes to enter the mother's utility function. First, consider results for the ability to speak (columns 1 without controls in the cost function and column 2 with controls). The preference parameter ω_s is the coefficient associated with beliefs concerning the returns to breastfeeding and playing in terms of the ability to speak. It is positive and statistically significant, suggesting that maternal investment choices are determined by mothers' subjective beliefs about returns to investments *and* that they care about this developmental dimension. The estimated cost of playing, δ_2, is negative and significant, suggesting that mothers who find playing costly are less likely to play. The estimated cost of breastfeeding, δ_1, is not statistically different from zero, suggesting that the cost of breastfeeding is not a deterrent to exclusively breastfeeding a newborn at the age of 3 months in our sample.

Columns (3) to (8) of table 1.5 show the estimates when we consider each of the other child developmental outcomes individually. The preference parameter for health (defined as diarrhea incidence, columns 3-4) is positive but about a third smaller in magnitude than the preference parameter for speaking, and is not precisely estimated. The preference parameters for socio-emotional development (defined as the child playing happily with other children by age 3, columns 5 and 6), is also positive, only slightly smaller in magnitude than the one associated with speaking, and borderline significant (p-value=0.074 without controls and 0.111 with controls). On the other hand, the preference parameter for learning (defined as the ability of a child to learn well in school, columns 7 and 8) is the largest in size, almost twice the size of the preference parameter for speaking, and statistically significant at the 1% level.

Controlling for mother-level covariates in the cost function does not change the magnitude or precision of the preference and cost parameters (see the first vs the second column for each outcome). As a matter of fact, maternal characteristics explain little of the variation in investments (see Table A.9, which presents the effect of mother's characteristics for all investments compared to no play and no breastfeeding). Wealthier women are more likely to make both investments (breastfeeding and play), as opposed to making no investment. On the other hand, women who were diagnosed with depression are less likely to make both investments, and women who already have at least two other children are less likely to choose playing and no breastfeeding.

We next estimate equation (1.3) by considering the child's health, cognitive, psycho-emotional, and learning outcomes jointly in the decision-making process, see columns (9) and (10) of table 1.5. Now only the preference parameter for learning well at school is statistically significantly different from zero at 1%. A reason for the dominance of this outcome may be that doing well at school requires success with the other outcomes – it requires cognitive ability (putting 2-3 words together by age 2), being healthy (lower diarrhea) and being socially well-grounded (playing happily with other children by age 3), so it may in fact incorporate concern over these other outcomes. Interestingly, the ordering of the estimated preference parameters is in line with self-reported valuations of developmental outcomes that we also elicited. In our sample, 80% of mothers responded that the ability of a child learning well is very important for a child's development, in contrast with a share of 64 to 67% for the other outcomes (table 1.1a), and this difference is statistically significant at the 1%

level.[21]

In all the specifications in Table 1.5, we find a negative and precisely estimated cost for playing, while the cost for breastfeeding is not precisely estimated.

Goodness of fit. We assess the fit of the estimated model by comparing actual investments to the model-predicted probability of the investments. See Appendix Table A.10, which shows that the model fit is very good not only overall but, importantly, for a number of sub-samples.

1.5.3 Choice elasticity

We next use the model parameter estimates to analyze the predicted responsiveness of investment choice to changes in expected returns and costs. We focus on the specification that estimates the preference parameters for all developmental outcomes jointly (Column 10, Table 1.5), and report results for expected returns in terms of the probability of a child learning well at school.

Results are shown in Table 1.6. A 1% increase in the expected return to breastfeeding increases by 0.47% the predicted probability that a woman decides only to breastfeed, and reduces the probability of neither breastfeeding nor playing by 0.23%. A 1% increase in the expected return to playing with the child increases the predicted probability of playing by 0.62%, which is the same increase in the probability of making both investments when the expected return from both increases by 1%.

We next look at the elasticity of investments to expected costs (last column of Table 1.6). A 1% increase in the cost of playing (playing becomes more tiring as opposed to not tiring) reduces the predicted probability of a mother playing with the child by 0.15% (irrespective of whether or not she also breastfeeds). Since we found

[21] We refrain from drawing conclusions about the mother's ranking of preferences for educational attainment or language development over health, recognizing that our marker for health at 3-month (frequent diarrhea) is only one indicator of health, and one that, in poor communities in Pakistan, is so common that it may be regarded as "natural".

no evidence that the perceived costs of breastfeeding influence mother's choices, we do not explore responsiveness to this cost.

The elasticities with respect to expected returns are about 4 to 5 times larger than in studies investigating the elasticities of educational choices to expected earnings (Arcidiacono, 2004; Delavande and Zafar, 2019; Wiswall and Zafar, 2015). For example, also in Pakistan, Delavande and Zafar (2019) report elasticities of 0.12. There are no previous studies on the elasticity of maternal investment with respect to perceived costs.

1.5.4 Willingness to pay

Our estimates have shown that mothers value child developmental outcomes, most of all learning well at school, and that they incur an effort cost of playing. In this section, we seek to monetize these results. We calculate the factor g by which family income would need to be increased to keep the mother's utility constant when the probability of her child's outcome j decreases from π_1 to π_2, i.e. we solve:

$$\beta ln(y_i) + \pi_1 u_{ji}(j) = \beta ln(y_i \cdot g) + \pi_2 u_{ji}(j)$$

Table 1.7 displays the results. We take the average of the three coefficients associated with income from the multinomial logit results and evaluate income at the sample mean and median. We estimate that mothers would be willing to forgo 60% of monthly household income to increase the probability of their child learning well at school by 10 pp, and 41% to reduce by 10 pp the effort cost of playing.[22]

These estimates are useful in affording a metric with which to compare the relative importance of expected returns and costs, but we are wary of interpreting them as a

[22] For this exercise we replace the asset-based index proxying wealth with the log of household income in the baseline estimation. Appendix table A.11 shows that the estimated preference and cost parameters are similar to the main results in Table 1.5.

measure of the absolute willingness to pay as this will depend on factors such as the period over which the mother obtains utility, and the period for which the investments are made.

1.5.5 Heterogeneity in preferences

So far, we have assumed that all mothers have the same preference parameters for child development ω_j and effort cost parameters δ_j. We now relax this assumption to evaluate whether heterogeneity in preferences over child developmental outcomes explains heterogeneity in investment decisions. We do this in two ways. First, we estimate a mixed logit model where the parameters ω_j are assumed to have a normal distribution.[23] The mixed logit relaxes the Independence of Irrelevant Alternatives (IIA) imposed by the multinomial logit. The results in Appendix Table A.12 indicate no heterogeneity in preferences for child development, as we systematically reject the hypothesis that the variance of the normal distribution of ω_j is different from zero. Second, we interact the expected returns and effort costs with mother characteristics, allowing ω_j, δ_1 and δ_2 to be different for mothers with high and low education levels (Column 1), high and low wealth (Column 2), and for depressed and non-depressed mothers (Column 3), see Table 1.8. In general, we find limited evidence of heterogeneity by these characteristics.[24]

All in all, these results point to limited if any systematic differences in mothers' valuations of child development outcomes, suggesting that differences in expected returns and effort costs are the main drivers of the observed differences in investment levels in children. This is in contrast to Cunha (2014) that finds that white parents value children developmental outcomes significantly more than black parents in the

[23]When estimating the mixed logit model we replace the categorical variables of education and parity with their continuous version in order to achieve convergence.

[24]There is a statistically significant difference in the health preferences parameter by depression status, but the estimates for each group are not statistically significantly different from zero. There is some evidence that less wealthy mothers value speaking more, and value health less.

US based on hypothetical choice questions. Using simulations, he concludes that heterogeneity in preferences is important to understand the racial gap in parental investments.

1.6 Robustness checks

This section reports a series of validation and specification checks designed to assess the robustness of our results.

Investment constraints

We first discuss time constraints and then physiological constraints on breastfeeding. The maximization problem stated in equation (1.3) abstracts away from time constraints. We allow for this to some extent by introducing expected effort costs, but it is possible that women who report a low expected cost when queried in pregnancy discover an actual time constraint when breastfeeding or playing 3 months after birth. If women were in fact time-constrained in their investment choices, we would expect them not to be able to act on their subjective expected returns. In this case, the coefficient associated with the beliefs would not be precisely estimated, but this is not what we see in Table 1.5.

Still, if some women are more constrained than others, the coefficients we estimate may be biased. We investigate this by allowing the coefficients associated with beliefs (ω) to vary with the a priori likelihood that a mother experiences different time constraints. First, we compare mothers living with an older female child (62% of the sample), and the rest. Given anecdotal evidence that older girls help the mother with household chores and childcare, we expect they contribute to relaxing time constraints. For the same reason, we group mothers by whether or not the child's grandmother lives in the household (55% of the sample). Third, we compare women who live in farming households (60% of the sample) with those who do not, as women often contribute to farm labour, tightening time constraints. We find no systematic significant differences across these groups (Appendix Table A.13). While this evidence is not conclusive, it is consistent with non-binding time constraints.

We have implicitly assumed that exclusive breastfeeding is a choice. However, some mothers may be unable to breastfeed for a number of medical or physiological reasons. To investigate this, we restrict the sample to women that report always having had enough money to buy food during pregnancy, and then to women with weight above the 10^{th} percentile at the time the investments were measured (3 months). Appendix Table A.14 shows that the estimates for these relatively unconstrained samples are qualitatively very similar to those in Table 1.5. We are unable to test constraints imposed by the health of the child as we do not have childbirth weight or any other measure of their ability to breastfeed.

Complementarity of the investments

The baseline estimation assumes that there is no (subjective) complementarity of the investments (Assumption 3). We now discuss how we assessed this assumption after the data used in the main analysis were collected. We recruited a different sample of twenty women in Pakistan of similar background to the women in this study, and elicited from them their probabilistic beliefs about the returns from making joint investments while also asking them the original questions with the investments presented independently.[25] Using responses to both sets of questions we can estimate perceived complementarities between breastfeeding and playing and correct our estimates in the main sample accordingly. More specifically, we seek to identify θ in the

[25] Women were asked the likelihood of a specific developmental outcome occurring when (*i*) the mother does not play and does not breastfeed, (*ii*) the mother breastfeeds but does not play, (*iii*) the mother does not breastfeed but plays, and (*iv*) the mother both breastfeeds and plays. We gratefully thank Ammara Riaz and Ayesha Riaz for invaluable help in the implementation of the questionnaire in the field.

following equation:

$$P_i(a_i|e_{i1} = 1, e_{i2} = 1) = max\big(P_i(a_i|e_{i1} = 1), P_i(a_i|e_{i2} = 1)\big) + \theta min\big(P_i(a_i|e_{i1} = 1), P_i(a_i|e_{i2} = 1)\big) \quad (1.4)$$

Data from this small pilot reveal an estimated θ of 0.018, or that mothers expect a complementarity among investments of 1.8%. We replicated Table 1.5 using equation (1.4) to evaluate $P_i(a_i|e_{i1} = 1, e_{i2} = 1)$ instead of relying on assumption 3. We present estimates with the estimated θ of 1.8% and, to analyze sensitivity to the alternative values also 5% and 10%, see Appendix Table A.15. The model estimates are very similar to those obtained using the baseline specification assuming no complementarity, and this is the case independently of the level of complementarity assumed.

Sensitivity to samples

We excluded treated women because of concerns that the intervention might have directly encouraged women to increase investments. As a robustness check, we re-estimated the model including treated mothers. The estimates are similar to those in Table 1.5, see Column (1) of Appendix Table A.16.

As discussed in Section 1.3.2, while the elicited beliefs data are on average of high quality, some women report negative expected returns from undertaking the investments. We assess the robustness of our results to how we treat these answers. First, we exclude mothers who expect more than one negative return out of eight, and the results are very similar to those in Table 1.5, see column (2), Appendix Table A.16. In an alternative specification where we use the whole sample, we replace negative returns with zero returns.[26] Again, we obtain very similar results to Table 1.5, see column (3), Appendix Table A.16.

[26] This affects 8 to 11% of the sample, depending on the outcome and investment. One exception is experiencing diarrhea with the playing investments, where this affects 24% of the sample.

Alternative definitions of play

We investigate the robustness of our results to alternative definitions of the play investment. Instead of using one item from the HOME inventory, we use: (*i*) the overall HOME score; (*ii*) a score based on items related to stimulation (i.e., those from the Responsivity and Involvement sections); (*iii*) the first principal component (PCA) of the items related to stimulation. We assume that women in the top tertile in terms of these measures are those who play frequently to make it comparable to our current main playing variable. See Data Appendix B for details. Table 1.9 shows that the results using these 3 other definitions for play are very similar to our baseline results.

Alternative specifications

Our main specification assumes that investments entail effort costs, but some women may instead derive utility from playing and breastfeeding (Caucutt et al., 2017). In fact, in the survey, 80% of mothers report they found playing and breastfeeding enjoyable "most of the time." We re-estimated the model generalizing the cost function to allow that making the investments is enjoyable, see Column (4) of Appendix Table A.16. We find that self-reported enjoyment does not predict the investment choices.

We elicited expected return and effort cost in pregnancy to avoid feedback effects from behaviour to beliefs/cost. However, our main sample includes mothers of all parity, including women who may have had the opportunity to learn from earlier pregnancies. This could bias the preferences parameters if women endowed with high expected returns were more likely to have invested and revised their beliefs upward. As a robustness check we re-estimated the model restricting the sample to mothers who were pregnant with their first child at baseline; see columns (5-6), Appendix Table A.16. Although slightly less precise, the results are similar.

Finally, we also replicate our baseline model without using weights, and again, the results are robust (column 7, Table A.16).

Within-village correlations of beliefs, cost and investments

Subjective expectations of returns and effort costs may respond to social norms. And the questions eliciting returns from individual women were phrased to ask her what she thought the returns for a generic woman in her community would be. To the extent that women live in close-knit communities, their investment behaviours may also be similar. This generates the concern that a spatial correlation in beliefs and investments could generate the results in Table 1.5 without women acting on their beliefs. To investigate this, we analysed the variation in beliefs, costs, and investments between and within villages. See Figure A.5, where panel (a) depicts a box plot of the expected return on "learning well" from breastfeeding for each of the 40 villages under study, showing considerable within village variation. Although not shown, similar variation is evident for the other developmental outcomes and investments. Panel (b) shows that there is also a lot of within village variation in the expected costs and investment realizations. Overall, this undermines the concern.

1.7 Policy experiments

We use the estimated preference parameters to simulate mothers' behavioural responses to a series of different plausible policy interventions targeted at increasing breastfeeding and stimulation during early-life. These include interventions that manipulate expected returns, effort costs, mother's education, and depression status. The simulations assume that all women fully comply with the intervention (e.g., they fully revise their expectations, they all recover from depression, etc.), and the results we present will therefore constitute the upper bound of the effects of an actual policy.

The estimates are in Table 1.10 for the full sample and in Appendix Tables A.17a and A.17b for various subsamples. Column (0) shows the baseline distributions of investments predicted by the multinomial logit model (Table 1.5, column 10) before any of the policies are introduced. We first discuss the average predicted probabilities of making the four possible investments under different **information interventions**, see columns (1)-(3). The first intervention shifts the expected returns of less wealthy mothers to the average of wealthy mothers (i.e., above median wealth index). This has limited impacts on overall investments, consistent with the raw data showing only moderate differences in expected returns across wealth groups (7.3 pp on average) as well as with the heterogeneity in expected returns within the low wealth group. The second raises the expected return to each investment by 10 pp for all women. Now the predicted probabilities of breastfeeding and playing increase by 1.4 pp (2.9% of baseline) and 0.9 pp (2.9% of baseline), respectively. The third intervention raises beliefs by increasing the expected return to each investment by the interquartile range of the average expected return from single investments (an increase of 43 pp on average).[27] We now see large increases in the probabilities of breastfeeding and playing of 6.3 pp (13%) and 3.8 pp (12.4%) respectively. Overall, a large increase in expected returns is required to obtain a large increase in investments.

We next simulate results of eliminating effort costs of playing. We notionally ascribe this to the creation of a **mother group** or **playgroup** in the community, where effort is pooled and mothers feel supported, see column (4). This is associated with an increase of 3.8 pp (12.4% of baseline) in the predicted probability of play, and a corresponding reduction in the predicted probability of not making either investment of 2 pp (5.7%).

We then combine first the second and then the third information intervention with the cost alleviating intervention. The predicted probability of playing increases by 4.8

[27] The expected probability of achieving a developmental outcome cannot be higher than 1. In the scenario in which the new computed expected probability would violate this, we obtain the desired increase in expected returns by lowering the expected probability of achieving the developmental milestone when mothers do not invest.

pp (15.3%) in the former case, and by 7.9 pp (25.5%) in the latter. Note that the effect of combining the two policies is slightly larger than their separate effect (e.g., 7.9 pp in column 6 versus 3.8+3.8=7.6pp in columns 3 and 4). This is suggestive that effort costs might prevent mothers from fully acting on newly acquired beliefs. Overall, a fairly large effect on playing can be achieved by jointly increasing perceived returns and lifting effort costs. This combined intervention is also effective at reducing the gaps in investment across groups. It reduces by about two-thirds the gap in playing between low and high educated mothers, low and high SES, and depressed and non-depressed (see Appendix Table A.17a).

The next simulation investigates impacts of an intervention that **treats maternal depression**, column (7). We posit that treated women are affected in three ways: the covariate indicating depression is set to zero, their expected costs are set to the average cost of non-depressed mothers, and their expected returns are set to the average returns reported by non-depressed mothers. In the subsample of depressed mothers, treating depression has, as we may expect, larger effects: an increase of 3.7 pp (7.9% of baseline in this sample) in breastfeeding and 8.2 pp (34.6%) in playing, see Appendix Table A.17a, panel A, column (7). Treating depression is the policy with the largest effects in this subsample, where investments are low at baseline, with effects similar to that of the intervention that simultaneously targets an increase in expected returns and elimination of psychic costs. This is consistent with the results in Baranov et al. (2019), who find that mothers treated for depression make larger time-intensive and monetary investments in children as long as seven years after the end of the intervention.

Finally, we consider an **education** program that results in all women achieving at least ten years of education. The education covariate is set to 10+ years and, at the same time, the expected beliefs and costs of less-educated women are set to the averages for women with 10 or more years of education. We see fairly limited effects on average (column 8, Table 1.10), though the effects are larger among the subsample of less-educated mothers (Appendix Table A.17a, column 8, panel B): for example, educating mothers increases playing by 3 ppt (10.1% of baseline in this subsample). Education is a relatively costly program compared, for instance, with providing information on returns and creating a playgroup in the community. However, education is likely to have benefits beyond the making of investments, for instance, on choices that influence the mother's own wellbeing.

We see larger effects of some of these policies on women who report zero or negative returns (panel D of Appendix Table A.17b) and on women who report high effort costs (panel E).[28] Among women who expect to find breastfeeding or playing costly most of the time, the mother group intervention increases play by 9.8 pp (41.5% of baseline), and the intervention that simultaneously increases returns and lowers costs increases play by 13.8 pp (58.5%). This is the largest increase among all the policies and subsamples we consider. While targeting interventions to these more responsive groups is currently difficult, if future household surveys elicit expected returns and costs, this problem may be alleviated.

Overall, our simulations suggest that providing information that increases women's subjective expected returns, alleviating psychic or effort costs, treating depression, and educating women all tend to increase maternal investment in children. Moreover, the returns to intervening are higher in the subgroups that are most treatable on account of low expected returns, high expected costs, baseline maternal depression, or low levels of maternal education.

[28]For example, the information intervention that moves the expected returns of low SES women up to the expected returns of wealthy women yields an increase of 2.3 ppt (5.3%) for breastfeeding and 1.3 ppt (5.2% of baseline) for play among women who report at least two expected zero or negative returns (column 1, panel D), while this increase was of the order of 0.2 ppt and 0.3 ppt respectively in the aggregated sample.

1.8 Conclusions

Heterogeneity in maternal investments may be driven by differences in expectations about returns to investments, preferences for child development outcomes, and financial as well as psychic resources. We investigate the role of subjective expectations of returns to and effort costs of the two main investments that mothers make in newborns. We find that differences in maternal beliefs regarding the technology of skills formation, and differences in perceived effort costs associated with investments in children both contribute to explaining the observed variation in maternal investments across families. We find limited evidence of heterogeneity in preferences over early child development outcomes in rural Pakistan, which suggests that mothers value these outcomes similarly.

We provide the first evidence for maternal investments in newborns in a developing country of the links between socio-economic status, expected returns, and investments, complementing recent work on US and UK data (Boneva and Rauh, 2018; Cunha et al., 2013). We also provide the first estimates in any context that a mother's perceived cost of effort constrains her investment. Moreover, we identify one important predictor of perceived costs among mothers of newborns, which is perinatal depression.

Simulation exercises suggest that policies aimed at increasing the mother's beliefs about returns and alleviating effort costs, through providing information on returns, creating mothers' groups, or treating postnatal depression, can substantially raise average investment levels. Future research is needed to better understand how to change women's expected returns. First, not all beliefs are equally responsive to information (Ciancio et al., 2020). Second, large effects on investments requires large changes in beliefs. More work is also needed to identify the most cost-effective way to alleviate effort cost among new mothers, especially in low-income settings where poverty and depression are widespread.

1.9 Figures

Figure 1.1a: Subjective probabilities of developmental outcomes by breastfeeding investment level

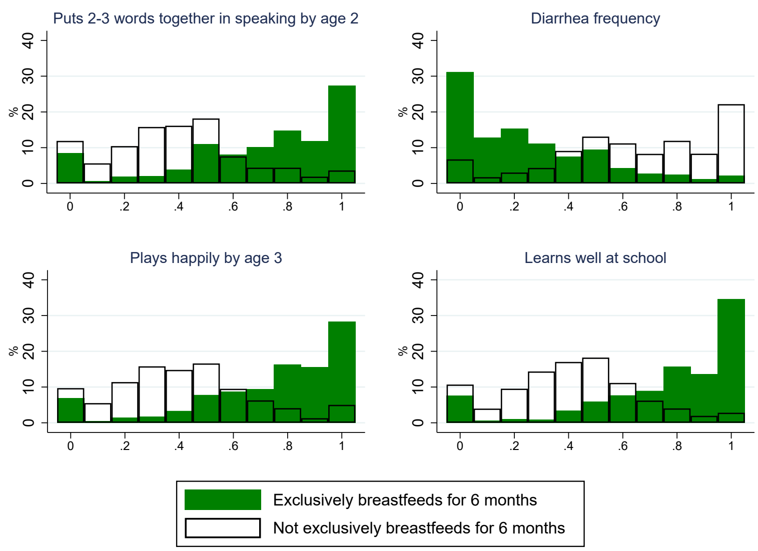


Figure 1.1b: Subjective probabilities of developmental outcomes by playing investment level

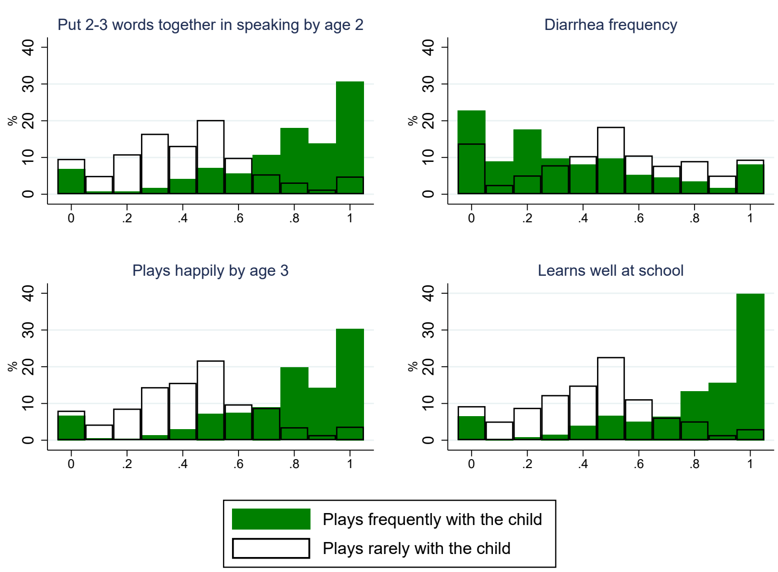
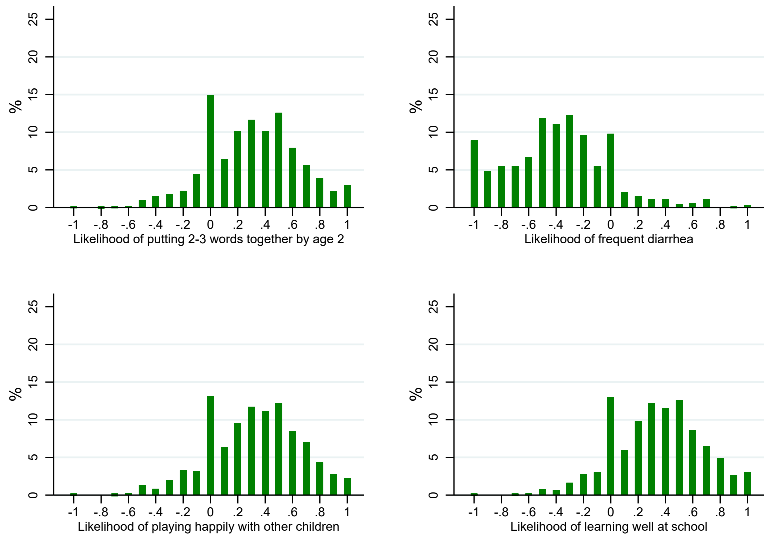
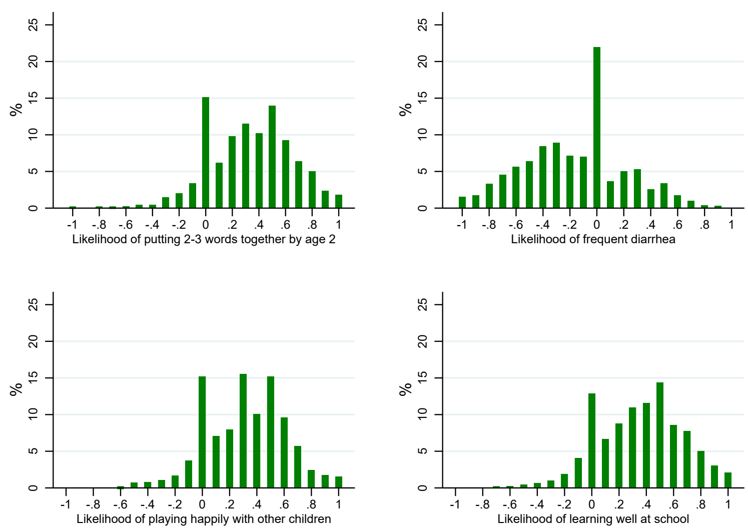


Figure 1.2a: Expected return from exclusively breastfeeding



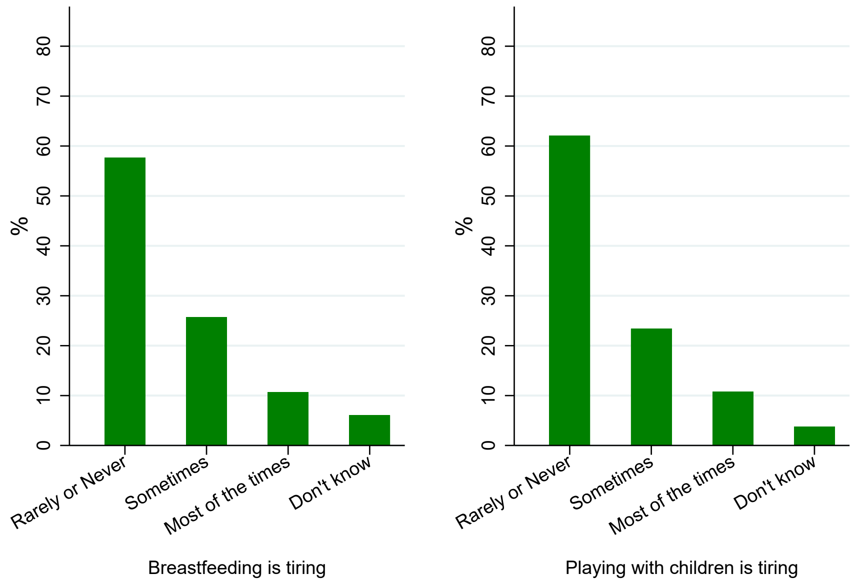
Note: Individual differences in the subjective probability of children achieving developmental outcomes when a mother exclusively breastfeeds for 6 months versus if a mother does not exclusively breastfeeds for 6 months.

Figure 1.2b: Expected return from playing with child



Note: Individual differences in the subjective probability of children achieving developmental outcomes when a mother plays frequently with her child versus if a mother plays rarely with her child.

Figure 1.3: Distribution of investments' effort cost



1.10 Tables

Table 1.1a: Baseline sample descriptives (mothers' and households' characteristics)

	(1) Non-weighted	(2) Weighted at baseline	(3) Weighted at 3 months	(4) Diff (1)-(2)	(5) Diff (2)-(3)	(6) Diff (1)-(3)
Mothers' age (years)	26.71	26.58	26.65	0.13	−0.07	0.06
	(4.54)	(4.44)	(4.51)	(0.19)	(0.20)	(0.20)
Mother's education (years)	7.70	8.04	8.03	−0.34*	0.00	−0.33*
	(4.48)	(4.45)	(4.48)	(0.19)	(0.20)	(0.20)
Husband's education (years)	8.63	8.83	8.90	−0.20	−0.07	−0.28*
	(3.42)	(3.38)	(3.30)	(0.14)	(0.15)	(0.15)
Parity	2.58	2.48	2.45	0.10*	0.03	0.13**
	(1.51)	(1.46)	(1.43)	(0.06)	(0.06)	(0.07)
Household's income (US dollars)	214.23	224.58	225.72	−10.35	−1.14	−11.49
	(170.30)	(177.32)	(181.18)	(8.74)	(9.72)	(9.56)
Mother normally works	0.06	0.06	0.06	0.00	0.00	0.00
	(0.24)	(0.24)	(0.23)	(0.01)	(0.01)	(0.01)
Woman is depressed	0.49	0.30	0.30	0.19***	0.00	0.19***
	(0.50)	(0.46)	(0.46)	(0.02)	(0.02)	(0.02)
Depression score	8.67	6.39	6.32	2.28***	0.06	2.35***
	(6.71)	(6.17)	(6.07)	(0.27)	(0.27)	(0.29)
High SES (above median)	0.50	0.54	0.55	−0.04**	−0.01	−0.05**
	(0.50)	(0.50)	(0.50)	(0.02)	(0.02)	(0.02)
Item non-response rate	0.06	0.06	0.06	−0.01	0.00	−0.01
	(0.23)	(0.24)	(0.24)	(0.01)	(0.01)	(0.01)
Mother's education (categorical)						
Education: 0 years	0.15	0.13	0.13	0.02	−0.00	0.01
	(0.35)	(0.34)	(0.34)	(0.01)	(0.02)	(0.02)
Education: 1-5 years	0.20	0.18	0.18	0.02	−0.00	0.02
	(0.40)	(0.38)	(0.38)	(0.02)	(0.02)	(0.02)
Education: 6-10 years	0.44	0.45	0.45	−0.01	0.00	−0.01
	(0.50)	(0.50)	(0.50)	(0.02)	(0.02)	(0.02)
Education: +10 years	0.22	0.24	0.24	−0.02	−0.00	−0.02
	(0.41)	(0.43)	(0.43)	(0.02)	(0.02)	(0.02)
Parity (categorical)						
Child in womb: 1st	0.29	0.31	0.31	−0.02	−0.00	−0.02
	(0.45)	(0.46)	(0.46)	(0.02)	(0.02)	(0.02)
Child in womb: 2nd	0.26	0.27	0.27	−0.01	−0.00	−0.01
	(0.44)	(0.44)	(0.45)	(0.02)	(0.02)	(0.02)
Child in womb: 3rd or higher	0.45	0.42	0.42	0.03	0.00	0.03
	(0.50)	(0.49)	(0.49)	(0.02)	(0.02)	(0.02)
Stated preferences						
Importance speaking	0.63	0.64	0.63	−0.01	0.00	−0.00
	(0.48)	(0.48)	(0.48)	(0.02)	(0.02)	(0.02)
Importance diarrhea	0.67	0.67	0.66	0.00	0.00	0.01
	(0.47)	(0.47)	(0.47)	(0.02)	(0.02)	(0.02)
Importance playing	0.66	0.67	0.66	−0.01	0.00	−0.00
	(0.47)	(0.47)	(0.47)	(0.02)	(0.02)	(0.02)
Importance learning	0.79	0.80	0.80	−0.01	0.00	−0.01
	(0.41)	(0.40)	(0.40)	(0.02)	(0.02)	(0.02)
Observations	1154	1154	871			

Note: Stated preferences reflect the level of importance that mothers attach to the developmental milestones under study (putting 2-3 words together in speaking by age 2, the frequency of diarrhea episodes, playing happily by age 3, and learning well in school) in promoting a child's development (mentally and physically) in the future, and depict the share of mothers that consider the specific milestone to be very important against unimportant, little important, moderately important, or just important.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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Table 1.1b: Baseline sample descriptives (beliefs and costs)

	(1) Non-weighted	(2) Weighted at baseline	(3) Weighted at 3 months	(4) Diff (1)-(2)	(5) Diff (2)-(3)	(6) Diff (1)-(3)
Likelihood of putting 2-3 words in speaking by age 2						
If the mother exclusively breastfeeds for 6 months	0.70	0.70	0.70	−0.00	0.00	0.00
	(0.30)	(0.30)	(0.31)	(0.01)	(0.01)	(0.01)
If the mother does not exclusively breastfeed for 6 months	0.39	0.39	0.39	0.00	0.00	0.00
	(0.25)	(0.25)	(0.25)	(0.01)	(0.01)	(0.01)
If the mother plays with the child frequently	0.74	0.74	0.73	−0.00	0.01	0.01
	(0.28)	(0.28)	(0.29)	(0.01)	(0.01)	(0.01)
If the mother plays with the child rarely	0.42	0.41	0.41	0.00	0.00	0.00
	(0.24)	(0.25)	(0.25)	(0.01)	(0.01)	(0.01)
Likelihood of diarrhea episodes						
If the mother exclusively breastfeeds for 6 months	0.25	0.25	0.25	0.00	−0.00	−0.00
	(0.25)	(0.26)	(0.26)	(0.01)	(0.01)	(0.01)
If the mother does not exclusively breastfeed for 6 months	0.64	0.64	0.64	0.00	0.00	0.00
	(0.30)	(0.30)	(0.31)	(0.01)	(0.01)	(0.01)
If the mother plays with the child frequently	0.35	0.34	0.35	0.01	−0.01	0.00
	(0.31)	(0.31)	(0.31)	(0.01)	(0.01)	(0.01)
If the mother plays with the child rarely	0.51	0.50	0.50	0.01	0.00	0.01
	(0.30)	(0.30)	(0.31)	(0.01)	(0.01)	(0.01)
Likelihood of playing happily by age 3						
If the mother exclusively breastfeeds for 6 months	0.73	0.73	0.73	−0.00	0.00	0.00
	(0.28)	(0.28)	(0.29)	(0.01)	(0.01)	(0.01)
If the mother does not exclusively breastfeed for 6 months	0.41	0.41	0.41	−0.00	0.00	0.00
	(0.25)	(0.26)	(0.26)	(0.01)	(0.01)	(0.01)
If the mother plays with the child frequently	0.75	0.75	0.75	−0.00	0.01	0.00
	(0.28)	(0.28)	(0.28)	(0.01)	(0.01)	(0.01)
If the mother plays with the child rarely	0.43	0.43	0.43	−0.00	0.00	0.00
	(0.24)	(0.24)	(0.24)	(0.01)	(0.01)	(0.01)
Likelihood of learning well						
If the mother exclusively breastfeeds for 6 months	0.75	0.75	0.75	0.00	0.00	0.01
	(0.29)	(0.29)	(0.30)	(0.01)	(0.01)	(0.01)
If the mother does not exclusively breastfeed for 6 months	0.41	0.41	0.41	−0.00	−0.00	−0.00
	(0.24)	(0.24)	(0.25)	(0.01)	(0.01)	(0.01)
If the mother plays with the child frequently	0.78	0.78	0.77	−0.00	0.01	0.01
	(0.28)	(0.29)	(0.29)	(0.01)	(0.01)	(0.01)
If the mother plays with the child rarely	0.43	0.43	0.42	0.00	0.00	0.00
	(0.24)	(0.24)	(0.24)	(0.01)	(0.01)	(0.01)
Expected return of breastfeeding						
On speaking	0.30	0.30	0.30	−0.00	−0.00	−0.00
	(0.33)	(0.33)	(0.33)	(0.01)	(0.02)	(0.02)
On diarrhea	0.39	0.39	0.39	0.00	0.00	0.00
	(0.37)	(0.38)	(0.38)	(0.02)	(0.02)	(0.02)
On playing happily	0.32	0.32	0.32	−0.00	0.00	0.00
	(0.33)	(0.33)	(0.33)	(0.01)	(0.02)	(0.02)
On learning well	0.34	0.34	0.33	0.00	0.01	0.01
	(0.33)	(0.32)	(0.33)	(0.01)	(0.02)	(0.02)
Expected return of playing						
On speaking	0.33	0.33	0.32	−0.00	0.01	0.00
	(0.31)	(0.32)	(0.32)	(0.01)	(0.01)	(0.01)
On diarrhea	0.16	0.16	0.15	−0.00	0.01	0.01
	(0.38)	(0.38)	(0.39)	(0.02)	(0.02)	(0.02)
On playing happily	0.31	0.32	0.31	−0.00	0.01	0.00
	(0.29)	(0.29)	(0.29)	(0.01)	(0.01)	(0.01)
On learning well	0.35	0.35	0.34	−0.00	0.01	0.00
	(0.31)	(0.31)	(0.31)	(0.01)	(0.01)	(0.01)
Costs of investments						
Breastfeeding is tiring	0.41	0.39	0.39	0.02	−0.01	0.02
	(0.49)	(0.49)	(0.49)	(0.02)	(0.02)	(0.02)
Playing is tiring	0.38	0.35	0.36	0.02	−0.01	0.02
	(0.49)	(0.48)	(0.48)	(0.02)	(0.02)	(0.02)
Either breastfeeding or playing is tiring	0.51	0.48	0.49	0.03	−0.00	0.02
	(0.50)	(0.50)	(0.50)	(0.02)	(0.02)	(0.02)
Observations	1154	1154	871			

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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Table 1.1c: Follow-up sample descriptives (investments)

	(1) Non-weighted	(2) Weighted at baseline	(3) Weighted at 3 months	(4) Diff (1)-(2)	(5) Diff (2)-(3)	(6) Diff (1)-(3)
Attrition rate	0.23	0.23	0.24	0.00	−0.01	−0.01
	(0.42)	(0.42)	(0.43)	(0.02)	(0.02)	(0.02)
Investments						
Exclusively breastfed last 24 hr	0.48	0.49	0.49	−0.01	−0.00	−0.01
	(0.50)	(0.50)	(0.50)	(0.02)	(0.03)	(0.03)
Guided play	0.31	0.33	0.33	−0.02	0.00	−0.02
	(0.46)	(0.47)	(0.47)	(0.02)	(0.02)	(0.02)
Joint investments						
Not breastfeeding and not playing	0.37	0.36	0.36	0.01	0.00	0.01
	(0.48)	(0.48)	(0.48)	(0.02)	(0.02)	(0.02)
Breastfeeding and not playing	0.32	0.31	0.32	0.01	−0.00	0.01
	(0.47)	(0.46)	(0.47)	(0.02)	(0.02)	(0.02)
Not breastfeeding and playing	0.15	0.15	0.15	−0.00	0.00	−0.00
	(0.36)	(0.36)	(0.36)	(0.02)	(0.02)	(0.02)
Breastfeeding and playing	0.16	0.18	0.18	−0.02	−0.00	−0.02
	(0.37)	(0.38)	(0.38)	(0.02)	(0.02)	(0.02)
Observations	1154	1154	871			

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 1.2: Heterogeneity in joint investments

	(1) no-bf, no-pl	(2) no-bf, no-pl	(3) bf, no-pl	(4) bf, no-pl	(5) no-bf, pl	(6) no-bf, pl	(7) bf, pl	(8) bf, pl
Education: 1-5 years	−0.082	−0.066	0.028	0.050	0.025	0.004	0.029	0.012
	(0.062)	(0.065)	(0.058)	(0.056)	(0.049)	(0.052)	(0.046)	(0.044)
Education: 6-10 years	−0.016	0.031	0.010	0.057	0.012	−0.025	−0.006	−0.063
	(0.059)	(0.064)	(0.046)	(0.054)	(0.043)	(0.052)	(0.046)	(0.053)
Education: +10 years	−0.122*	−0.049	−0.011	0.067	0.095*	0.034	0.038	−0.051
	(0.062)	(0.066)	(0.054)	(0.069)	(0.050)	(0.070)	(0.052)	(0.063)
Age (years)	−0.046	−0.051	0.009	−0.003	−0.010	0.015	0.046	0.039
	(0.043)	(0.045)	(0.047)	(0.049)	(0.033)	(0.036)	(0.031)	(0.031)
Age squared	0.001	0.001	−0.000	0.000	0.000	−0.000	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Index child is female	0.012	0.015	−0.012	−0.009	0.001	−0.003	−0.001	−0.003
	(0.034)	(0.033)	(0.030)	(0.031)	(0.030)	(0.030)	(0.025)	(0.025)
Husband's education (years)		−0.001		−0.005		0.002		0.004
		(0.008)		(0.008)		(0.005)		(0.006)
Asset-based SES		−0.019		−0.012		0.006		0.026**
		(0.017)		(0.019)		(0.010)		(0.012)
Child in womb: 2nd		−0.009		0.042		−0.102**		0.069*
		(0.060)		(0.054)		(0.042)		(0.038)
Child in womb: 3rd or higher		0.047		0.065		−0.129**		0.018
		(0.051)		(0.043)		(0.049)		(0.042)
Woman is depressed		0.057*		0.030		−0.007		−0.081**
		(0.032)		(0.042)		(0.031)		(0.034)
Constant	1.064*	1.110*	0.150	0.295	0.241	−0.044	−0.455	−0.362
	(0.547)	(0.597)	(0.653)	(0.693)	(0.426)	(0.466)	(0.426)	(0.449)
Observations	662	662	662	662	662	662	662	662
R^2	0.013	0.023	0.002	0.009	0.010	0.030	0.006	0.033

Note: Results estimated with an OLS regression of joint investment choices on mothers' characteristics. no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Excludes depressed mothers in the intervention group.

Table 1.3a: Heterogeneity in expected returns from breastfeeding

	(1) Bf on speaking	(2) Bf on speaking	(3) Bf on diarrhea	(4) Bf on diarrhea	(5) Bf on social	(6) Bf on social	(7) Bf on learning	(8) Bf on learning
Education: 1-5 years	0.094**	0.078**	0.102**	0.085*	0.086**	0.080**	0.108***	0.099**
	(0.037)	(0.037)	(0.047)	(0.044)	(0.038)	(0.039)	(0.037)	(0.037)
Education: 6-10 years	0.083***	0.046	0.143***	0.110***	0.079**	0.060	0.075**	0.054
	(0.030)	(0.032)	(0.041)	(0.040)	(0.039)	(0.042)	(0.035)	(0.038)
Education: +10 years	0.079**	0.026	0.131***	0.082*	0.079**	0.055	0.056	0.025
	(0.034)	(0.036)	(0.039)	(0.044)	(0.037)	(0.044)	(0.034)	(0.038)
Age (years)	0.020	0.015	0.020	0.022	0.015	0.004	0.032*	0.026
	(0.020)	(0.022)	(0.026)	(0.027)	(0.018)	(0.020)	(0.018)	(0.020)
Age squared	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.001*	−0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Husband's education (years)		0.001		0.002		0.001		0.002
		(0.004)		(0.004)		(0.004)		(0.004)
Asset-based SES		0.024***		0.017		0.017**		0.016*
		(0.008)		(0.010)		(0.008)		(0.009)
Child in womb: 2nd		0.027		0.011		0.038		0.037
		(0.025)		(0.026)		(0.030)		(0.027)
Child in womb: 3rd or higher		0.040		−0.012		0.078**		0.044
		(0.032)		(0.038)		(0.031)		(0.033)
Woman is depressed		0.013		0.035		0.008		0.017
		(0.021)		(0.025)		(0.021)		(0.024)
Constant	−0.057	0.037	−0.043	−0.079	0.060	0.211	−0.134	−0.053
	(0.289)	(0.325)	(0.354)	(0.371)	(0.264)	(0.275)	(0.255)	(0.268)
Observations	1090	1090	1090	1090	1090	1090	1090	1090
R^2	0.008	0.020	0.017	0.022	0.008	0.019	0.012	0.020

Note: Results estimated with an OLS regression of expected returns from breastfeeding on mothers' characteristics. Bf is short for breastfeeding. Bf on speaking = Expected return from breastfeeding on the probability that a child puts 2-3 together in speaking by age 2; Bf on diarrhea = Expected return from breastfeeding on the probability of lower incidence of diarrhea episodes; Bf on social = Expected return from breastfeeding on the probability that a child plays happily with other children by age 3; Bf on learning = Expected return from breastfeeding on the probability of a child learning well.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: All mothers.

Table 1.3b: Heterogeneity in expected returns from playing

	(1) Playing on speaking	(2) Playing on speaking	(3) Playing on diarrhea	(4) Playing on diarrhea	(5) Playing on social	(6) Playing on social	(7) Playing on learning	(8) Playing on learning
Education: 1-5 years	0.108**	0.092**	0.091*	0.080	0.069	0.056	0.078*	0.061
	(0.041)	(0.038)	(0.051)	(0.051)	(0.042)	(0.041)	(0.044)	(0.043)
Education: 6-10 years	0.119***	0.079*	0.060	0.037	0.090**	0.057	0.072*	0.035
	(0.041)	(0.040)	(0.038)	(0.041)	(0.036)	(0.040)	(0.038)	(0.041)
Education: +10 years	0.110***	0.054	0.062	0.021	0.074*	0.024	0.090**	0.034
	(0.038)	(0.043)	(0.043)	(0.052)	(0.037)	(0.044)	(0.039)	(0.049)
Age (years)	0.067***	0.059***	−0.001	0.003	0.029	0.023	0.032*	0.029
	(0.020)	(0.019)	(0.024)	(0.025)	(0.018)	(0.018)	(0.017)	(0.018)
Age squared	−0.001***	−0.001***	0.000	−0.000	−0.001*	−0.000	−0.001*	−0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Husband's education (years)		−0.002		0.007*		0.003		0.001
		(0.004)		(0.004)		(0.003)		(0.004)
Asset-based SES		0.029***		0.001		0.018**		0.022***
		(0.007)		(0.011)		(0.008)		(0.008)
Child in womb: 2nd		0.072***		−0.029		0.056**		0.030
		(0.021)		(0.030)		(0.025)		(0.028)
Child in womb: 3rd or higher		0.036		−0.023		0.027		0.011
		(0.025)		(0.037)		(0.028)		(0.031)
Woman is depressed		0.003		0.004		0.005		0.014
		(0.019)		(0.017)		(0.019)		(0.022)
Constant	−0.673**	−0.543*	0.107	0.024	−0.122	−0.056	−0.134	−0.095
	(0.277)	(0.278)	(0.344)	(0.360)	(0.253)	(0.265)	(0.237)	(0.251)
Observations	1090	1090	1090	1090	1090	1090	1090	1090
R^2	0.025	0.046	0.004	0.009	0.013	0.027	0.010	0.021

Note: Results estimated with an OLS regression of expected returns from playing with the child on mothers' characteristics. Playing on speaking = Expected return from playing on the probability that a child puts 2-3 together in speaking by age 2; Playing on diarrhea = Expected return from playing on the probability of lower incidence of diarrhea episodes; Playing on social = Expected return from playing on the probability that a child plays happily with other children by age 3; Playing on learning = Expected return from playing on the probability of a child learning well.

* p < 0.1, ** p < 0.05, *** p < 0.01. Robust standard errors clustered at the village level in parentheses.

Sample: All mothers.

Table 1.4: Effort costs by characteristics

	(1) Breastfeeding is tiring	(2) Breastfeeding is tiring	(3) Playing is tiring	(4) Playing is tiring
Education: 1-5 years	−0.078	−0.041	−0.142**	−0.094*
	(0.061)	(0.061)	(0.057)	(0.055)
Education: 6-10 years	−0.127**	−0.049	−0.212***	−0.107**
	(0.051)	(0.055)	(0.044)	(0.048)
Education: +10 years	−0.161***	−0.054	−0.246***	−0.096
	(0.058)	(0.069)	(0.054)	(0.059)
Age (years)	0.045	0.053	0.068**	0.073**
	(0.031)	(0.032)	(0.030)	(0.031)
Age squared	−0.001	−0.001	−0.001**	−0.001**
	(0.001)	(0.001)	(0.001)	(0.001)
Husband's education (years)		0.008		0.005
		(0.006)		(0.004)
Asset-based SES		−0.044***		−0.058***
		(0.014)		(0.014)
Child in womb: 2nd		−0.008		0.040
		(0.038)		(0.043)
Child in womb: 3rd or higher		0.028		0.019
		(0.036)		(0.039)
Woman is depressed		0.097**		0.080**
		(0.038)		(0.030)
Constant	−0.105	−0.356	−0.406	−0.630
	(0.394)	(0.411)	(0.396)	(0.415)
Observations	1021	1021	1044	1044
R^2	0.012	0.038	0.029	0.063

Note: Results estimated with an OLS regression of expected effort cost of investments on mothers' characteristics.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: All mothers.

Table 1.5: Baseline model estimates of the preference and cost parameters

	Speak		Health		Social		Learn		All outcomes	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ω_speak	0.582**	0.528**							0.234	0.192
	(0.249)	(0.241)							(0.361)	(0.340)
ω_health			0.209	0.195					0.040	0.039
			(0.265)	(0.254)					(0.275)	(0.268)
ω_social					0.401*	0.389			−0.358	−0.289
					(0.224)	(0.245)			(0.353)	(0.367)
ω_learn							0.931***	0.849***	1.003***	0.901***
							(0.229)	(0.241)	(0.333)	(0.345)
Breastfeeding is tiring	0.202	0.213	0.195	0.204	0.201	0.211	0.232*	0.240	0.232*	0.240
	(0.132)	(0.145)	(0.131)	(0.145)	(0.131)	(0.144)	(0.134)	(0.148)	(0.134)	(0.148)
Playing is tiring	−0.690***	−0.610***	−0.722***	−0.638***	−0.703***	−0.621***	−0.674***	−0.596***	−0.675***	−0.597***
	(0.185)	(0.191)	(0.180)	(0.188)	(0.179)	(0.189)	(0.180)	(0.189)	(0.183)	(0.191)
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2504	2504	2504	2504	2504	2504	2504	2504	2504	2504
# mothers	626	626	626	626	626	626	626	626	626	626

Note: Results estimated using a multinomial logit model where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. The model includes a constant and the investment alternatives are evaluated against not breastfeeding and not playing (omitted category). ω_speak = preference parameter for a child being able to put 2-3 words together in speaking by age 2. ω_health = preference parameter for a child not experiencing frequent diarrhea. ω_social = preference parameter for a child playing happily with other children by age 3. ω_learn = preference parameter for a child learning well at school. Controls include the age of the mother and its square, the sex of the index child, 3 levels of parity (first child in womb, second, and third or higher), 4 levels of mother's education (no education, 1-5 years, 6-10 years, and +10 years), husband's education in years, a SES asset-based index, and a dummy for being diagnosed with depression at baseline. See Table A.9 for the estimated coefficients.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Excludes depressed mothers in the intervention group.

Table 1.6: Elasticities of investments to beliefs on learning and to cost of playing

Learn **Investment choice** **(change in %)**	**BF return** **(1 % increase)**	**PL return** **(1 % increase)**	**Joint investments return** **(1 % increase)**	**Not investing return** **(1 % increase)**	**Playing cost** **(1 % increase)**
Pr(No-bf, no-pl)	-0.23	-0.10	-0.12	0.28	0.06
Pr(Bf, no-pl)	0.47	-0.10	-0.12	-0.17	0.06
Pr(No-bf, pl)	-0.23	0.62	-0.12	-0.17	-0.15
Pr(Bf, pl)	-0.23	-0.10	0.62	-0.17	-0.15

Note: Predicted probabilities estimated after a multinomial logit model that evaluates the preference for developmental outcomes jointly and where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. Estimates of the model are shown in Column 10 of Table 1.5. BF is short for breastfeeding. PL is short for playing.

Table 1.7: Estimated monetary value of learning well and cost of playing

	Evaluated at mean income*	Evaluated at median income**	Proportion of monthly income
Increase of 10 pp in the probability of learning well	14,480.6	11,186.0	0.60
Increase of 10 pp in the cost of playing	-9,786.6	-7,560.0	-0.41
*Income (mean) PKR	23,948.9		
**Income (median) PKR	18,500.0		

Note: Marginal willingness to pay (MWTP) calculated using (a) the coefficient estimates of the preference parameter of learning well and the cost of playing from a multinomial logit model and (b) the average of the coefficient estimates of the log of household income (estimates shown in Table A.11)

Table 1.8: Heterogeneity in the preference parameters

	(1) Education	(2) SES	(3) Depression
ω_speak x 1[Low charac.]	0.110	0.944*	0.101
	(0.374)	(0.511)	(0.431)
ω_speak x 1[High charac.]	0.559	−0.396	0.488
	(0.903)	(0.480)	(0.460)
ω_health x 1[Low charac.]	−0.271	−0.654	0.386
	(0.307)	(0.448)	(0.337)
ω_health x 1[High charac.]	0.818	0.597**	−0.611
	(0.704)	(0.298)	(0.399)
ω_social x 1[Low charac.]	−0.235	−0.419	−0.264
	(0.433)	(0.573)	(0.496)
ω_social x 1[High charac.]	−0.569	−0.095	−0.472
	(0.752)	(0.537)	(0.771)
ω_learn x 1[Low charac.]	0.846**	0.712	0.563
	(0.395)	(0.554)	(0.469)
ω_learn x 1[High charac.]	1.383*	0.870*	1.651***
	(0.768)	(0.470)	(0.574)
Breastfeeding is tiring x 1[Low charac.]	0.455***	0.312	0.156
	(0.163)	(0.252)	(0.199)
Breastfeeding is tiring x 1[High charac.]	−0.412	0.146	0.513**
	(0.302)	(0.206)	(0.212)
Playing is tiring x 1[Low charac.]	−0.439*	−0.845***	−0.450*
	(0.229)	(0.219)	(0.248)
Playing is tiring x 1[High charac.]	−1.043**	−0.423	−0.973**
	(0.421)	(0.258)	(0.437)
Controls	Yes	Yes	Yes
p-value: ω_speak[Low charac.] = ω_speak[High charac.]	0.638	0.062	0.537
p-value: ω_health[Low charac.] = ω_health[High charac.]	0.172	0.016	0.050
p-value: ω_social[Low charac.] = ω_social[High charac.]	0.716	0.695	0.841
p-value: ω_learn[Low charac.] = ω_learn[High charac.]	0.529	0.826	0.169
p-value: Bf Tiring[Low charac.] = Bf Tiring[High charac.]	0.012	0.636	0.219
p-value: Pl Tiring[Low charac.] = Pl Tiring[High charac.]	0.228	0.156	0.346
Observations	2504	2504	2504
# mothers	626	626	626

Note: Results estimated using a multinomial logit model where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. The model includes a constant and the investment alternatives are evaluated against not breastfeeding and not playing (omitted category). ω_speak = preference parameter for a child being able to put 2-3 words together in speaking by age 2. ω_health = preference parameter for a child not experiencing frequent diarrhea. ω_social = preference parameter for a child playing happily with other children by age 3. ω_learn = preference parameter for a child learning well at school. Controls include the age of the mother and its square, the sex of the index child, 3 levels of parity (first child in womb, second, and third or higher), 4 levels of mother's education (no education, 1-5 years, 6-10 years, and +10 years), husband's education in years, a SES asset-based index, and a dummy for being diagnosed with depression at baseline. Column (1) interacts beliefs and costs with education level (high characteristic = +10 years of education). Column (2) interacts beliefs and costs with SES level (high characteristic = SES above median). Column (3) interacts beliefs and costs by depression status (high characteristic = depressed).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Excludes depressed mothers in the intervention group.

Table 1.9: Model estimates of the preference and cost parameters with alternative measures of maternal play

	HOME Score				Stimulation Score				PCA Stimulation items			
	(1) Learn	(2) Learn	(3) All outcomes	(4) All outcomes	(5) Learn	(6) Learn	(7) All outcomes	(8) All outcomes	(9) Learn	(10) Learn	(11) All outcomes	(12) All outcomes
ω_speak			0.138	0.104			0.097	0.100			−0.153	−0.159
			(0.334)	(0.310)			(0.335)	(0.320)			(0.363)	(0.354)
ω_health			−0.144	−0.154			0.132	0.126			0.143	0.152
			(0.270)	(0.277)			(0.243)	(0.254)			(0.276)	(0.282)
ω_social			−0.303	−0.301			−0.334	−0.342			−0.118	−0.094
			(0.349)	(0.362)			(0.378)	(0.393)			(0.363)	(0.370)
ω_learn	0.576**	0.505**	0.720*	0.666*	0.602***	0.602**	0.710**	0.715*	0.693***	0.670***	0.811**	0.773*
	(0.226)	(0.251)	(0.372)	(0.385)	(0.232)	(0.249)	(0.358)	(0.377)	(0.224)	(0.239)	(0.378)	(0.396)
Breastfeeding is tiring	0.205	0.213	0.205	0.214	0.202	0.212	0.202	0.212	0.206	0.224	0.207	0.225
	(0.134)	(0.148)	(0.134)	(0.148)	(0.137)	(0.150)	(0.138)	(0.151)	(0.136)	(0.152)	(0.137)	(0.153)
Playing is tiring	−0.490**	−0.346	−0.495**	−0.353*	−0.502***	−0.447***	−0.506***	−0.450***	−0.396**	−0.340*	−0.403**	−0.344**
	(0.198)	(0.211)	(0.198)	(0.211)	(0.149)	(0.164)	(0.148)	(0.164)	(0.165)	(0.174)	(0.164)	(0.174)
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2504	2504	2504	2504	2504	2504	2504	2504	2504	2504	2504	2504
# mothers	626	626	626	626	626	626	626	626	626	626	626	626

Note: Results estimated using a multinomial logit model where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. The model includes a constant and the investment alternatives are evaluated against not breastfeeding and not playing (omitted category). ω_speak = preference parameter for a child being able to put 2-3 words together in speaking by age 2. ω_health = preference parameter for a child not experiencing frequent diarrhea. ω_social = preference parameter for a child playing happily with other children by age 3. ω_learn = preference parameter for a child learning well at school. Controls include the age of the mother and its square, the sex of the index child, 3 levels of parity (first child in womb, second, and third or higher), 4 levels of mother's education (no education, 1-5 years, 6-10 years, and +10 years), husband's education in years, a SES asset-based index, and a dummy for being diagnosed with depression at baseline. A mother is considered to be making the playing investment when she scores in the top tertile of: the HOME Score (Columns 1 to 4), the Stimulation Score (Responsivity + Involvement score) (Columns 5 to 8), or the first principal component (PCA) of the Stimulation items (Responsivity and Involvement items) (Columns 9 to 12).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Excludes depressed mothers in the intervention group.

Table 1.10: Policy Simulations

	(0) Baseline Predicted	(1) High SES beliefs	(2) Increase returns (v1)	(3) Increase returns (v2)	(4) Playing not costly	(5) 2 + 4	(6) 3 + 4	(7) Treat depression	(8) Educate women
Pr(No-bf, no-pl)	36.6	36.2	34.8	28.5	34.5	32.8	26.8	34.9	33.6
Pr(Bf, no-pl)	32.0	32.1	32.9	36.2	30.2	31.0	33.9	31.2	32.7
Pr(No-bf, pl)	14.3	14.5	14.7	16.0	16.0	16.4	17.8	14.8	17.4
Pr(Bf, pl)	17.1	17.3	17.6	19.2	19.3	19.8	21.6	19.1	16.3
Pr(Bf)	49.1	49.4	50.5	55.5	49.5	50.8	55.5	50.3	49.0
Pr(Pl)	31.4	31.7	32.3	35.3	35.3	36.2	39.4	33.9	33.7
Δ Pr(No-bf, no-pl)	**0.0**	**-0.4**	**-1.8**	**-8.0**	**-2.0**	**-3.8**	**-9.8**	**-1.6**	**-3.0**
Δ Pr(Bf)	**0.0**	**0.2**	**1.4**	**6.3**	**0.4**	**1.7**	**6.3**	**1.1**	**-0.1**
Δ Pr(Pl)	**0.0**	**0.3**	**0.9**	**3.8**	**3.8**	**4.8**	**7.9**	**2.5**	**2.2**

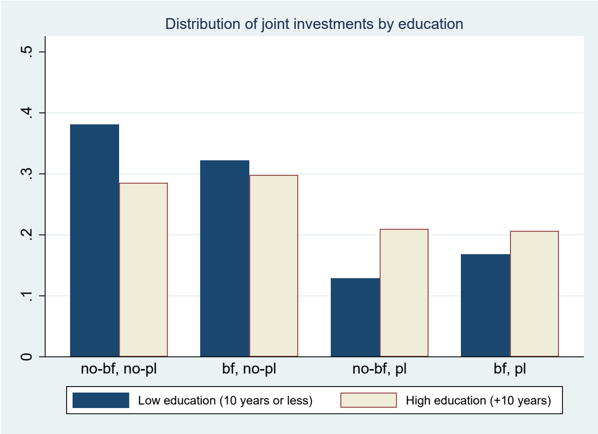
Note: Predicted probabilities estimated after a multinomial logit model where the preference parameters for children's developmental outcomes are evaluated jointly and where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. Col (0) - Baseline predicted probabilities; Col (1) - Low SES mothers have the beliefs held by the high SES mothers; Col (2) - The probability of children achieving developmental outcomes is increased by 10 pp. Col (3) - The probability of children achieving developmental outcomes is increased by the IQR of the average expected return of single investments (average increase of 43 pp); Col (4) - The effort cost of playing is suppressed; Col (5) - Combines Col (2) and Col (4); Col (6) - Combines Col (3) and Col (4); Col (7) - Depression status is changed to not depressed, and beliefs and costs are set at the value that not depressed mothers have; Col (8) - Education level is set at +10 years of education, and beliefs and costs are set at the value that mothers with +10 years of education have.

Appendix A

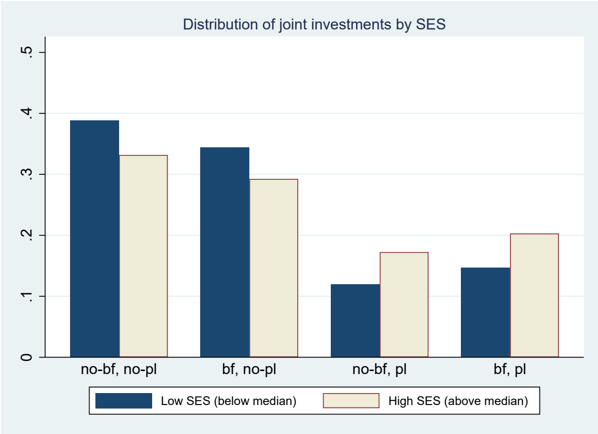
Appendix Figures and Tables

Figure A.1: Joint investments by characteristics

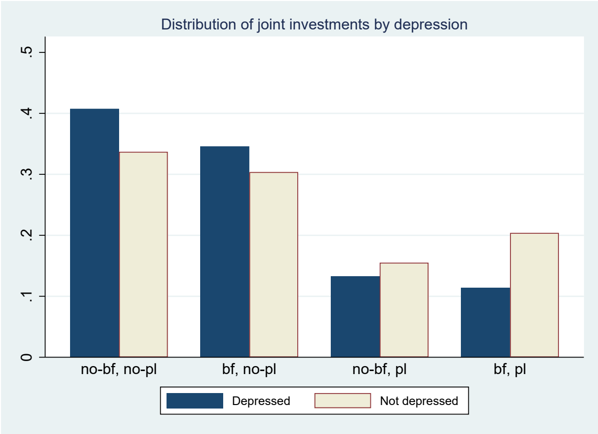
(a) By education



(b) By SES



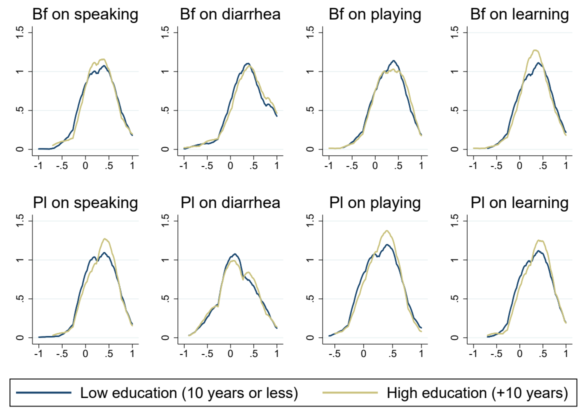
(c) By depression



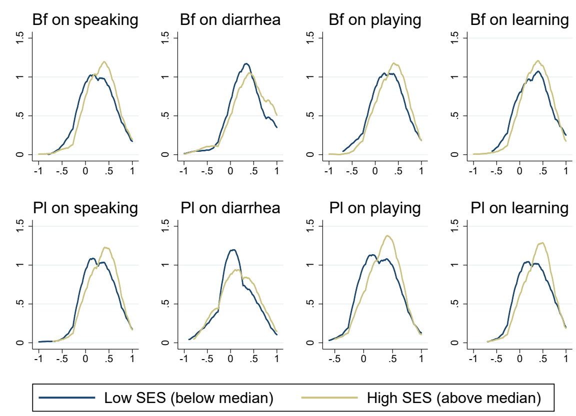
Note: Joint investments: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing

Figure A.2: Expected returns by characteristics

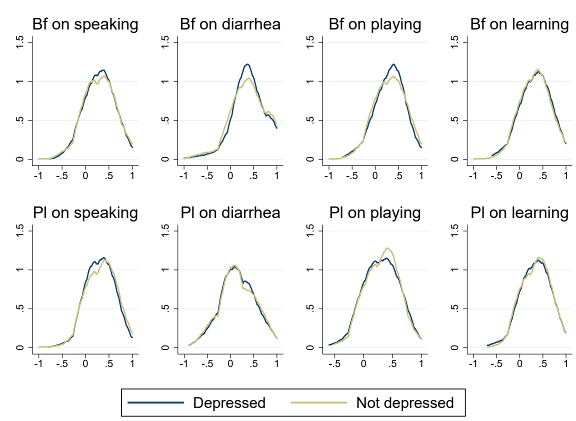
(a) By education



(b) By SES

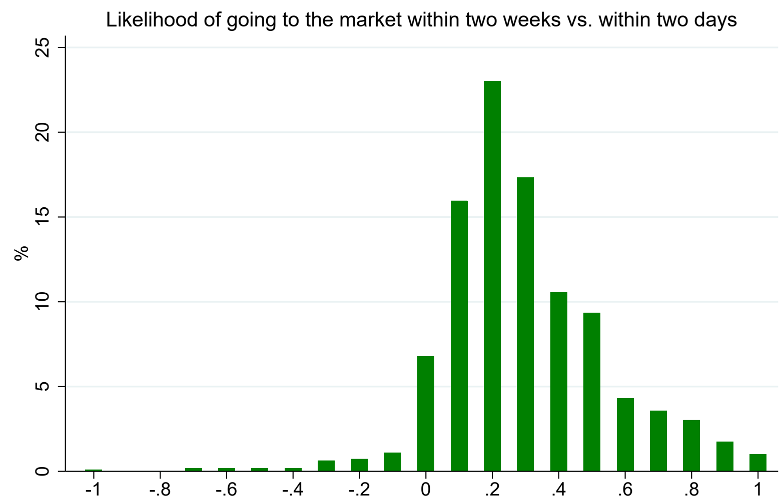


(c) By depression



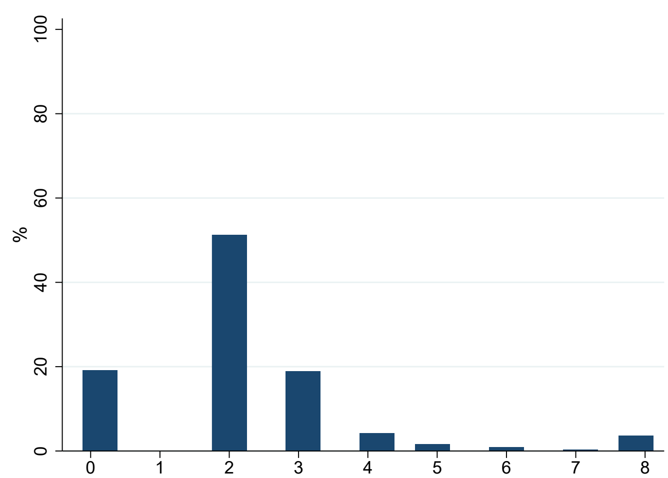
Note: Kernel distributions of individual differences in the subjective probability of children achieving developmental outcomes when a mother makes the high level investment versus when a mother makes the low level investment. Bf is short for breastfeeding. Pl is short for playing.

Figure A.3: Test question. Monotonicity property of probability distributions



Note: Individual differences in the probability that a woman would go to the market within the next two weeks versus the probability a woman would go to the market within the next two days. Negative values violate the monotonicity property.

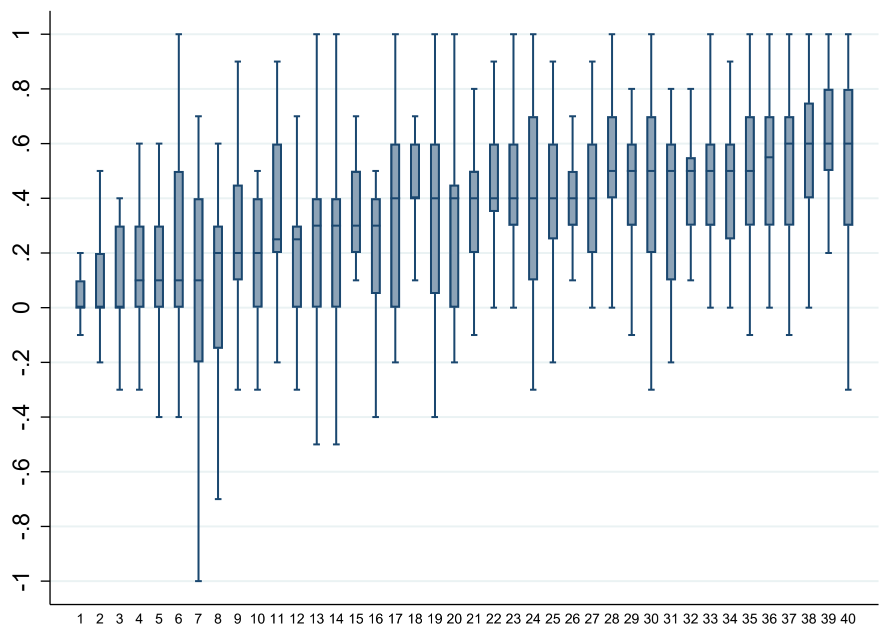
Figure A.4: Individual distribution of repeated beliefs



Note: Incidence of repeated combinations of beliefs from low and high investment levels across the different developmental outcomes considered.

Figure A.5: Between and within village variation in beliefs, investments, and costs

(a) Variation in beliefs: Expected return of breastfeeding on learning



(b) Variation in investments and costs

SD	Exclusively breastfeeding	Playing	Breastfeeding is tiring	Playing is tiring
Overall	0.500	0.468	0.492	0.485
Between	0.152	0.177	0.156	0.196
Within	0.482	0.445	0.471	0.446
Observations	662	662	1021	1044
Clusters	40	40	40	40

Note: (a) Box plot (excluding outliers) of the expected return of breastfeeding on learning well in each of the 40 villages under study.
(b) Within and between village variation in breastfeeding and playing practices, and costs, in the villages under study.

Table A.1: Attrition at month 3

	(1) No attrited	(2) Attrited	(3) Diff
Mothers' age (years)	26.59	26.85	–0.27
Mother's education (years)	8.05	7.97	0.08
Husband's education (years)	8.92	8.83	0.09
Parity	2.49	2.35	0.14
Household's income (US dollars)	229.64	214.31	15.33
Mother normally works	0.06	0.06	–0.00
High SES (above median)	0.55	0.56	–0.01
Likelihood of putting 2-3 words in speaking by age 2			
If the mother exclusively breastfeeds for 6 months	0.70	0.68	0.02
If the mother does not exclusively breastfeed for 6 months	0.39	0.40	–0.01
If the mother plays with the child frequently	0.74	0.71	0.03
If the mother plays with the child rarely	0.41	0.42	–0.02
Likelihood of diarrhea episodes			
If the mother exclusively breastfeeds for 6 months	0.24	0.30	–0.06**
If the mother does not exclusively breastfeed for 6 months	0.65	0.62	0.02
If the mother plays with the child frequently	0.35	0.34	0.01
If the mother plays with the child rarely	0.50	0.50	–0.00
Likelihood of playing happily by age 3			
If the mother exclusively breastfeeds for 6 months	0.73	0.72	0.02
If the mother does not exclusively breastfeed for 6 months	0.41	0.43	–0.02
If the mother plays with the child frequently	0.75	0.74	0.01
If the mother plays with the child rarely	0.43	0.45	–0.03
Likelihood of learning well			
If the mother exclusively breastfeeds for 6 months	0.76	0.71	0.05*
If the mother does not exclusively breastfeed for 6 months	0.41	0.42	–0.01
If the mother plays with the child frequently	0.77	0.75	0.02
If the mother plays with the child rarely	0.41	0.46	–0.04**
Costs of investments			
Breastfeeding is tiring	0.39	0.41	–0.02
Playing is tiring	0.35	0.39	–0.04
Either breastfeeding or playing is tiring	0.48	0.52	–0.03
Observations	662	209	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2: Feeding practices at 3 months

	(1) All mothers	(2) Breastfeeding but not exclusively	(3) Not breastfeeding
Breast milk	0.930	1.000	0.000
Ghutti	0.024	0.049	0.042
Herbal water (Kehwa/Gripe water)	0.138	0.279	0.242
Water	0.094	0.192	0.149
Tea (Chai)	0.010	0.023	0.000
Formula Milk	0.178	0.321	0.544
Other animal milk (cow/goat/buffalo)	0.183	0.346	0.456
Semi solid food	0.015	0.030	0.023
Solid food	0.007	0.017	0.000
Other	0.017	0.032	0.045
Observations	662	290	46

Sample: Excludes depressed mothers in the intervention group.

Table A.3: Heterogeneity in single investments

	(1) Exclusively breastfeeding	(2) Exclusively breastfeeding	(3) Playing	(4) Playing
Education: 1-5 years	0.057	0.062	0.054	0.016
	(0.051)	(0.051)	(0.072)	(0.071)
Education: 6-10 years	0.004	−0.006	0.006	−0.089
	(0.048)	(0.054)	(0.060)	(0.073)
Education: +10 years	0.027	0.016	0.133*	−0.018
	(0.057)	(0.072)	(0.067)	(0.093)
Age (years)	0.056	0.037	0.037	0.054
	(0.041)	(0.045)	(0.039)	(0.041)
Age squared	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Index child is female	−0.013	−0.012	−0.000	−0.006
	(0.036)	(0.037)	(0.033)	(0.033)
Husband's education (years)		−0.001		0.006
		(0.008)		(0.006)
Asset-based SES		0.014		0.031**
		(0.016)		(0.015)
Child in womb: 2nd		0.111*		−0.033
		(0.058)		(0.054)
Child in womb: 3rd or higher		0.083		−0.111*
		(0.055)		(0.062)
Woman is depressed		−0.051		−0.088**
		(0.043)		(0.040)
Constant	−0.305	−0.066	−0.214	−0.406
	(0.551)	(0.621)	(0.511)	(0.550)
Observations	662	662	662	662
R^2	0.005	0.015	0.015	0.044

* p < 0.1, ** p < 0.05, *** p < 0.01. Robust standard errors clustered at the village level in parentheses.

Note: Results estimated with an OLS regression of single investments on mothers characteristics.

Sample: Excludes depressed mothers in the intervention group.

Table A.4a: Heterogeneity in expected returns from breastfeeding: Different depression measures

	(1) Bf on speaking	(2) Bf on speaking	(3) Bf on speaking	(4) Bf on diarrhea	(5) Bf on diarrhea	(6) Bf on diarrhea	(7) Bf on social	(8) Bf on social	(9) Bf on social	(10) Bf on learning	(11) Bf on learning	(12) Bf on learning
Education: 1-5 years	0.078**	0.078**	0.078**	0.087*	0.087*	0.087*	0.080**	0.080**	0.080**	0.100**	0.100**	0.099**
	(0.037)	(0.037)	(0.037)	(0.045)	(0.045)	(0.045)	(0.039)	(0.039)	(0.039)	(0.037)	(0.037)	(0.037)
Education: 6-10 years	0.047	0.046	0.048	0.112***	0.110***	0.111***	0.060	0.060	0.062	0.054	0.053	0.055
	(0.032)	(0.031)	(0.032)	(0.040)	(0.040)	(0.040)	(0.042)	(0.041)	(0.042)	(0.039)	(0.038)	(0.038)
Education: +10 years	0.027	0.026	0.029	0.084*	0.082*	0.085*	0.055	0.055	0.059	0.025	0.025	0.028
	(0.037)	(0.036)	(0.037)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.039)	(0.038)	(0.039)
Age (years)	0.015	0.014	0.017	0.022	0.020	0.022	0.004	0.004	0.007	0.026	0.025	0.027
	(0.022)	(0.022)	(0.022)	(0.027)	(0.027)	(0.027)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Age squared	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.001	−0.001	−0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Husband's education (years)	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.001	0.002	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Asset-based SES	0.024***	0.024***	0.026***	0.016	0.016	0.017	0.016*	0.017**	0.019**	0.016*	0.015*	0.017*
	(0.008)	(0.008)	(0.008)	(0.010)	(0.010)	(0.010)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)
Child in womb: 2nd	0.027	0.027	0.027	0.011	0.012	0.011	0.039	0.038	0.037	0.037	0.038	0.037
	(0.025)	(0.025)	(0.025)	(0.026)	(0.026)	(0.026)	(0.030)	(0.030)	(0.030)	(0.027)	(0.027)	(0.027)
Child in womb: 3rd or higher	0.040	0.040	0.036	−0.012	−0.011	−0.015	0.079**	0.076**	0.071**	0.044	0.044	0.039
	(0.032)	(0.033)	(0.032)	(0.038)	(0.037)	(0.038)	(0.031)	(0.032)	(0.032)	(0.033)	(0.033)	(0.034)
Depression score, 8 cut-off	0.012			0.028			−0.002			0.015		
	(0.020)			(0.025)			(0.023)			(0.023)		
Depression score, 15 cut-off		0.018			0.024			0.024			0.022	
		(0.022)			(0.023)			(0.020)			(0.024)	
Depression score (baseline)			0.003*			0.003			0.003*			0.003*
			(0.001)			(0.002)			(0.002)			(0.002)
Constant	0.036	0.046	−0.001	−0.076	−0.049	−0.093	0.222	0.210	0.157	−0.054	−0.042	−0.092
	(0.319)	(0.317)	(0.322)	(0.373)	(0.370)	(0.373)	(0.277)	(0.267)	(0.278)	(0.270)	(0.263)	(0.271)
Observations	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090
R^2	0.020	0.020	0.022	0.022	0.021	0.023	0.019	0.020	0.022	0.020	0.020	0.022

Note: Results estimated with an OLS regression of expected returns from breastfeeding on mothers' characteristics. Bf on speaking = Expected return from breastfeeding on the probability that a child puts 2-3 together in speaking by age 2; Bf on diarrhea = Expected return from breastfeeding on the probability of lower incidence of diarrhea episodes; Bf on social = Expected return from breastfeeding on the probability that a child plays happily with other children by age 3; Bf on learning = Expected return from breastfeeding on the probability of a child learning well. Depression score is calculated using the patient health questionnaire (PHQ-9), and its value ranges from 0 to 27, where a higher score indicates a higher presence of depression symptoms.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: All mothers.

Table A.4b: Heterogeneity in expected returns from playing: Different depression measures

	(1) Pl on speaking	(2) Pl on speaking	(3) Pl on speaking	(4) Pl on diarrhea	(5) Pl on diarrhea	(6) Pl on diarrhea	(7) Pl on social	(8) Pl on social	(9) Pl on social	(10) Pl on learning	(11) Pl on learning	(12) Pl on learning
Education: 1-5 years	0.092**	0.092**	0.092**	0.081	0.081	0.081	0.056	0.056	0.056	0.061	0.062	0.061
	(0.038)	(0.038)	(0.038)	(0.050)	(0.051)	(0.051)	(0.041)	(0.041)	(0.041)	(0.043)	(0.043)	(0.043)
Education: 6-10 years	0.080*	0.079*	0.080*	0.036	0.038	0.037	0.058	0.057	0.058	0.036	0.034	0.036
	(0.040)	(0.040)	(0.040)	(0.041)	(0.041)	(0.041)	(0.040)	(0.040)	(0.040)	(0.041)	(0.041)	(0.041)
Education: +10 years	0.055	0.054	0.056	0.019	0.021	0.020	0.025	0.025	0.027	0.036	0.034	0.038
	(0.043)	(0.043)	(0.043)	(0.052)	(0.052)	(0.052)	(0.045)	(0.044)	(0.044)	(0.049)	(0.048)	(0.048)
Age (years)	0.060***	0.059***	0.061***	0.001	0.002	0.002	0.023	0.023	0.025	0.030	0.029	0.031*
	(0.019)	(0.020)	(0.019)	(0.025)	(0.025)	(0.026)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Age squared	−0.001***	−0.001***	−0.001***	0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.001*	−0.001*	−0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Husband's education (years)	−0.002	−0.002	−0.002	0.007*	0.007*	0.007*	0.003	0.003	0.003	0.001	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Asset-based SES	0.030***	0.029***	0.030***	−0.001	0.000	0.000	0.018**	0.018**	0.019**	0.022***	0.021***	0.023***
	(0.007)	(0.007)	(0.007)	(0.012)	(0.011)	(0.012)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Child in womb: 2nd	0.072***	0.072***	0.072***	−0.028	−0.029	−0.029	0.056**	0.056**	0.055**	0.029	0.030	0.029
	(0.021)	(0.021)	(0.021)	(0.030)	(0.030)	(0.030)	(0.025)	(0.025)	(0.025)	(0.028)	(0.029)	(0.028)
Child in womb: 3rd or higher	0.035	0.035	0.033	−0.021	−0.021	−0.022	0.027	0.026	0.022	0.010	0.010	0.005
	(0.025)	(0.025)	(0.025)	(0.037)	(0.037)	(0.037)	(0.028)	(0.029)	(0.028)	(0.031)	(0.032)	(0.031)
Depression score, 8 cut-off	0.014			−0.021			0.009			0.024		
	(0.018)			(0.021)			(0.018)			(0.019)		
Depression score, 15 cut-off		0.013			−0.015			0.013			0.021	
		(0.021)			(0.020)			(0.022)			(0.026)	
Depression score (baseline)			0.001			−0.001			0.002*			0.003**
			(0.001)			(0.002)			(0.001)			(0.001)
Constant	−0.557*	−0.545*	−0.570**	0.057	0.035	0.039	−0.063	−0.056	−0.098	−0.111	−0.087	−0.143
	(0.276)	(0.279)	(0.280)	(0.361)	(0.361)	(0.366)	(0.263)	(0.259)	(0.267)	(0.252)	(0.247)	(0.257)
Observations	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090
R^2	0.047	0.046	0.047	0.009	0.009	0.009	0.027	0.027	0.029	0.021	0.021	0.024

Note: Results estimated with an OLS regression of expected returns from playing with the child on mothers' characteristics. Pl on speaking = Expected return from playing on the probability that a child puts 2-3 together in speaking by age 2; Pl on diarrhea = Expected return from playing on the probability of lower incidence of diarrhea episodes; Pl on social = Expected return from playing on the probability that a child plays happily with other children by age 3; Pl on learning = Expected return from playing on the probability of a child learning well. Depression score is calculated using the patient health questionnaire (PHQ-9), and its value ranges from 0 to 27, where a higher score indicates a higher presence of depression symptoms.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: All mothers.

Table A.5: Mother's characteristics and expected zero returns

	(1) Only one expected null return	(2) Two to three expected null returns	(3) Four to eight expected null returns	(4) More than one expected negative returns
Education: 1-5 years	0.026	−0.028	−0.060*	−0.112**
	(0.040)	(0.033)	(0.032)	(0.052)
Education: 6-10 years	−0.038	0.041	−0.067*	−0.046
	(0.036)	(0.033)	(0.035)	(0.052)
Education: +10 years	−0.032	0.055	−0.065	−0.007
	(0.051)	(0.043)	(0.038)	(0.059)
Age (years)	0.010	−0.013	−0.002	−0.040
	(0.031)	(0.022)	(0.020)	(0.028)
Age squared	−0.000	0.000	0.000	0.001
	(0.001)	(0.000)	(0.000)	(0.001)
Husband's education (years)	0.004	−0.004	−0.004	−0.004
	(0.003)	(0.004)	(0.003)	(0.006)
Asset-based SES	−0.002	−0.033***	−0.008	−0.032***
	(0.010)	(0.008)	(0.008)	(0.011)
Child in womb: 2nd	0.013	−0.011	−0.022	−0.010
	(0.036)	(0.023)	(0.026)	(0.036)
Child in womb: 3rd or higher	−0.008	−0.024	−0.026	−0.032
	(0.038)	(0.024)	(0.029)	(0.032)
Woman is depressed	−0.003	−0.015	−0.036	−0.011
	(0.029)	(0.021)	(0.023)	(0.021)
Constant	0.013	0.309	0.252	0.844**
	(0.415)	(0.281)	(0.278)	(0.371)
Mean depvar	0.190	0.130	0.107	0.215
Observations	1090	1090	1090	1090
R^2	0.005	0.024	0.014	0.025

Note: Results estimated with an OLS regression of the incidence of expected null returns from investments on mothers' characteristics (Columns 1 to 3), and of the incidence of expected negative returns on mothers' characteristics (Column 4).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: All mothers.

Table A.6: Calibration of beliefs

In sample expected likelihood of frequent diarrhea episodes	%
If the mother exclusively breastfeeds for 6 months	25.2
If the mother does not exclusively breastfeed for 6 months	64.4
If the mother plays with the child frequently	35.3
If the mother plays with the child rarely	51.0

Proportion of children with diarrhea in the last 2 weeks according to 2012-2013 Pakistan DHS	%
< 6 months old	25.8
6-11 months old	35.3
12-23 months old	32.9

In sample expected likelihood of putting 2-3 words together by age 2	%
If the mother exclusively breastfeeds for 6 months	69.8
If the mother does not exclusively breastfeed for 6 months	39.5
If the mother plays with the child frequently	74.1
If the mother plays with the child rarely	41.5

Proportion of children that speak partial sentences by age 2	%
In the US according to Cunha et al. (2020)	72.0

Table A.7: Effort cost by characteristics

	Education		**SES**		**Depression**	
	Low	High	Low	High	Yes	No
Breastfeeding is tiring						
Rarely or never	0.57	0.61	0.51	0.63	0.49	0.62
Sometimes	0.27	0.23	0.30	0.22	0.30	0.24
Most of the time	0.11	0.09	0.13	0.08	0.15	0.09
Don't know	0.05	0.08	0.06	0.06	0.07	0.06
Playing is tiring						
Rarely or never	0.60	0.68	0.52	0.71	0.53	0.66
Sometimes	0.25	0.19	0.29	0.18	0.27	0.22
Most of the time	0.11	0.09	0.13	0.09	0.15	0.09
Don't know	0.04	0.04	0.05	0.03	0.05	0.03
Observations	854	236	548	542	547	543

Note: Low education = 10 years or less of education. High education = + 10 years of education. Low SES = SES asset-based index below the median. High SES = SES asset-based index above the median. Depressed = PHQ-9 questionnaire score 10 or above. Not depressed = PHQ-9 questionnaire score below 10.

Sample: All mothers.

Table A.8: Correlation of beliefs and costs

	(1) Bf on speaking	(2) Bf on speaking	(3) Bf on diarrhea	(4) Bf on diarrhea	(5) Bf on social	(6) Bf on social	(7) Bf on learning	(8) Bf on learning	(9) Pl on speaking	(10) Pl on speaking	(11) Pl on diarrhea	(12) Pl on diarrhea	(13) Pl on social	(14) Pl on social	(15) Pl on learning	(16) Pl on learning
Bf sometimes tiring	0.111***	0.104***	0.052	0.038	0.121***	0.119***	0.103***	0.103***								
	(0.032)	(0.029)	(0.044)	(0.043)	(0.036)	(0.036)	(0.031)	(0.030)								
Bf most of the times tiring	0.080**	0.080**	0.056	0.052	0.071*	0.074**	0.028	0.030								
	(0.038)	(0.037)	(0.050)	(0.049)	(0.036)	(0.036)	(0.034)	(0.034)								
Pl sometimes tiring									0.097**	0.093**	0.169***	0.159***	0.153***	0.147***	0.193***	0.190***
									(0.042)	(0.044)	(0.035)	(0.034)	(0.030)	(0.029)	(0.035)	(0.034)
Pl most of the times tiring									0.058	0.057	0.057	0.056	0.032	0.030	0.035	0.034
									(0.047)	(0.048)	(0.040)	(0.041)	(0.040)	(0.041)	(0.045)	(0.045)
Education: 1-5 years		0.072*		0.084*		0.073*		0.093**		0.071		0.073**		0.038		0.040
		(0.037)		(0.044)		(0.038)		(0.036)		(0.052)		(0.036)		(0.039)		(0.042)
Education: 6-10 years		0.039		0.109**		0.051		0.046		0.029		0.060		0.038		0.012
		(0.030)		(0.041)		(0.039)		(0.036)		(0.041)		(0.036)		(0.037)		(0.036)
Education: +10 years		0.022		0.081*		0.050		0.020		0.016		0.042		0.012		0.018
		(0.034)		(0.044)		(0.041)		(0.037)		(0.050)		(0.038)		(0.040)		(0.044)
Age (years)		0.013		0.022		0.002		0.026		0.005		0.063***		0.027		0.036*
		(0.024)		(0.027)		(0.021)		(0.021)		(0.025)		(0.020)		(0.019)		(0.018)
Age squared		−0.000		−0.000		−0.000		−0.001		−0.000		−0.001***		−0.001		−0.001**
		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)
Husband's education (years)		0.001		0.002		0.001		0.002		0.007*		−0.001		0.003		0.002
		(0.004)		(0.004)		(0.004)		(0.004)		(0.004)		(0.004)		(0.003)		(0.004)
Asset-based SES		0.022***		0.017*		0.014		0.012		−0.003		0.019***		0.008		0.010
		(0.007)		(0.010)		(0.009)		(0.009)		(0.011)		(0.007)		(0.008)		(0.008)
Child in womb: 2nd		0.019		0.011		0.027		0.029		−0.035		0.062***		0.048*		0.023
		(0.025)		(0.027)		(0.032)		(0.027)		(0.030)		(0.021)		(0.025)		(0.030)
Child in womb: 3rd or higher		0.036		−0.011		0.072**		0.040		−0.029		0.025		0.017		0.001
		(0.031)		(0.039)		(0.032)		(0.033)		(0.036)		(0.024)		(0.028)		(0.030)
Woman is depressed		0.021		0.036		0.018		0.027		0.012		0.019		0.019		0.032
		(0.021)		(0.025)		(0.021)		(0.023)		(0.018)		(0.019)		(0.019)		(0.022)
Constant	0.220***	−0.007	0.344***	−0.112	0.233***	0.164	0.272***	−0.111	0.085**	−0.066	0.219***	−0.683**	0.220***	−0.193	0.227***	−0.294
	(0.032)	(0.347)	(0.043)	(0.378)	(0.037)	(0.283)	(0.030)	(0.272)	(0.033)	(0.357)	(0.032)	(0.280)	(0.028)	(0.276)	(0.033)	(0.250)
Observations	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090
R^2	0.016	0.032	0.002	0.024	0.022	0.038	0.020	0.037	0.010	0.018	0.073	0.102	0.075	0.089	0.090	0.100

Note: Results estimated with an OLS regression of expected returns from investments on the expected effort cost of investments and mothers characteristics. Bf on speaking = Expected return from breastfeeding on the probability that a child puts 2-3 together in speaking by age 2; Bf on diarrhea = Expected return from breastfeeding on the probability of lower incidence of diarrhea episodes; Bf on social = Expected return from breastfeeding on the probability that a child plays happily with other children by age 3; Bf on learning = Expected return from breastfeeding on the probability of a child learning well. Pl on speaking = Expected return from playing on the probability that a child puts 2-3 together in speaking by age 2; Pl on diarrhea = Expected return from playing on the probability of lower incidence of diarrhea episodes; Pl on social = Expected return from playing on the probability that a child plays happily with other children by age 3; Pl on learning = Expected return from playing on the probability of a child learning well.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: All mothers.

Table A.9: Baseline model estimates: Effect of characteristics on investment choice

	(1) Speak	(2) Health	(3) Social	(4) Learn	(5) All outcomes
bf, no-pl					
Education: 1-5 years	0.345	0.380	0.346	0.308	0.318
	(0.300)	(0.302)	(0.303)	(0.304)	(0.308)
Education: 6-10 years	0.195	0.219	0.189	0.168	0.180
	(0.280)	(0.281)	(0.283)	(0.285)	(0.295)
Education: +10 years	0.350	0.387	0.342	0.314	0.331
	(0.304)	(0.300)	(0.317)	(0.315)	(0.331)
Child in womb: 2nd	0.202	0.214	0.206	0.168	0.167
	(0.324)	(0.321)	(0.321)	(0.327)	(0.331)
Child in womb: 3rd or higher	0.134	0.158	0.125	0.104	0.116
	(0.237)	(0.234)	(0.240)	(0.227)	(0.233)
Index child is female	−0.019	−0.040	−0.033	−0.030	−0.028
	(0.163)	(0.163)	(0.161)	(0.163)	(0.165)
Age (years)	0.164	0.180	0.179	0.158	0.152
	(0.259)	(0.255)	(0.260)	(0.261)	(0.258)
Age squared	−0.003	−0.003	−0.003	−0.003	−0.002
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Asset-based SES	−0.002	0.004	−0.001	−0.000	0.001
	(0.095)	(0.094)	(0.094)	(0.093)	(0.094)
Husband's education (years)	−0.016	−0.017	−0.015	−0.015	−0.016
	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)
Woman is depressed	−0.093	−0.088	−0.092	−0.086	−0.084
	(0.187)	(0.192)	(0.190)	(0.186)	(0.184)
no-bf, pl					
Education: 1-5 years	0.032	0.064	0.037	−0.005	0.001
	(0.533)	(0.532)	(0.534)	(0.538)	(0.537)
Education: 6-10 years	−0.365	−0.341	−0.368	−0.384	−0.374
	(0.532)	(0.528)	(0.534)	(0.535)	(0.535)
Education: +10 years	0.173	0.189	0.155	0.128	0.144
	(0.554)	(0.553)	(0.557)	(0.560)	(0.555)
Child in womb: 2nd	−0.568	−0.528	−0.551	−0.546	−0.544
	(0.369)	(0.371)	(0.370)	(0.373)	(0.366)
Child in womb: 3rd or higher	−1.108***	−1.076***	−1.104***	−1.094***	−1.086***
	(0.349)	(0.353)	(0.352)	(0.358)	(0.350)
Index child is female	0.087	0.069	0.078	0.072	0.072
	(0.263)	(0.262)	(0.262)	(0.263)	(0.262)
Age (years)	0.242	0.283	0.281	0.242	0.225
	(0.347)	(0.346)	(0.347)	(0.349)	(0.345)
Age squared	−0.003	−0.004	−0.004	−0.003	−0.003
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Asset-based SES	0.073	0.084	0.082	0.074	0.070
	(0.106)	(0.105)	(0.107)	(0.105)	(0.103)
Husband's education (years)	0.003	0.002	0.002	0.005	0.006
	(0.055)	(0.055)	(0.055)	(0.055)	(0.056)
Woman is depressed	−0.230	−0.221	−0.228	−0.227	−0.226
	(0.254)	(0.256)	(0.257)	(0.259)	(0.258)
bf, pl					
Education: 1-5 years	−0.097	−0.070	−0.090	−0.134	−0.132
	(0.388)	(0.390)	(0.390)	(0.389)	(0.392)
Education: 6-10 years	−0.613	−0.600	−0.618	−0.631	−0.622
	(0.422)	(0.428)	(0.419)	(0.420)	(0.429)
Education: +10 years	−0.378	−0.360	−0.390	−0.403	−0.389
	(0.523)	(0.517)	(0.519)	(0.524)	(0.529)
Child in womb: 2nd	0.331	0.348	0.331	0.322	0.326
	(0.343)	(0.341)	(0.342)	(0.345)	(0.346)
Child in womb: 3rd or higher	−0.064	−0.042	−0.081	−0.064	−0.044
	(0.384)	(0.383)	(0.382)	(0.381)	(0.379)
Index child is female	−0.033	−0.058	−0.048	−0.046	−0.042
	(0.205)	(0.203)	(0.204)	(0.204)	(0.205)
Age (years)	0.322	0.350	0.354	0.314	0.299
	(0.280)	(0.275)	(0.275)	(0.279)	(0.280)
Age squared	−0.006	−0.006	−0.006	−0.005	−0.005
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Asset-based SES	0.201**	0.214**	0.208**	0.203**	0.202**
	(0.100)	(0.101)	(0.100)	(0.100)	(0.100)
Husband's education (years)	0.022	0.022	0.022	0.024	0.024
	(0.048)	(0.048)	(0.048)	(0.048)	(0.047)
Woman is depressed	−0.563*	−0.557*	−0.567*	−0.575*	−0.570*
	(0.297)	(0.296)	(0.298)	(0.302)	(0.301)
Observations	2504	2504	2504	2504	2504
# mothers	626	626	626	626	626

Note: Results estimated using a multinomial logit model where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. The model includes a constant and the investment alternatives are evaluated against not breastfeeding and not playing (omitted category). Speak = when estimating the preference parameter for a child being able to put 2-3 words together in speaking by age 2. Health = when estimating the preference parameter for a child not experiencing frequent diarrhea. Social = when estimating the preference parameter for a child playing happily with other children by age 3. Learn = when estimating the preference parameter for a child learning well at school. All outcomes = when estimating all preference parameters simultaneously. Other coefficients are presented in Table 5.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Excludes depressed mothers in the intervention group.

Table A.10: Goodness of fit: Observed and predicted distribution of investments

	All mothers		**Depressed**		**Low educated**		**Low SES**		**At least two expected 0 returns**		**Any investment has high cost**	
	Observed	Predicted	Observed	Predicted	Observed	Predicted	Observed	Predicted	Observed	Predicted	Observed	Predicted
Pr(No-bf, no-pl)	36.56	36.56	41.18	41.18	38.53	38.53	40.11	40.05	42.78	42.32	34.18	39.92
Pr(Bf, no-pl)	32.00	32.00	34.80	34.80	32.91	32.91	35.11	34.64	31.93	30.84	38.95	36.48
Pr(No-bf, pl)	14.30	14.30	12.25	12.25	12.34	12.34	10.80	11.82	10.25	12.53	9.43	9.76
Pr(Bf, pl)	17.14	17.14	11.76	11.76	16.22	16.22	13.98	13.48	15.04	14.30	17.45	13.83
Pr(Bf)	**49.14**	**49.14**	**46.57**	**46.57**	**49.13**	**49.13**	**49.09**	**48.13**	**46.97**	**45.15**	**56.40**	**50.32**
Pr(Pl)	**31.44**	**31.44**	**24.02**	**24.02**	**28.56**	**28.56**	**24.78**	**25.30**	**25.29**	**26.83**	**26.88**	**23.60**

Note: Observed and predicted probabilities estimated after a multinomial logit model where the preference parameters for children's developmental outcomes are evaluated jointly and where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. Depressed = PHQ-9 questionnaire score 10 or above. Low educated = 10 years or less of education. Low SES = SES asset-based index below the median.

Table A.11: Model estimates of the cost and preference parameters using income

		bf, no-pl	no-bf, pl	bf, pl
ω_speak	0.255			
	(0.334)			
ω_health	0.026			
	(0.269)			
ω_social	−0.304			
	(0.362)			
ω_learn	0.893***			
	(0.337)			
Breastfeeding is tiring	0.256*			
	(0.152)			
Playing is tiring	−0.647***			
	(0.188)			
Education: 1-5 years		0.343	0.024	−0.037
		(0.323)	(0.541)	(0.391)
Education: 6-10 years		0.144	−0.336	−0.401
		(0.282)	(0.539)	(0.418)
Education: +10 years		0.231	0.179	−0.075
		(0.332)	(0.571)	(0.528)
Child in womb: 2nd		0.185	−0.536	0.339
		(0.328)	(0.372)	(0.346)
Child in womb: 3rd or higher		0.116	−1.079***	−0.031
		(0.229)	(0.357)	(0.386)
Index child is female		−0.035	0.075	0.004
		(0.164)	(0.264)	(0.219)
Age (years)		0.148	0.226	0.300
		(0.261)	(0.344)	(0.277)
Age squared		−0.002	−0.003	−0.005
		(0.005)	(0.006)	(0.005)
Husband's education (years)		−0.028	0.007	0.048
		(0.038)	(0.054)	(0.047)
Woman is depressed		−0.074	−0.222	−0.621**
		(0.189)	(0.254)	(0.295)
Log of hh income		0.326**	0.219	0.022
		(0.161)	(0.182)	(0.194)
Observations	2504			
# mothers	626			

Note: Results estimated using a multinomial logit model where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. The model includes a constant and the investment alternatives are evaluated against not breastfeeding and not playing (omitted category). ω_speak = preference parameter for a child being able to put 2-3 words together in speaking by age 2. ω_health = preference parameter for a child not experiencing frequent diarrhea. ω_social = preference parameter for a child playing happily with other children by age 3. ω_learn = preference parameter for a child learning well at school.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Excludes depressed mothers in the intervention group.

Table A.12: Mixed logit model

	(1)	(2)	(3)	(4)	(5)
ω_speak	0.489*				0.158
	(0.251)				(0.374)
ω_health		0.306			0.162
		(0.455)			(0.442)
ω_social			0.361		−0.329
			(0.248)		(0.385)
ω_learn				0.873***	1.012***
				(0.247)	(0.369)
Breastfeeding is tiring	0.201	0.202	0.200	0.231	0.243
	(0.143)	(0.152)	(0.144)	(0.147)	(0.156)
Playing is tiring	−0.599***	−0.644***	−0.608***	−0.581***	−0.606***
	(0.191)	(0.214)	(0.188)	(0.190)	(0.208)
SD					
ω_speak	0.088				0.020
	(0.125)				(0.283)
ω_health		1.210			1.258
		(2.070)			(1.921)
ω_social			0.152		0.476
			(0.381)		(1.834)
ω_learn				0.163	0.104
				(0.778)	(0.257)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	2504	2504	2504	2504	2504
# mothers	626	626	626	626	626

Note: Results estimated using a mixed logit model where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. The model includes a constant and the investment alternatives are evaluated against not breastfeeding and not playing (omitted category). ω_speak = preference parameter for a child being able to put 2-3 words together in speaking by age 2. ω_health = preference parameter for a child not experiencing frequent diarrhea. ω_social = preference parameter for a child playing happily with other children by age 3. ω_learn = preference parameter for a child learning well at school. Controls include the age of the mother and its square, the sex of the index child, parity, mother's education in years, husband's education in years, a SES asset-based index, and a dummy for being diagnosed with depression at baseline.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Excludes depressed mothers in the intervention group.

Table A.13: Heterogeneity in the preference parameters by constraint levels

	(1) Female Child	(2) Grandmother	(3) Agricultural household
ω_speak x 1[Constrained]	0.109	0.450	−0.073
	(0.575)	(0.719)	(0.524)
ω_speak x 1[No constrained]	0.240	0.097	0.515
	(0.448)	(0.403)	(0.589)
ω_health x 1[Constrained]	0.080	−0.899	0.244
	(0.403)	(0.580)	(0.339)
ω_health x 1[No constrained]	0.042	0.377	−0.107
	(0.329)	(0.319)	(0.416)
ω_social x 1[Constrained]	0.059	0.023	−0.203
	(0.689)	(0.644)	(0.535)
ω_social x 1[No constrained]	−0.519	−0.260	−0.223
	(0.397)	(0.455)	(0.721)
ω_learn x 1[Constrained]	0.651	0.996	1.456***
	(0.506)	(0.738)	(0.492)
ω_learn x 1[No constrained]	1.095**	0.750*	0.159
	(0.459)	(0.443)	(0.501)
Breastfeeding is tiring x 1[Constrained]	0.093	0.038	0.096
	(0.279)	(0.242)	(0.234)
Breastfeeding is tiring x 1[No constrained]	0.374*	0.347*	0.405*
	(0.214)	(0.193)	(0.214)
Playing is tiring x 1[Constrained]	−0.476*	−0.833**	−0.300
	(0.285)	(0.377)	(0.231)
Playing is tiring x 1[No constrained]	−0.693***	−0.529**	−1.082***
	(0.225)	(0.218)	(0.290)
Controls	Yes	Yes	Yes
p-value: ω_speak[Constr.] = ω_speak[No constr.]	0.861	0.675	0.497
p-value: ω_health[Constr.] = ω_health[No constr.]	0.938	0.061	0.506
p-value: ω_social[Constr.] = ω_social[No constr.]	0.445	0.727	0.984
p-value: ω_learn[Constr.] = ω_learn[No constr.]	0.512	0.789	0.078
p-value: Bf Tiring[Constr.] = Bf Tiring[No constr.]	0.477	0.324	0.368
p-value: Pl Tiring[Constr.] = Pl Tiring[No constr.]	0.504	0.473	0.022
Observations	2504	2504	2504
# mothers	626	626	626

Note: Results estimated using a multinomial logit model where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. The model includes a constant and the investment alternatives are evaluated against not breastfeeding and not playing (omitted category). ω_speak = preference parameter for a child being able to put 2-3 words together in speaking by age 2. ω_health = preference parameter for a child not experiencing frequent diarrhea. ω_social = preference parameter for a child playing happily with other children by age 3. ω_learn = preference parameter for a child learning well at school. Controls include the age of the mother and its square, the sex of the index child, 3 levels of parity (first child in womb, second, and third or higher), 4 levels of mother's education (no education, 1-5 years, 6-10 years, and +10 years), husband's education in years, a SES asset-based index, and a dummy for being diagnosed with depression at baseline. Column (1) interacts beliefs and costs with a dummy indicating whether there is an older female child in the household (constrained = no female child). Column (2) interacts beliefs and costs with a dummy indicating whether the grandmother lives in the household (constrained = grandmother not in household). Column (3) interacts beliefs and costs with a dummy indicating whether the mother lives in an agricultural household (constrained = agricultural household). A household is considered agricultural if anyone in the household owns or rents land for farming.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Excludes depressed mothers in the intervention group.

Table A.14: Women with potentially no breastfeeding constraints

	(1) If had enough food	(2) If weight>10^{th} pctile.
ω_speak	0.055	0.154
	(0.380)	(0.385)
ω_health	−0.045	0.071
	(0.250)	(0.270)
ω_social	−0.211	−0.111
	(0.403)	(0.387)
ω_learn	1.003***	0.728**
	(0.348)	(0.367)
Breastfeeding is tiring	0.253	0.146
	(0.169)	(0.156)
Playing is tiring	−0.670***	−0.448**
	(0.192)	(0.195)
Controls	Yes	Yes
Observations	2216	2248
# mothers	554	562

Note: Results estimated using a multinomial logit model where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. The model includes a constant and the investment alternatives are evaluated against not breastfeeding and not playing (omitted category). ω_speak = preference parameter for a child being able to put 2-3 words together in speaking by age 2. ω_health = preference parameter for a child not experiencing frequent diarrhea. ω_social = preference parameter for a child playing happily with other children by age 3. ω_learn = preference parameter for a child learning well at school. Controls include the age of the mother and its square, the sex of the index child, 3 levels of parity (first child in womb, second, and third or higher), 4 levels of mother's education (no education, 1-5 years, 6-10 years, and +10 years), husband's education in years, a SES asset-based index, and a dummy for being diagnosed with depression at baseline.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Excludes depressed mothers in the intervention group. In addition, Column (1) excludes women that did not have enough money to by food at baseline, and Column (2) excludes women with weight equal or below the 10^{th} percentile.

Table A.15: Model estimates of the preference parameters with complementarities in investments

	Speak		Health		Social		Learn		All outcomes	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Complementarity from pilot										
ω_speak	0.584**	0.531**							0.233	0.191
	(0.250)	(0.242)							(0.363)	(0.342)
ω_health			0.209	0.194					0.039	0.037
			(0.265)	(0.254)					(0.276)	(0.268)
ω_social					0.401*	0.389			−0.371	−0.303
					(0.225)	(0.245)			(0.355)	(0.369)
ω_learn							0.942***	0.861***	1.023***	0.923***
							(0.229)	(0.241)	(0.335)	(0.348)
Breastfeeding is tiring	0.203	0.213	0.195	0.204	0.201	0.211	0.233*	0.241	0.233*	0.241
	(0.132)	(0.145)	(0.131)	(0.145)	(0.131)	(0.144)	(0.134)	(0.148)	(0.134)	(0.148)
Playing is tiring	−0.690***	−0.611***	−0.722***	−0.638***	−0.703***	−0.621***	−0.674***	−0.596***	−0.675***	−0.597***
	(0.185)	(0.192)	(0.180)	(0.188)	(0.180)	(0.189)	(0.180)	(0.189)	(0.183)	(0.191)
5% complementarity										
ω_speak	0.588**	0.535**							0.230	0.188
	(0.251)	(0.242)							(0.366)	(0.345)
ω_health			0.208	0.192					0.036	0.033
			(0.265)	(0.254)					(0.276)	(0.268)
ω_social					0.400*	0.388			−0.395	−0.328
					(0.225)	(0.245)			(0.358)	(0.372)
ω_learn							0.961***	0.882***	1.059***	0.963***
							(0.229)	(0.240)	(0.340)	(0.353)
Breastfeeding is tiring	0.203	0.213	0.195	0.204	0.202	0.212	0.234*	0.242	0.234*	0.242
	(0.132)	(0.145)	(0.131)	(0.145)	(0.131)	(0.144)	(0.134)	(0.148)	(0.135)	(0.148)
Playing is tiring	−0.690***	−0.611***	−0.722***	−0.638***	−0.703***	−0.621***	−0.674***	−0.596***	−0.675***	−0.598***
	(0.185)	(0.192)	(0.180)	(0.188)	(0.180)	(0.189)	(0.181)	(0.189)	(0.184)	(0.191)
10% complementarity										
ω_speak	0.592**	0.541**							0.225	0.184
	(0.253)	(0.243)							(0.371)	(0.348)
ω_health			0.206	0.189					0.031	0.026
			(0.265)	(0.254)					(0.276)	(0.268)
ω_social					0.396*	0.384			−0.428	−0.365
					(0.225)	(0.244)			(0.361)	(0.375)
ω_learn							0.987***	0.912***	1.111***	1.020***
							(0.228)	(0.240)	(0.345)	(0.359)
Breastfeeding is tiring	0.204	0.214	0.195	0.204	0.202	0.212	0.235*	0.244	0.236*	0.244
	(0.132)	(0.145)	(0.131)	(0.145)	(0.131)	(0.144)	(0.134)	(0.149)	(0.135)	(0.149)
Playing is tiring	−0.691***	−0.611***	−0.722***	−0.638***	−0.704***	−0.622***	−0.673***	−0.596***	−0.676***	−0.599***
	(0.185)	(0.192)	(0.180)	(0.188)	(0.180)	(0.189)	(0.181)	(0.189)	(0.184)	(0.191)
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2504	2504	2504	2504	2504	2504	2504	2504	2504	2504
# mothers	626	626	626	626	626	626	626	626	626	626

Note: Results estimated using a multinomial logit model where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. The model includes a constant and the investment alternatives are evaluated against not breastfeeding and not playing (omitted category). ω_speak = preference parameter for a child being able to put 2-3 words together in speaking by age 2. ω_health = preference parameter for a child not experiencing frequent diarrhea. ω_social = preference parameter for a child playing happily with other children by age 3. ω_learn = preference parameter for a child learning well at school. Controls include the age of the mother and its square, the sex of the index child, 3 levels of parity (first child in womb, second, and third or higher), 4 levels of mother's education (no education, 1-5 years, 6-10 years, and +10 years), husband's education in years, a SES asset-based index, and a dummy for being diagnosed with depression at baseline. "Complementarity from pilot" defines a 1.8% complementarity between investments when mothers both breastfeed and play with the child. This level of complementarity is calculated using a sample of women for which expected returns from investments where asked both jointly and independently. "5% complementarity" assumes there is a 5% complementary between investments when mothers both breastfeed and play with the child; while "10% complementarity" assumes this level is of the order of 10%.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Excludes depressed mothers in the intervention group.

Table A.16: Model estimates: Additional specifications

	(1) Including treated mothers	(2) Positive returns	(3) Negative returns set to 0	(4) Cost and enjoyment of investments	(5) First-time mothers	(6) First-time mothers	(7) Baseline model (Unweighted)
ω_speak	0.127	−0.008	0.044	0.221		0.569	0.204
	(0.333)	(0.439)	(0.354)	(0.346)		(0.729)	(0.336)
ω_health	0.100	0.211	0.302	0.078		0.252	0.012
	(0.269)	(0.323)	(0.284)	(0.272)		(0.488)	(0.267)
ω_social	−0.067	0.256	0.021	−0.269		−0.559	−0.292
	(0.340)	(0.404)	(0.411)	(0.377)		(0.753)	(0.366)
ω_learn	0.664**	0.722*	0.686**	0.939***	0.931**	0.936	0.934***
	(0.339)	(0.394)	(0.348)	(0.342)	(0.448)	(0.608)	(0.340)
Breastfeeding is tiring	0.195	0.098	0.223	0.247*	0.350	0.372	0.248*
	(0.142)	(0.186)	(0.148)	(0.147)	(0.350)	(0.346)	(0.146)
Playing is tiring	−0.540***	−0.707***	−0.605***	−0.583***	−1.013***	−0.993***	−0.610***
	(0.179)	(0.219)	(0.188)	(0.189)	(0.333)	(0.340)	(0.189)
Breastfeeding is enjoyable				−0.291			
				(0.265)			
Playing is enjoyable				−0.223			
				(0.407)			
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3352	2008	2504	2504	720	720	2504
# mothers	838	502	626	626	180	180	626

Note: Results estimated using a multinomial logit model where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. The model includes a constant and the investment alternatives are evaluated against not breastfeeding and not playing (omitted category). ω_speak = preference parameter for a child being able to put 2-3 words together in speaking by age 2. ω_health = preference parameter for a child not experiencing frequent diarrhea. ω_social = preference parameter for a child playing happily with other children by age 3. ω_learn = preference parameter for a child learning well at school. Controls include the age of the mother and its square, the sex of the index child, 3 levels of parity (first child in womb, second, and third or higher), 4 levels of mother's education (no education, 1-5 years, 6-10 years, and +10 years), husband's education in years, a SES asset-based index, and a dummy for being diagnosed with depression at baseline. Column (1) includes depressed mothers in the intervention group; Column (2) excludes mothers with more than one negative expected returns from investments, Column (3) assumes returns from investments cannot be negative; Column (4) includes whether mothers find breastfeeding and playing with the child enjoyable in the cost function. Columns (5) and (6) show results of the baseline model (but replacing categories of education with continuous years of education) estimated only for first-time mothers. Column (7) shows the results of estimating the baseline model without weighting observations to adjust for depression prevalence.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the village level in parentheses.

Sample: Column (1) all mothers, Columns (2 - 4) and (7) exclude depressed mothers in the intervention group. In addition, Column (2) excludes mothers with more than one negative expected returns from investments. Columns (5) and (6) exclude women that had cared for babies of their own before.

Table A.17a: Policy evaluations for different subsamples

Panel A: sample of depressed mothers (30% of women)

	(0) Baseline Predicted	(1) High SES beliefs	(2) Increase returns (v1)	(3) Increase returns (v2)	(4) Playing not costly	(5) 2 + 4	(6) 3 + 4	(7) Treat depression	(8) Educate women
Pr(No-bf, no-pl)	41.2	40.6	39.4	32.7	38.9	37.2	30.6	35.8	37.8
Pr(Bf, no-pl)	34.8	35.0	35.8	39.9	32.9	33.8	37.4	32.0	35.6
Pr(No-bf, pl)	12.3	12.5	12.5	13.9	14.3	14.6	16.1	13.9	15.5
Pr(Bf, pl)	11.8	11.9	12.2	13.5	13.9	14.4	15.8	18.3	11.0
Pr(Bf)	46.6	46.9	48.0	53.4	46.8	48.2	53.2	50.3	46.7
Pr(Pl)	24.0	24.4	24.7	27.4	28.2	29.0	31.9	32.3	26.5
Δ Pr(No-bf, no-pl)	**0.0**	**-0.6**	**-1.8**	**-8.5**	**-2.2**	**-4.0**	**-10.5**	**-5.4**	**-3.4**
Δ Pr(Bf)	**0.0**	**0.4**	**1.5**	**6.8**	**0.2**	**1.6**	**6.6**	**3.7**	**0.1**
Δ Pr(Pl)	**0.0**	**0.4**	**0.7**	**3.4**	**4.2**	**4.9**	**7.9**	**8.2**	**2.5**
Gap (Bf)	3.7	3.3	2.2	-3.2	3.5	2.1	-3.0	-0.1	3.5
Gap (Pl)	10.6	10.2	9.9	7.2	6.4	5.6	2.7	2.3	8.0

Panel B: sample of low educated mothers (76% of women)

	(0) Baseline Predicted	(1) High SES beliefs	(2) Increase returns (v1)	(3) Increase returns (v2)	(4) Playing not costly	(5) 2 + 4	(6) 3 + 4	(7) Treat depression	(8) Educate women
Pr(No-bf, no-pl)	38.5	38.0	36.7	30.2	36.4	34.7	28.4	36.6	34.6
Pr(Bf, no-pl)	32.9	33.1	33.9	37.5	31.1	31.9	35.1	32.0	33.9
Pr(No-bf, pl)	12.3	12.5	12.7	13.9	14.0	14.4	15.7	12.9	16.4
Pr(Bf, pl)	16.2	16.4	16.7	18.3	18.5	19.1	20.8	18.4	15.1
Pr(Bf)	49.1	49.5	50.6	55.8	49.6	51.0	55.9	50.5	49.0
Pr(Pl)	28.6	28.9	29.4	32.3	32.5	33.4	36.5	31.3	31.5
Δ Pr(No-bf, no-pl)	**0.0**	**-0.5**	**-1.8**	**-8.3**	**-2.1**	**-3.9**	**-10.1**	**-1.9**	**-3.9**
Δ Pr(Bf)	**0.0**	**0.3**	**1.5**	**6.7**	**0.4**	**1.8**	**6.8**	**1.4**	**-0.2**
Δ Pr(Pl)	**0.0**	**0.3**	**0.9**	**3.7**	**3.9**	**4.9**	**8.0**	**2.8**	**3.0**
Gap (Bf)	0.1	-0.3	-1.4	-6.6	-0.4	-1.8	-6.7	-1.3	0.2
Gap (Pl)	11.8	11.5	10.9	8.1	7.8	6.9	3.8	9.0	8.8

Panel C: sample of mothers with low SES (45% of women)

	(0) Baseline Predicted	(1) High SES beliefs	(2) Increase returns (v1)	(3) Increase returns (v2)	(4) Playing not costly	(5) 2 + 4	(6) 3 + 4	(7) Treat depression	(8) Educate women
Pr(No-bf, no-pl)	40.1	39.2	38.3	31.6	37.7	36.0	29.6	37.9	36.4
Pr(Bf, no-pl)	34.6	34.9	35.6	39.6	32.6	33.5	36.9	33.6	35.9
Pr(No-bf, pl)	11.8	12.2	12.2	13.4	13.8	14.2	15.5	12.6	15.3
Pr(Bf, pl)	13.5	13.8	13.9	15.3	15.9	16.4	18.0	15.9	12.4
Pr(Bf)	48.1	48.6	49.5	54.9	48.5	49.9	54.9	49.4	48.3
Pr(Pl)	25.3	25.9	26.1	28.8	29.7	30.6	33.5	28.5	27.7
Δ Pr(No-bf, no-pl)	**0.0**	**-0.9**	**-1.8**	**-8.4**	**-2.3**	**-4.1**	**-10.5**	**-2.1**	**-3.6**
Δ Pr(Bf)	**0.0**	**0.5**	**1.4**	**6.8**	**0.4**	**1.7**	**6.8**	**1.3**	**0.1**
Δ Pr(Pl)	**0.0**	**0.6**	**0.8**	**3.5**	**4.4**	**5.3**	**8.2**	**3.2**	**2.4**
Gap (Bf)	1.9	1.4	0.5	-4.9	1.5	0.2	-4.9	0.6	1.7
Gap (Pl)	11.3	10.7	10.5	7.9	7.0	6.1	3.1	8.1	8.9

Note: Predicted probabilities estimated after a multinomial logit model where the preference parameters for children's developmental outcomes are evaluated jointly and where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. Col (0) - Baseline predicted probabilities; Col (1) - Low SES mothers have the beliefs held by the high SES mothers; Col (2) - The probability of children achieving developmental outcomes is increased by 10 pp. Col (3) - The probability of children achieving developmental outcomes is increased by the IQR of the average expected return of single investments (average increase of 43 pp); Col (4) - The effort cost of playing is suppressed; Col (5) - Combines Col (2) and Col (4); Col (6) - Combines Col (3) and Col (4); Col (7) - Depression status is changed to not depressed, and beliefs and costs are set at the value that not depressed mothers have; Col (8) - Education level is set at +10 years of education, and beliefs and costs are set at the value that mothers with +10 years of education have. Low educated mothers are defined as those with 10 or less years of education. The gap in investments is given by the difference between the predicted investment level among the treated group in each of the policy scenarios and the predicted investment level at baseline of the untreated group, which is: Panel A = nondepressed mothers; Panel B = high educated mothers; Panel C = high SES mothers.

Table A.17b: Policy evaluations for different subsamples

Panel D: sample of mothers with at least two expected zero return (exluding 0 return on diarrhea from playing) (36% of women)

	(0) Baseline Predicted	(1) High SES beliefs	(2) Increase returns (v1)	(3) Increase returns (v2)	(4) Playing not costly	(5) 2 + 4	(6) 3 + 4	(7) Treat depression	(8) Educate women
Pr(No-bf, no-pl)	42.3	39.4	40.5	33.1	39.4	37.7	30.5	39.3	35.5
Pr(Bf, no-pl)	30.8	32.4	31.7	35.9	28.7	29.4	33.0	30.5	33.3
Pr(No-bf, pl)	12.5	13.1	12.9	14.4	14.8	15.3	16.9	13.5	16.7
Pr(Bf, pl)	14.3	15.1	14.8	16.6	17.1	17.6	19.6	16.7	14.5
Pr(Bf)	45.1	47.5	46.5	52.5	45.7	47.1	52.6	47.2	47.8
Pr(Pl)	26.8	28.2	27.7	31.0	31.9	32.9	36.5	30.2	31.2
Δ Pr(No-bf, no-pl)	**0.0**	**-2.9**	**-1.8**	**-9.2**	**-2.9**	**-4.7**	**-11.8**	**-3.0**	**-6.8**
Δ Pr(Bf)	**0.0**	**2.3**	**1.4**	**7.4**	**0.6**	**1.9**	**7.5**	**2.1**	**2.6**
Δ Pr(Pl)	**0.0**	**1.3**	**0.9**	**4.1**	**5.1**	**6.1**	**9.6**	**3.3**	**4.4**
Gap (Bf)	6.2	3.8	4.8	-1.2	5.6	4.2	-1.3	4.1	3.5
Gap (Pl)	7.1	5.8	6.2	3.0	2.1	1.1	-2.5	3.8	2.8

Panel E: sample of mothers with high cost on any investment (17% of women)

	(0) Baseline Predicted	(1) High SES beliefs	(2) Increase returns (v1)	(3) Increase returns (v2)	(4) Playing not costly	(5) 2 + 4	(6) 3 + 4	(7) Treat depression	(8) Educate women
Pr(No-bf, no-pl)	39.9	38.9	38.0	31.1	34.8	32.9	26.6	37.3	35.3
Pr(Bf, no-pl)	36.5	37.0	37.7	41.9	31.8	32.7	35.9	34.1	34.9
Pr(No-bf, pl)	9.8	10.0	10.1	11.1	14.0	14.4	15.6	11.5	15.2
Pr(Bf, pl)	13.8	14.1	14.3	15.8	19.4	19.9	21.8	17.1	14.5
Pr(Bf)	50.3	51.1	51.9	57.7	51.3	52.7	57.8	51.2	49.5
Pr(Pl)	23.6	24.1	24.4	26.9	33.4	34.3	37.4	28.6	29.7
Δ Pr(No-bf, no-pl)	**0.0**	**-1.0**	**-2.0**	**-8.8**	**-5.1**	**-7.0**	**-13.3**	**-2.6**	**-4.6**
Δ Pr(Bf)	**0.0**	**0.8**	**1.6**	**7.4**	**0.9**	**2.4**	**7.4**	**0.9**	**-0.8**
Δ Pr(Pl)	**0.0**	**0.5**	**0.8**	**3.3**	**9.8**	**10.7**	**13.8**	**5.0**	**6.1**
Gap (Bf)	-1.0	-1.8	-2.6	-8.4	-1.9	-3.4	-8.4	-1.9	-0.2
Gap (Pl)	9.5	9.0	8.7	6.2	-0.3	-1.2	-4.3	4.5	3.4

Note: Predicted probabilities estimated after a multinomial logit model where the preference parameters for children's developmental outcomes are evaluated jointly and where mothers' alternatives are: no-bf, no-pl = not breastfeeding and not playing; bf, no-pl = breastfeeding but not playing; no-bf, pl = not breastfeeding but playing; bf, pl = breastfeeding and playing. Col (0) - Baseline predicted probabilities; Col (1) - Low SES mothers have the beliefs held by the high SES mothers; Col (2) - The probability of children achieving developmental outcomes is increased by 10 pp. Col (3) - The probability of children achieving developmental outcomes is increased by the IQR of the average expected return of single investments (average increase of 43 pp); Col (4) - The effort cost of playing is suppressed; Col (5) - Combines Col (2) and Col (4); Col (6) - Combines Col (3) and Col (4); Col (7) - Depression status is changed to not depressed, and beliefs and costs are set at the value that not depressed mothers have; Col (8) - Education level is set at +10 years of education, and beliefs and costs are set at the value that mothers with +10 years of education have. The gap in investments is given by the difference between the predicted investment level among the treated group in each of the policy scenarios and the predicted investment level at baseline of the untreated group, which is: Panel D = mothers with less than two expected zero returns (excluding 0 return on diarrhea from playing); Panel D = mothers with low cost on both investments.

Appendix B

Data Appendix

B.1 Questionnaire

Now I am going to ask you some questions about your beliefs regarding certain behaviours that a mother in your community could have and its effect on her child.

Before that, let's talk about how I am going to understand your answers better. We will use different sizes of bars to record your answer. I will show you ten bars of different sizes. I would like you to choose one of the bars out of these ten bars over here to express what you think is the chance of a specific event happening. The smaller the bar, the lesser chances are for that specific event to happen. On the other hand, the bigger the bar, the higher the chances are for that specific event to happen. In other words, as you increase the size of the bar, the chances increase. If you choose zero, it means you are sure that the event will NOT happen. If you choose 1, it means one chance out of 10. If you choose 1 or 2, it means you think the event is not likely to happen, but it is still possible. If you pick 5, it means that it is just as likely it happens as it does not happen (fifty-fifty). If you pick 6, it means the event is slightly more likely to happen than not to happen. If you put 10, it means you are sure the event will happen. There is no right or wrong answer; I just want to know what you think.

Let me ask you a couple of questions to make sure you understand how to answer using the bars.

Pick the size of the bar that reflects how likely the following event can happen... (*Training questions*)

(a) A woman in your community will go to the market at least once within the next 2 days.

(b) A woman in your community will go to the market at least once within the next 2 weeks.

Within your community, the maternal behaviors that we are interested in are a) breastfeeding and b) playing with the child. We are interested in whether you think these might influence the health and growth of children (including getting ill, doing well at school, being able to speak and engage with others).

Some people think these behaviors affect their children, and some people don't think they make a difference. Among people who think they make a difference, some think they make a big difference and others think they make only a small difference. There is no right or wrong answer; we just want to know what you think. When answering the questions, please think of another mother like you.

First, I am going to ask you questions regarding breastfeeding and its influence on the health and growth of children. Please provide your answers to the questions that I will ask you with the help of the bars.

(1) In your view, what is the likelihood of a child/infant in your community to frequently have diarrhea:

  (a) If the mother exclusively breastfeeds for 6 months.

  (b) If the mother does not exclusively breastfeed for 6 months.

(2) In your view, what is the likelihood of a child to put 2-3 words together in speaking by age 2 years of his/her life:

   (a) If the mother exclusively breastfeeds for 6 months.
   (b) If the mother does not exclusively breastfeed for 6 months.

(3) In your view, what is the likelihood that a child will happily play with other children by age 3:

   (a) If the mother exclusively breastfeeds for 6 months.
   (b) If the mother does not exclusively breastfeed for 6 months.

(4) In your view, what is the likelihood that a child in your community will learn well at school:

   (a) If the mother exclusively breastfeeds for 6 months.
   (b) If the mother does not exclusively breastfeed for 6 months.

Now we are going to ask the same questions that we asked earlier but this time we will relate them to someone who plays with the child instead of to breastfeeding behavior. Again, there is no right or wrong answer; we just want to know what you think.

Please provide your answers to the questions that I will ask you with the help of the bars.

(1) In your view, what is the likelihood of a child/infant in your community to frequently have diarrhea:

   (a) If the mother plays with the child frequently to help them learn new things.
   (b) If the mother plays with the child rarely to help them learn new things.

(2) In your view, what is the likelihood of a child to put 2-3 words together in speaking by age 2 years of his/her life:

  (a) If the mother plays with the child frequently to help them learn new things.
  (b) If the mother plays with the child rarely to help them learn new things.

(3) In your view, what is the likelihood that a child will happily play with other children by age 3:

  (a) If the mother plays with the child frequently to help them learn new things.
  (b) If the mother plays with the child rarely to help them learn new things.

(4) In your view, what is the likelihood that a child in your community will learn well at school:

  (a) If the mother plays with the child frequently to help them learn new things.
  (b) If the mother plays with the child rarely to help them learn new things.

B.2 Construction of variables

Measuring depression. Depression was assessed using the patient health questionnaire (PHQ-9), which queries a series of symptoms of depression, each being scored on a four-point Likert scale. The PHQ-9 asks about the following 9 items: 1) Little interest or pleasure in doing things. 2) Feeling down, depressed, or hopeless. 3) Trouble falling or staying asleep, or sleeping too much. 4) Feeling tired or having little energy. 5) Poor appetite or overeating. 6) Feeling bad about yourself, or that you are a failure or have let yourself or your family down. 7) Trouble concentrating on things, such as reading the newspaper or watching television. 8) Moving or speaking so slowly that other people could have noticed? Or the opposite, being so fidgety or restless that you have been moving around a lot more than usual. 9) Thoughts that you would be better off dead or of hurting yourself in some way. Women were classified as depressed when their score was 10 or above, as this cut-off point has been proven to have a high predictive power for the diagnosis of depressive disorder (Kroenke, Spitzer, and Williams 2001).

Measuring maternal investments *Exclusive breastfeeding* is measured by asking mothers all the nutrients given to their child in the last 24 hours, including breast milk, a herbal cocktail (ghutti), herbal water, water, tea (chai), formula milk, other animal milk (cow, goat, buffalo), semi-solid food, solid food, or other. See Appendix Table A.2 for a detailed summary of feeding practices in our study area. Mothers are considered as exclusively breastfeeding if they are giving only breast milk.

Play is measured through a question collected within the Infant-Toddler HOME (Home Observation Measurement of the Environment) inventory questionnaire designed for children aged 0-3 (Cox et al., 2002). The enumerators are instructed to look out for the behavior and to question the mother. The HOME inventory has 6 sections covering the following topics:

I RESPONSIVITY

1. Parent permits child to engage in “messy” play.
2. Parent spontaneously vocalizes to the child at least twice.
3. Parent responds verbally to the child’s vocalizations or verbalizations.
4. Parent tells child name of object or person during visit.
5. Parent’s speech is distinct, clear, and audible.
6. Parent initiates verbal interchanges with visitor.
7. Parent converses freely and easily.
8. Parent spontaneously praises child at least twice.
9. Parent’s voice conveys positive feelings towards child.
10. Parent caresses or kisses child at least once.
11. Parent responds positively to praise of child offered by visitor.

II ACCEPTANCE

12. No more than one instance of physical punishment during past week.
13. Family has a pet.
14. Parent does not shout at child.
15. Parent does not express overt annoyance with or hostility to child.
16. Parent neither slaps nor spanks child during visit.
17. Parent does not scold or criticize child during visit.
18. Parent does not interfere with or restrict child more than three times during visit.
19. At least ten books are present and visible.

III ORGANIZATION

20. Child care, if used, is provided by one of three regular substitutes.
21. Child is taken to grocery store at least once a week.
22. Child gets out of house at least four times a week.
23. Child is taken regularly to doctor's office or clinic.
24. Child has a special place for toys and treasures.
25. Child's play environment is safe.

IV LEARNING MATERIAL

26. Muscle activity toys or equipment.
27. Push or pull toys.
28. Stroller or walker, kiddie car, scooter, or tricycle.
29. Cuddly toys or role- playing toys.
30. Learning facilitators-mobile, table, and chair, high chair, play pen.
31. Simple hand-eye coordination toys.
32. Complex hand-eye coordination toys.
33. Toys for literature and music.
34. Parent provides toys for child to play with during visit.

V INVOLVEMENT

35. Parent talks to child while doing household work.
36. Parent consciously encourages developmental advance.
37. Parent invests maturing toys with value via personal attention.
38. Parent guides during play/structures child's play period.
39. Parent provides toys that challenge child to develop new skills.
40. Parent keeps child in visual range, looks at often.

VI VARIETY

41. Father provides some care daily.
42. Parent reads stories to child at least three times weekly.
43. Child eats at least one meal a day with mother and father.
44. Family visit relatives or receives visits once a month or so.
45. Child has three or more books of his/her own.

All items are answered with either yes (value of 1) or no (value of 0). Our main outcome of play uses the answer to item 38. In Section 1.6, we conduct robustness checks by considering mothers to be making the playing investment when she scores in the top tertile of:

1– The HOME Score

2– The Stimulation Score (combining the score in the Responsivity and Involvement sections)

3– The first principal component (PCA) of the Stimulation items (Responsivity and Involvement items)

Measuring expected cost We elicited expected effort costs associated with making the investments by asking mothers at baseline (before birth) to report on a Likert scale how tiring they expected it would be to breastfeed or to play with a baby. The scale had 4 points, indicating rarely or never, sometimes, most of the times, or don't know.

Other constructed variables *Wealth*: We construct a measure of wealth using an asset-based index that has been widely used in household surveys such as the Demographic and Health Surveys. It is constructed using polychoric correlations, more suited for categorical variables than standard correlations (Kolenikov and Angeles, 2004). It includes asset variables for which less than or equal to 90% of people owned the asset and less than or equal to 90% of people did not own the item. This ensured enough variability in the items going into the principal components score. The full list of assets meeting this condition was: own or rent a farm, ownership of animals, radio, television, fridge, washing machine, electric water pump, bed, chair, cabinet, clock, sofa, sewing machine, camera, laptop computer, wrist-watch, car/truck, piped natural gas, flush toilet, roof made of reinforced brick cement or concrete cement, wall made of baked bricks or cement blocks, and floor made of bricks/terrazzo or ceramic tiles.

Farming household: If women respond that she or any other household member owns or rent any land for farming, we consider the women as living in an agricultural or farming household (60% of households).

Chapter 2

Taking Cover: Human Capital Accumulation in the Presence of Shocks and Health Insurance

2.1 Introduction

In the past decades, the education level of the world's population has experienced a remarkable and sustained increase (J.-W. Lee and Lee, 2016). This has also been the case for low and middle-income countries, for which the number of out-of-school children has been steadily decreasing amidst the push to achieve universal primary and secondary education (UIS, 2018). However, an alarming number of children attending school perform poorly in cognitive assessments, large disparities in cognitive achievement both across countries and population groups persist, and current learning gaps are closing at a sluggish pace (Hanushek, 2013; UIS, 2017).

With the improvements in schooling, the international community has moved the attention towards its quality. However, although schools and the teaching they provide play a critical role in the cognitive development of children (Araujo et al., 2016;

Dearden et al., 2002; Deming et al., 2014), quality alone cannot provide an exhaustive explanation of what is being considered a global learning crisis. There exist other important and complementary inputs in the education production function over which families have a closer control and that explain a substantial part of the variation observed in cognition levels, including time, monetary, and health investments in children (see Currie and Almond (2011); and Almond et al. (2018) for a review of the studies). Moreover families (especially in low-income areas), are often exposed to shocks, and negative disturbances affecting family means might result in interruptions in children's cognitive development.

Whether shocks impact children's human capital, however, depend on the ability and coping mechanisms households have access to (Almond et al., 2018; Frankenberg and Thomas, 2017). This study seeks to investigate the extent to which access to public health insurance, a form of safety net, is able to protect children's performance in school during adversity. I define shocks as atypical rainfall levels and use the expansion of a large-scale pro-poor health insurance program in Mexico that sought to extend access to public healthcare to the uninsured (estimated to be around half of the population at the program start). The reasons why adverse rainfall might impact learning include its effect on health and the disease environment (Aguilar and Vicarelli, 2011; Bleakley, 2010; Colón-González et al., 2013; Duque et al., 2019; Maccini and Yang, 2009; Rocha and Soares, 2015; Rosales, 2014; Wu et al., 2015), on income, food security, and the opportunity cost of schooling (Amare et al., 2018; Gabrysch et al., 2018; Shah and Steinberg, 2017; Skoufias and Vinha, 2013), on mental distress (OBrien et al., 2014; Rataj et al., 2016), and more broadly on economic and political stability (Barrios et al., 2010; Hsiang et al., 2013; Miguel et al., 2004).

On the other hand, healthcare coverage has been linked to higher endowment levels at birth (Bhalotra et al., 2019), lower incidence of sickness and preventable hospitalizations (Currie et al., 2008; Miller and Wherry, 2019), better mental health

(Finkelstein et al., 2012), and higher levels of education attained (Brown et al., 2015; Cohodes et al., 2016; Levine and Schanzenbach, 2009; Miller and Wherry, 2019; Wherry et al., 2016). Moreover, studies have shown an association between financial protection in health and a lower probability of suffering catastrophic and impoverishing health expenditures (Gross and Notowidigdo, 2011; Wherry et al., 2016), and higher levels of consumption through a reduction in precautionary savings (Gruber and Yelowitz, 1999; Maynard and Qiu, 2009).

The health insurance program under study is Seguro Popular (or Popular Health Insurance, hereafter also referred to as SP). The SP was the result of a reform of the Mexican health system in response to a political debate after national estimates showed that more than 50% of the health expenditures in the country were out of pocket, with 2 to 4 million families estimated to be suffering from catastrophic and impoverishing health expenditures each year (Knaul et al., 2006). Starting in 2002 as a pilot program, it offered a comprehensive package of health services to individuals outside of the social security system and, after ten years of program expansion and more than 52 million new affiliations, it achieved its target of establishing universal healthcare.

In this study I analyze the capacity of universal healthcare in protecting the cognitive development of children in the event of negative shocks. To do so, I combine information from a yearly national standardized test delivered to all students in certain grades in primary education, the expansion in health coverage induced by the reform of the health system and the creation of Seguro Popular, and rainfall precipitation measured at the school-locality level in a region where climatic conditions are influenced by El Niño/Southern Oscillation (ENSO)[1]. The results show that while adverse rainfall shocks reduce mathematics and verbal attainment by 0.022 and 0.020 standard deviations respectively, a one standard deviation increase in healthcare cov-

[1] An irregular climatic phenomenon that has been shown to affect precipitation levels in Mexico.

erage mitigates 55% and 52% of the negative effect.[2] The estimated results are driven by schools located in more marginalized and rural areas. Moreover, the impact of the shocks differs by intensity and nature, with dry periods imposing a higher burden on the process of learning and during which health coverage offsets the highest proportion of the adverse effect. On the other hand, robustness specifications suggest a null impact of health coverage on cognitive attainment in the absence of shocks.

An exploration of the underlying mechanisms using household survey data shows that when hit by rainfall shocks, access to SP reduces the incidence of sickness among children from eligible families, decreases the demand for children's time, and protects household's consumption levels. While negative rainfall shocks increase by 6.6 percentage points the probability of children being sick, and by 14.1 percentage points their probability of being involved in domestic chores, each additional year of SP eligibility reduces these probabilities by 1.5 and 3.5 percentage points respectively (significant at the 5% level). Similarly, rainfall shocks are associated with a reduction of 16% in consumption expenditures among program-eligible households (18% in rural households and similar to the 16.7% reduction estimated by Bobonis (2009) for a sample of rural households in Mexico). Each additional year of SP availability, however, reduces by 4% (3%) the negative effect.

Overall, the story that emerges from the findings is one of positive spillovers on education from public investments in health. It provides evidence of the capacity of universal healthcare in building resilience in cognitive attainment against negative shocks experienced during childhood, and contributes to our understanding of some of the mechanisms at play. The results contribute to and are in line with recent studies evaluating the extent to which different programs can mitigate the negative effect of climatic and other environmental shocks on human capital. For instance, conditional

[2] The effect of rainfall shocks on mathematics test scores is equivalent to erasing more than one-fourth of the gains from interventions that provide instructional materials, or more than one-sixth of the gains from teacher training programs (see McEwan (2015) for a review of randomized educational experiments in developing countries).

cash transfers ease the negative effect of rainfall shocks on educational attainment in Mexico (Adhvaryu et al., 2018) and Colombia (Duque et al., 2019), vitamin A supplementation at-birth reduces the adverse effects of exposure to a tornado on infant health in Bangladesh (Gunnsteinsson et al., 2019), a rural employment scheme in India mitigates the impact of heatwaves on children's cognition (Garg et al., 2017), public health improvements in West Africa weaken the link between dust storms and child mortality (Adhvaryu et al., 2019), and the introduction of air conditioning in schools alleviates the effect of heat exposure on test scores in the US (Park et al., 2020).

This study also speaks to the literature evaluating the effect of healthcare coverage on children's educational outcomes. While most of the previous studies have focused on the role of health insurance in fostering education in advanced economies and have limited the analysis to a sub-samples of households, I estimate the effect of healthcare coverage in a context of high regional imbalances and exploit a nationwide policy to implement universal health coverage.[3] One other study has attempted to evaluate the link between health insurance and education in Mexico (Alcaraz et al., 2016), finding a positive association between healthcare coverage, school enrolment, and educational performance at the municipality level. I expand on previous findings by assessing the capacity of healthcare coverage in building resilience in children's performance in school, and by investigating some of the mechanisms by which universal healthcare might help children and their families endure adverse environmental shocks. This study is similar in spirit as Liu (2016), who using survey data shows that the expansion in health coverage across rural China increased the probability of children being enrolled in school following a household health shock. To avoid the potential endogeneity of health shocks and risk-sharing networks among neighboring

[3] Most of the evidence comes from the Medicaid program and the CHIP (Children's Health Insurance Program) in the US, which target families and children in poverty and under specific vulnerable conditions.

households, I focus on climatic shocks experienced at the locality level, and focus on children's performance in school (instead of enrollment) using administrative data.

Because adverse rainfall shocks are one of the most prevalent disturbances experienced among the poor (Dinkelman, 2013), the results of this study are highly relevant to a large share of the population of the world. Climate instability has consolidated as one of the major threats to developmental gains, including gains in human capital, and there is international consensus to develop and implement policies that mitigate its negative effects on the population (Field et al., 2012). Universal health coverage has recently evidenced its potential to protect the world's population against global health shocks (Aarabi et al., 2020). The WHO pushes for its expansion as a major goal for health reform (WHO and World Bank, 2017, 2020), and many countries across the world are increasing access to social health insurance among the disadvantaged population (Boerma et al., 2014; Marten et al., 2014; Reich et al., 2016). To the best of my knowledge, this is the first study to assess the capacity of universal healthcare in mitigating the effect of negative shocks on children's cognitive performance.

The rest of the paper is organized as follows. Section 2.2 introduces the social health insurance expansion in Mexico. Section 2.3 describes the academic, climate, affiliation to Seguro Popular, and household survey data. The empirical strategy is discussed in section 2.4, and the results follow in section 2.5. I conduct a series of robustness checks in Section 2.6. Finally, Section 2.7 explores the mechanisms at play and Section 2.8 concludes.

2.2 Seguro Popular: health insurance for the poor

Before the creation of Seguro Popular, social health insurance was administered by two main institutions that still exist today. On the one hand, the Mexican Social

Security Institute (IMSS), covering the workers of the private sector; and the Institute for Social Security and Services for State Workers (ISSSTE), covering public employees.[4,5]

Those families not integrated into any of the former institutions could seek healthcare assistance through the conditional cash transfer program and main anti-poverty program in the country (Progresa/Oportunidades), or in the Coverage Expansion Program (PAC), which consisted of mobile healthcare teams visiting the most isolated regions and communities in the country.[6] All other workers in the informal sector and individuals detached from the labor market could seek medical care in either health facilities managed by the Ministry of Health (SSA) or in the private sector. In both cases, medical attention and prescription drugs were at the expense of the user. As a result, the health system left half of the population uninsured. While Mexico ranked 51 out of 191 countries in the overall attainment in health in the World Health Report 2000, its health system placed 144 with respect to its fairness in financial contribution (WHO, 2000). National-level estimates showed that more than 50% of the health expenditures were out of pocket and that between 2 to 4 million families suffered from catastrophic and impoverishing health expenditures each year (Knaul et al., 2006).

The low levels of financial protection in health were one of the major catalysts for the creation of Seguro Popular, which was introduced in 2002 as a pilot program and became the central pillar of the reform of the health system of 2003. The new law, effective from January 1st, 2004, created the System of Social Protection in Health (or SPSS in its acronym in Spanish) to provide health coverage and financial

[4]Also playing a more marginal role, the Mexican Petroleums (PEMEX), covering workers in the oil industries.

[5]These institutions also administered other benefits such as pensions, disability benefits, and severance payments.

[6]The Progresa program started in 1997 in rural areas and was renamed Oportunidades in 2002 when it expanded to urban areas. In 2014 the program's name changed to Prospera. The Coverage Expansion Program or Programa de Ampliación de Cobertura (PAC) started in 1996.

protection in health to all citizens with no access to social security and to consolidate universal health care and the right to health (Knaul et al., 2006).[7,8] The services offered, listed in the Universal Catalog of Health Services (CAUSES), expanded as the program consolidated across the territory, and included the most cost-effective health interventions and the leading causes for outpatient and hospital utilization in the country (Bonilla-Chacín and Aguilera, 2013).

The health reform also sought to increase the funds of the public health system and to reduce the inequalities in public health spending across insurance schemes and regions (Kurowski et al., 2012). See also Figures 2.1 and 2.2. The push for universal healthcare resulted in the construction of new patient clinics and hospitals, with the proportion of the Ministry of Health budget devoted to investments in healthcare infrastructure increasing from 3.8% in 2000 to 9.1% in 2006 (Frenk et al., 2009). Moreover, the gap in the availability of medical personnel between individuals covered by the Social Security and those that were not decreased substantially (Knaul et al., 2012), as did the difference in the number of hospitals and beds between poor and rich municipalities (Conti and Ginja, 2017).

The financial resources of SP come mostly from the federal government and the states.[9] Although initially only families in the first two deciles of the income distribution were exempt from any payments, in practice very few households ever paid (Knaul et al., 2012).[10] Furthermore, the reform introduced incentives for the states to expand coverage, as historical health budget allocations were replaced with a pre-

[7]The self-employed, the underemployed, the unemployed, those detached from the labor market, and their families.

[8]The requirements to enroll in SP are proof of residence, Mexican ID, and lack of access to health insurance.

[9]The contributions to SP from the states are a subsidy in nature. These are set as a fraction of the total expected cost in health services per capita (which vary by state) adjusted by differentials in regional wages, and capped at a maximum of 30% of the total per-family expected cost.

[10]Knaul et al. (2006) show that by the end of 2011 only 1% of the families were paying the family premium.

mium based on the number of affiliates (Bonilla-Chacín and Aguilera, 2013).[11] In 2012 and after having enrolled 52.6 million individuals, Mexico achieved universal health coverage.

2.3 Data

This study combines an extensive array of publicly available information obtained from different institutions, all described in greater detail below.

School and academic performance

I measure educational achievement with a yearly national standardized test: the National Evaluation of Academic Achievement in Schools (or ENLACE in its acronym in Spanish). Since its implementation in 2006 the test evaluates the mathematical and verbal abilities of students in grades 3 to 6 in primary education and 7 to 9 in lower secondary education.[12] The data are available from Mexico's Ministry of Education (SEP), with school results disaggregated by grade and subject. In this study I focus on the evaluation of schools in primary education, for which I can obtain disaggregated results by grade and subject for all the years in which the test was implemented (2006-2013).[13] The information provided includes test score results in the different subjects under evaluation, the distribution of students falling

[11]Previously, the states' budget for the health system was based on their infrastructure and health care personnel in the late 1990s adjusted for inflation and mortality levels (Bonilla-Chacín and Aguilera, 2013).

[12]From 2008 the test also evaluates competencies in a third subject that rotates on a yearly basis: Natural Sciences in 2008, Civics and Ethics in 2009, History in 2010, Geography in 2011, Science in 2012, and Civics and Ethics again in 2013.

[13]The ENLACE was replaced by another standardized test (PLANEA), which was then canceled in 2019 due to budget constraints.

in different categories of proficiency: inadequate, fair, good, or excellent results[14]; the number of students sitting the test, the number of students considered to have been involved in copying, dictating answers, or other fraudulent practices, and the level of marginalization experienced in the school's location.[15] The evaluation date is scheduled in advance of the start of the academic year, and the test is simultaneously administered to all schools during the national evaluation week (typically towards the end of the school year).[16]

I complement these data with school information held in the Estadística 911 (Statistic 911). The 911 is an administrative questionnaire that all schools in Mexico are required to fill at the beginning and the end of the school year, detailing information on students, teachers, and other school characteristics. With the information provided I calculate the number of students per teacher, the share of female pupils, and the dropout rate (the proportion of students that left the school throughout the academic year), all for the grades evaluated in ENLACE. Also, I create an indicator for whether the head of the school has teaching responsibilities.

Table 2.1 shows that around 20% of the pupils in each school do not achieve minimum levels of proficiency in both the mathematics and verbal section of ENLACE, with around half of the students obtaining just a pass (see Appendix Figure C.1 for a more detailed distribution of the test results). On average, there are no sex imbalances in the classroom (49% of students are female), and there are 26 students per

[14]The definition of each of these categories is as follows: inadequate, the student needs to acquire the knowledge and develop the relevant skills of the subject assessed; fair, the student needs to strengthen most of the knowledge and develop the relevant skills; good, the student shows an adequate level of knowledge and has the relevant skills; excellent, the student masters the knowledge and the skills of the subject evaluated.

[15]The census authorities in Mexico create and maintain a marginalization index that reflects the different levels of development observed throughout the country and at different administration levels. At the smallest regional disaggregation (AGEB or Basic Geostatistical Area), it is calculated with different measures related to education and literacy, access to services, child mortality, and the quality of housing, depending on whether it is an urban or a rural location.

[16]More specifically, the test was administered from the 5th to the 9th of June in 2006, 23rd to the 27th of April in 2007, 14th to the 18th of April in 2008, 23rd to the 29th of April in 2009, 19th to the 23rd of April in 2010, 23rd to the 27th of May in 2011, 4th to the 8th of June in 2012, and 3rd to the 7th of June in 2013.

teacher in the sample of schools. In 29% of the schools the head also teaches, and 137 is the number of students evaluated yearly in each school. Moreover, around 40% of the schools are experiencing some degree of marginalization (but only 4% are in very high marginalized areas).

During the study period three different school-level programs could have influenced school performance in Mexico: the PES (Programa de Escuela Segura) or Safe School Program, promoting an inclusive and peaceful environment in schools for effective learning; the PETC (Programa Escuelas de Tiempo Completo) or Extending School Hours Program, extending the school day to expand learning opportunities and strengthen the development of the curriculum; and the PEC (Programa Escuelas de Calidad) or Quality Schools Program, a program involving schools and their communities in resolving issues preventing schools from offering better educational services. The list of schools participating in these programs in each academic year is obtained from the Ministry of Education. Table 2.1 shows that the Quality Schools program was the most expanded (implemented in 26% of the schools), followed by the Safe School program (present in 17% of the schools), and the Extending School Hours program (implemented in only 2% of the schools).

To derive the geolocation of the schools I use the 2013 school census, provided by INEGI (the National Institute of Statistics and Geography), the Statistics 911, and the ENLACE evaluation. The geographic information that all three sources provide is the state, municipality, and locality code in which the school is located (following the Unique Catalogue of Geostatistical State, Municipal, and Local Areas). With this information, I match each school to its respective locality.[17,18] The final

[17] Although the ENLACE evaluation provides information to track the localities in which the schools are based, the information is not always consistent across all years (in part due to changes in the coding system). Therefore, I prefer to use the school census of 2013 to infer the geographical location of schools, and in the few occasions that this one is missing, infer it from the Statistics 911 and the ENLACE evaluation when the codes provided are consistent across all evaluation years.

[18] A locality in Mexico refers to the lowest of the three sub-national divisions contemplated by the law.

sample excludes those schools with inconsistent geographic information and in the top percentile of the share of students considered to have cheated during the test.[19] Moreover, I restrict the analysis to those schools observed in all periods, and with 15 or more students evaluated. After applying this filter, the sample consists of 49,751 schools, observed uninterruptedly for 8 years.

Health insurance coverage

Administrative records on affiliation to Seguro Popular are provided by the Ministry of Health (SSA), containing the number of affiliates to the program by municipality and quarter.[20] I measure the expansion of SP across the country by dividing the number of beneficiaries in a municipality by its population size. Yearly population at the municipality level is calculated assuming linear growth between the two census years of 2005 and 2010, and with projections of municipality population estimated by the National Population Council (CONAPO) after 2010. Figure 2.3 displays the evolution of the affiliation to SP and its coverage at the national level. It shows that by 2013 the program was covering almost half of the Mexican population with 55 million beneficiaries. Figure 2.4 displays the regional expansion of the coverage rate. In the sample of schools, the average coverage rate during the study period is around 34%, and the average observed expansion is 36.3 percentage points (standard deviation of 17.3) (Table 2.1).

In addition to the coverage rate, I calculate the start date of the program in each municipality. Following previous studies (Bosch and Campos-Vazquez, 2014), I define the quarter of program implementation as when at least 10 individuals enroll in SP.[21] With this definition, Appendix Figure C.2 and C.3 display the timing and the pace

[19] Equivalent to excluding those schools where more than 58% of students have invalid test results.

[20] A municipality in Mexico refers to the second-level administrative division of the country, and it is equivalent to a county in the US.

[21] The reason being is that some of the municipalities, especially at the beginning of the program, show a very low affiliation (zero or close to zero) for several quarters, making it difficult to infer whether the program was operational during that period.

at which municipalities joined the program. As Appendix Figure C.3 shows, most municipalities had already joined the program by 2008.

Rainfall shocks

I use rainfall data from the National Oceanic and Atmospheric Administration (NOAA). They offer monthly hydrometeorology information from 1950 to 2013 for all the North America in grid cells of approximately 6 km width (1/16°). The dataset improves on previously available information in the reduction of transboundary discontinuities and with an adjustment of orographic precipitations in Mexico (see Livneh et al. (2015) for a more detailed discussion). I measure monthly precipitation at the school-locality level by constructing a linear distance weighted rainfall variable using all the data points located within a 20 km radius of each locality centroid. The baseline specification defines the existence of a rainfall shock when the precipitation gathered in a given locality in the 12 months preceding the academic evaluation is below or above 1 standard deviation from the historical regional mean (since 1950). However, I further explore heterogeneity in shock intensity and differentiate between rain excess and rain shortage. With the use of a relative instead of an absolute measure of rainfall I make sure that I am not comparing localities that are more prone to gather higher levels of rainfall with localities that typically receive much less rain. Instead, the measure captures the effect of locality-specific departures from their normal precipitation levels. This definition of rainfall shock has shown to best explain the evolution of agricultural income in Mexico (Adhvaryu et al., 2018; Bobonis, 2009). Figure 2.5 displays the geographical distribution of rainfall shocks with the previous definition for the state of Puebla in 2006 and for localities with at least one school in the final sample. Triangles depict periods when the rainfall gathered in a locality exceeded in 1 standard deviation the historical regional rainfall mean (rain excess), crosses represent rainfall levels below 1 standard deviation from the historical records (rain shortage), and grey dots represent stable precipitation. Rainfall variation in Mexico is partly affected by the country falling under the influence of El Niño-Southern Oscillation (ENSO). This climatic phenomenon, which causes irregular fluctuations in the temperature of the sea surface, alters precipitations in the country differently by region and phase of the cycle (Magana et al., 2003).[22] Appendix Figure C.5 shows the evolution in the probability of ENSO-induced climate alterations in the past years.

MxFLS (Mexican Family Life Survey)

To inspect the potential mechanisms by which availability of health insurance might interact with shocks and educational achievement I draw on the Mexican Family Life Survey (MxFLS). The MxFLS is a multi-thematic longitudinal household survey representative of the Mexican population at the national, urban, rural, and regional level, interviewing around 8,400 households in 150 locations (Rubalcava and Teruel, 2006, 2013). Relevant to this study, the survey gathers information relating to children's health, time use, household economic resources, and availability and access to health insurance. I focus the analysis on the children aged 6 to 14 during the third wave of the survey (carried between 2009 and 2011). Table 2.2 shows summary statistics of the children and their families. On average, children are 10 years old and have had access to Seguro Popular in their municipality of residence (conditional on eligibility) for 4.6 years (standard deviation of 1.66 years). School enrolment is high (with 96% of children attending school), and the incidence of child labor is low (only 3% work for pay, 3% work in agriculture, and 1% work in the family business). On the other hand, the share of children with other household responsibilities is high, which include domestic chores (56%), and caring for elder, sick members in the household, or other children (16%).

[22] ENSO fluctuations can be divided by El Niño, periods with above-average temperature in the sea surface; and La Niña, periods with sea surface temperature below the average.

Other

Information on health facilities and medical personnel, on the share of eligible individuals at the program start, on pre-program indicators relating to primary education (pass rate and completion rate), and on the marginalization level of municipalities is obtained from SIMBAD (State and Municipal Database System). Also, I compute a measure of regional political alignment with state and municipal election results with data from CIDAC (Development Research Centre). I use these variables to analyze the determinants of the rollout of the SP health insurance program across the country, discussed in greater detail in Section 2.6.

2.4 Empirical strategy

To identify the extent to which health insurance can mitigate the impact of rainfall shocks on children's educational performance I exploit rainfall disturbances in the school-locality and the expansion of Seguro Popular (SP) across municipalities. The large scale of the program required a gradual implementation of SP across the country, subject to financial resources and health infrastructure availability. Using the share of the population covered at a given point in time in a municipality I estimate the following equation:

$$y_{slmt} = \beta_1 R_{lmt} + \beta_2 SP_{mt} + \beta_3 SP_{mt} R_{lmt} + \alpha' Z_{slmt} + \zeta' X_{mt} + \delta_t \mu_r + a_s + \epsilon_{slmt} \quad (2.1)$$

Where y_{slmt} are the evaluation results of primary school s in locality l of municipality m during the school year t, R_{lmt} is a rainfall shock dummy that equals one when precipitation gathered in the school-locality during the 12 months preceding the academic evaluation is above or below one standard deviation from the regional historical mean, SP_{mt} is the coverage rate of Seguro Popular in municipality m measured at the end of the year in which the academic year started[23], and $SP_{mt}R_{lmt}$ is the interaction of the two terms. The equation also includes a vector of school characteristics Z_{slmt} to control for the ratio of students per teacher, the share of girls, whether the school principal has teaching duties, the marginalization level of the school area[24], three dummy variables indicating whether the school participates in educational programs in year t (i.e., Safe School, Extending School Hours, or Quality School program), and the share of students marked as carrying fraudulent practices during the test. X_{mt} is a vector of covariates including population size[25], the homicide rate, and the transfers per capita from the Oportunidades/Progresa program[26] at the municipality level. The regression further includes state-year fixed effects $\delta_t\mu_r$ to account for yearly disturbances common to all schools in a given state, and school fixed effects a_s, which capture time-invariant characteristics of the school, its location, and the environment.[27]

The coefficients of interest are β_1 and β_3; the impact of rainfall shocks on school performance and the capacity of social healthcare to mitigate this effect. I focus on the intensive instead of the extensive margin in health coverage because the school test scores data are only available from the academic year 2005/06, and SP rollout began in year 2002. Thus, there are no pre-SP school data for most schools. However, the share of population covered by SP in a municipality is subject to endogeneity. While school and state-year fixed effects might capture a lot of the relevant heterogeneity in SP expansion and school performance, β_2 (the effect of health insurance on test

[23] For example, for the academic year 2005/06, the healthcare coverage rate used is the one observed at the end of 2005.

[24] In five categories: very low, low, medium, high, and very high marginalization.

[25] Divided into seven categories: i) less than 5k, ii) between 5k and 20k, iii) between 20k and 50k, iv) between 50k and 100k, v) between 100k and 200k, vi) between 200k and 500k, and vii) higher than 500k.

[26] The Mexican conditional cash transfer program for education.

[27] There are 30 states represented in the sample (out of 32 in the country) and 1,696 municipalities (out of a total of 2,463). The sample totals an average of 107.6 municipalities per state (standard deviation of 67.5), and 35.9 localities per municipality (standard deviation of 31.2). Municipalities are at the second administrative division level in Mexico, and localities at the lowest of the three sub-national divisions.

scores during years of stable precipitations) is likely not identified. The SP coverage rate is therefore introduced in the regression as a control, and I focus the discussion on the estimates of β_1 and β_3. To interpret the effect of β_2 as causal one would need to assume that conditional on school and state-year fixed effects, the availability and expansion of SP was orthogonal to the evolution of academic performance. Although there could have been political interests in implementing the newly created health insurance program earlier in regions that were seeing an improvement in their health levels, it is less likely that SP rollout responded to educational performance.[28] Section 2.6 explores the determinants of the timing and expansion of SP and conducts some robustness tests to shed more light on this issue.

Moreover, the reduced form estimates will capture potential spillovers to the untreated population (not eligible for SP). These spillovers could be positive if there are positive externalities from improved overall levels of the health and disease environment, or negative, if the increase in the demand for health services is not matched with an equal increase in the health infrastructure, leading to crowding of healthcare services.[29]

2.5 Results

2.5.1 Basic specification

Does health insurance mitigate the effect of negative rainfall shocks on educational achievement? Tables 2.3 and 2.4 show the results of estimating equation (2.1). Column 1 displays the results with test scores as the dependent variable, while columns 2 to 4 show estimates of the effect on the distribution of test achievement. Column

[28] Nevertheless, Conti and Ginja (2017) show that the expansion of SP was not associated with pre-trends in child mortality.

[29] At least, Conti and Ginja (2017) show that the gap in terms of healthcare facilities and medical personnel was reduced between individuals covered and not covered by the Social Security, as a result of a higher increase in health care infrastructure in SSA centers (managed by the Health Ministry and responsible for the provision of Seguro Popular), than in non-SSA centers.

1 of Table 2.3 shows that students experiencing a negative rainfall shock during the academic year score 0.022 standard deviations lower in the mathematics test, and this reduction is significant at the 1% level. However, an increase of 10 pp in the health coverage rate mitigates the negative effect by 0.007 standard deviations (32% of the effect). A closer look at the distribution of test results shows that the share of students failing the evaluation (inadequate performance) increases by 0.65 pp in the event of a rainfall shock (column 2), with a 10 pp increase in health coverage reducing the effect by 0.21 pp (both estimates significant at the 1%). The results show a positive and significant correlation between the expansion of health insurance and mathematics test results (of 0.020 standard deviations from a 10 pp increase in health coverage), with stronger associations at the bottom of the test score distribution (see columns 2 to 4). Regarding the effect of other school characteristics, both a higher number of students per teacher and having a school principal with teaching responsibilities are correlated with lower performance. On the contrary, a higher share of girls in the classroom and participating in the school programs Extended School Hours and Quality Schools are positively correlated with higher test score results in mathematics.

Table 2.4 shows the results for the verbal test. The experience of a rainfall shock has a smaller impact in the verbal section of the evaluation (-0.020 standard deviations, column 1), with a 10 pp increase in the SP coverage rate mitigating in 0.006 standard deviations the negative effect (both magnitudes significant at the 1% level).

2.5.2 Direction and intensity of shocks

The basic specification defined the occurrence of a shock when local precipitation deviates by one standard deviation from the historical regional mean. Now, I introduce flexibility in the specification by allowing for a) different effects by the intensity level of the shock, and b) differential impacts by the nature of the shock – differentiating between periods with an excess of rainfall from periods characterized by rainfall shortage. Appendix Tables C.1 and C.2 divide rainfall shocks in three intensity categories: between 1 and 2 standard deviations away from normal precipitation, between 2 and 3 standard deviations, and 3 or more standard deviations. As expected, more extreme climatic conditions, that will more likely resemble floods and droughts, have larger impacts on test scores. While the reduction in the students' mathematics achievement is of the order of 0.015 standard deviations in the event of milder shocks (precipitations between 1 and 2 standard deviations), the occurrence of severe shocks (precipitations above or below 3 standard deviations) reduce the mathematics' achievement score by 0.15 standard deviations and increase the test failure rate by 4 pp (significant at the 1% level) (columns 1 and 2 of Table C.1). However, a 10 pp increase in health coverage absorbs 33% of the effect of mild shocks on mathematics test scores, and 22% of the effect during severe shocks (significant at the 1% level) (column 1, Table C.1). In the verbal section (Table C.2), milder shocks lower the attainment score by 0.014 standard deviations (column 1). In comparison, greater adverse shocks reduce by 0.11 standard deviations the verbal mark, with a 10 pp increase in health coverage offsetting by 24% the negative effect (both magnitudes significant at the 1% level).

Appendix Table C.3 shows the results of dividing climate shocks by excess and shortage of rainfall. The results show that while experiencing an abnormally high period of rain does not have a significant effect on educational performance, the occurrence of a dry spell does. In column 1 of Panel A we see that abnormally dry periods reduce the students' mathematics achievement score by 0.047 standard deviations and in column 2, that they increase by 1.06 pp the share of students with inadequate performance. This result is in line with the findings in Adhvaryu et al. (2018), who show that droughts in Mexico carry a higher penalty for children in terms of total years of completed education and grade progression. Nevertheless, a 10 pp increase in the share of individuals covered by health insurance buffers around 32% of the impact on test scores, and 37% of the effect on the exam failure rate (columns 1 and 2). The results for the verbal test display a similar picture, but with somewhat smaller point estimates (Panel B).

Appendix Tables C.4 and C.5 show the results of combining the intensity of rainfall with the type of shock and divide shocks by floods (precipitations above 2 standard deviations from the regional historical mean), rainfall above-normal levels (between 1 and 2 standard deviations above), below-normal rainfall (between 1 and 2 standard deviations below), and droughts (below 2 standard deviations). The results show that while floods increase by 0.91 pp the failure rate in mathematics (significant at the 10% level) (column 1 of Table C.4), droughts increase the share of students with inadequate attainment by 4.4 pp (significant at the 1% level). However, in the event of droughts, each 10 pp increase in the SP coverage rate mitigates by 1.1 pp the negative effect. Table C.5 shows similar results for the verbal evaluation, with the experience of droughts having more negative consequences on students' cognitive attainment than periods of rainfall excess.

2.5.3 Regional disparities

Although disturbances in precipitation levels could impact students' productivity in school in many ways, the effect of rainfall in disrupting performance may vary across areas with different levels of development and infrastructure. To assess whether there is regional heterogeneity in the impact of shocks on cognitive achievement I divide schools by the level of marginalization of the area in which they are located.[30] When schools in marginalized areas experience a negative rainfall shock, students' achievement score in mathematics drops by 0.022 standard deviations (column 1 of

[30] I consider a school to be marginalized if it is established in a locality considered to be experiencing some degree of marginalization (medium, high, or very high) according to the National Population Council (CONAPO).

Table 2.5). However, each 10 pp increase in the health coverage rate absorbs 27% of the negative effect (significant at the 1% level). This reduction is of 0.020 standard deviations in the verbal section, with a 10 pp increase in the coverage rate mitigating 30% of the effect. On the other hand, rainfall shocks have no statistically significant effect on test scores in non-marginalized areas (column 1 of Table 2.6).

I also differentiate the effects between rural localities, small urban localities with less than 50,000 inhabitants, and large urban localities with more than 50,000 inhabitants. The results show that while rainfall shocks negatively affect mathematics learning in rural areas (Appendix Table C.6), they pose no statistically significant reduction in test performance in urban areas irrespective of their population size (Appendix Tables C.7 and C.8). The estimated results in the verbal section of the national evaluation are similar. For instance, rainfall shocks in rural locations increase the verbal failure rate by 0.43 pp, with health insurance mitigating by 0.15 pp the negative effect per each 10 pp increase in the health coverage rate (column 2 of Table C.6).

These results point out that rainfall shocks and health insurance have significant differential effects depending on the region's characteristics. In rural areas, where precipitations are more closely linked to income generation through agricultural production (or in more marginalized areas, where there is lower infrastructure and the population is more vulnerable to shocks), the experience of atypical rainfall may result in higher stress levels for families and children. Indeed, Mexico is considered an arid or semi-arid country, and according to the National Agricultural Survey[31] of 2017, the share of rainfed agriculture in Mexico amounts to 79% of the total cultivated area. In urban areas, on the other hand, rainfall disturbances might not be the best measure to capture shocks (either health or income shocks) to children and their families, and the benefits from SP are less likely to be linked to its ability to

[31] Encuesta Nacional Agropecuaria, carried out by the National Institute of Statistics and Geography (INEGI).

build resilience against climatic shocks.

2.6 Robustness

As noted earlier, the rolling out of Seguro Popular was not random (which prevents from identifying β_2 in equation (2.1) – the effect of health insurance in the absence of shocks). The expansion of the program gave priority to states and municipalities with a) low social security coverage, b) larger number of uninsured individuals in the first six deciles of income, c) capacity to offer the services granted, d) higher pool of potential affiliates, and e) explicit request from the state authorities, all subject to available financial resources.[32] In this section I first assess the determinants of the timing of SP implementation following Bosch and Campos-Vazquez (2014) and Conti and Ginja (2017) by estimating the following equation:

$$Quarter_{ms} = \theta X_{ms} + \mu_s + \epsilon_{ms} \tag{2.2}$$

Where $Quarter_{ms}$ is the quarter of implementation of SP in municipality m of state s, X_{ms} is a series of socio-demographic, political, health care, and primary education indicators measured before the program start, and ϵ_{ms} is the error term. The regression includes state fixed effects μ_s, as the timing in which the states were offering the new health scheme was negotiated with the federal government. On the other hand, it was less clear as to which municipalities were to receive the program first. Therefore, I study the determinants of the program rollout within states but also estimate the model without state fixed effects for comparison. While I do not have information on test results before the start of the program, I measure municipality pre-program trends in education with the evolution of the primary completion rate,

[32] Diario oficial Viernes 04 de Julio de 2003: Acuerdo por el que la Secretaría de Salud da a conocer las reglas de operación e indicadores de gestión y evaluación del Programa Salud para Todos (Seguro Popular de Salud).

and with the pass rate of the grades evaluated in ENLACE.

Appendix Table C.9 displays the results of estimating equation (2.2). Columns 1 and 3 show the model estimates without state fixed effects. At the country level, municipalities with greater population size and with more medical personnel received the program first. Political alignment is also a good predictor of program implementation, as the occurrence of same political party in both the state and municipal government predict the implementation of SP three quarters earlier than in municipalities without political alignment. With this specification, municipalities with a higher share of eligible population and with higher levels of marginalization implemented the program later. In columns 2 and 4, when assessing the program expansion within states, we observe a similar picture, except for the share of individuals that were eligible to the program, which coefficient changes sign and suggests that within states the program started first in areas with higher potential demand. Moreover, the evolution in the primary completion rate and in the pass rate of the grades evaluated in ENLACE in the 5 years preceding the program start is not significantly correlated with the timing of the program implementation in any of the specifications. Although the coefficient for missing pre-program information on the evolution of primary education predicts receiving SP 2.5 quarters later, it is not statistically significant when including state fixed effects.

I further inspect the determinants of the SP coverage rate expansion after it is implemented in a municipality. Appendix Table C.10 shows the results of estimating a variation of equation (2.2) where the dependent variable quarter of implementation is replaced with the increase in the coverage rate in the first, second, and third year after the program implementation. Columns 1 and 2 show that, once SP is implemented, the share of eligible individuals is the main determinant of its expansion. The coverage rate increases by 33 percentage points in the first year in a municipality where everybody is eligible. Higher marginalization, which is closely linked to eligibility, also explains higher program enrolment. On the other hand, population size is negatively related with coverage expansion. Health infrastructure measured as doctors per eligible population also predicts a small but significant higher coverage expansion in the first year. In the second year (Columns 3 and 4), only eligibility and population size are able to explain enrolment, and in the third year, only eligibility remains significant (Columns 5 and 6). Political alignment and the evolution of indicators in primary education do not predict coverage expansion. In line with these results, Appendix Figure C.4 shows that coverage greatly responds to availability in the first year, it is stable in the following four years, and further lowers from year six onward as the program nears full coverage.

With the previous results, I test the robustness of the main findings to various specifications. Moreover, I also show the coefficient estimate of β_2 from equation (2.1) to examine how its value changes across specifications. Results for the mathematics test are displayed in Table 2.7, while Table 2.8 shows the results in the verbal evaluation. Column 1 shows the coefficient estimates from the main specification. In column 2 I add an interaction term of the presence of a rainfall shock with municipality expenses per capita on the Oportunidades/Progresa program. This interaction allows testing whether the estimated shock-mitigating effect from the expansion of health insurance partly reflects the mitigating effect of cash transfers in Mexico. Results remain unchanged. Column 3 controls for the political alignment defined as same political party in the state and municipal government. This specification accounts for the possibility that the political environment could be affecting the level of resources (including higher expenses on both education and health) in the different municipalities. The results are practically identical. In column 4 I include all the pre-program municipality characteristics correlated with the rollout of Seguro Popular (except for the share of eligible individuals) interacted with a linear trend (see Appendix Tables C.9 and C.10). Notice that this is a demanding test, as the information on test scores is only available from 2006 onward, and the expansion of SP could have already affected the evolution of educational achievement. The point estimates reduce in magnitude. The effect of a rainfall shock on the mathematics test scores reduces from -0.022 to -0.017 standard deviations, and the mitigating effect from 0.007 to 0.006 standard deviations (column 4 of Table 2.7). Moreover, the correlation between SP expansion and test scores during stable precipitations becomes null, suggesting that health insurance impacted cognitive attainment only through its ability to mitigate the negative effect of shocks on students' performance in school. Column 5 further includes the share of eligible individuals at the program start interacted with a trend. This specification produces the lowest point estimates, as the coverage rate of Seguro Popular is highly correlated with population eligibility, and the program is suspected to have the largest effect in regions with a higher proportion of eligible individuals. Even then, the shock-mitigating effect of SP on mathematics test scores is estimated to be of 0.005 standard deviations per each 10 pp increase in the coverage rate (column 5 of Table 2.7), and of 0.004 standard deviations on the verbal results (column 5 of Table 2.8), both magnitudes significant at the 1% level. Column 6 displays the results of a placebo test that consists of interacting future rainfall shocks with the healthcare coverage rate and shows that future rainfall does not have a significant effect on current test scores. Column 7 includes one lag of the rainfall shock and shows that the effect on test scores is mainly driven by contemporaneous disturbances. However, there is a lasting protective effect on current test scores from health coverage during past negative shocks. In the base specification, I cluster the standard errors at the municipality level. Column 8 shows standard errors adjusted for spatial correlation with the method developed in Conley (1999), and using a radius of 200km around each locality centroid to define areas independent of administrative boundaries. Column 9 excludes those localities in which there is no variation in rainfall shocks (either always or never experienced a rainfall shock), and column 10 replaces school-locality level rainfall shocks with shocks measured at the municipality level. Rainfall shocks measured at the municipality level have a larger effect on school achievement, and healthcare coverage has a lower mitigating effect. However, this likely reflects the impact of a larger shock in absolute terms, as average precipitations are more stable when computed over a broader area. The results discussed above still hold.

As noted earlier, I do not have information on test scores before 2006 to test for pre-trends in the full sample. However, I can conduct a test of pre-trends in academic achievement for a sample of late reformers. With the available data the test consists in analyzing whether the evolution in test scores between 2006 and 2007 (earliest pair of years) can predict future SP implementation. Given that by the end of 2007 most of the municipalities had already implemented the social healthcare program (see Appendix Figure C.3), I define late reformers as those municipalities in which by 2007 the program had not yet been widely expanded (low coverage rate). More specifically, I define two groups of late reformers: a) municipalities with a coverage rate below 5% in 2007; and b) municipalities with a coverage rate below 10% in 2007. Formally, I estimate the following equation:

$$\Delta score_{(06-07)slm} = \eta + \rho \Delta SP_{(07-08)m} + \alpha' Z_{slm} + \zeta' X_{lm} + \mu_r + \epsilon_{slm} \tag{2.3}$$

Where $\Delta score_{(06-07)slm}$ is the increase in test scores between 2006 and 2007 in school s, of locality l, in municipality m; $\Delta SP_{(07-08)m}$ is the increase in the Seguro Popular coverage between 2007 and 2008 in municipality m; Z_{slm} and X_{lm} are the same school and regional controls as in equation (2.1), and μ_r are state fixed effects. Appendix Table C.11 shows the estimated results. In columns 1 and 3 the sample is restricted to those municipalities in which the coverage rate in 2007 was lower than 5% and in columns 2 and 4, lower than 10%. The estimated coefficient ρ is practically zero and statistically insignificant, suggesting that the expansion in health coverage induced by SP was not related to the evolution of students' performance in school.

Another concern for the validity of the results involves endogenous migration patterns (or children leaving the school more generally). If rainfall shocks affect migration decisions of families and family characteristics are related to both migration decisions and child characteristics, the effect of rainfall shocks on school test scores could be biased. The bias would be downwards if higher-performing children are the ones leaving the school, or upwards, if the children leaving are those with lower educational performance. Using the Statistics 911 I create an indicator for the ratio of children that did not complete the academic year in the school in which they started it (the share of students that drop out), and inspect whether this indicator is related to the experience of rainfall shocks or the interaction term of rainfall with SP expansion. Column 1 of Appendix Table C.12 shows that the probability of students dropping out from the school is not associated with the experience of a rainfall shock in the locality nor with SP expansion in the event of shocks.

Finally, to rule out any additional compositional bias arising from negative shocks in the locality affecting the type of students that sit the academic evaluation, I test whether the number of students evaluated in each school is affected by the experience of a rainfall shock. The results of this test, displayed in column 2 of Appendix Table C.12, show that neither rainfall shocks nor the interaction of rainfall with the expansion of SP have a significant effect on the number of students evaluated.

2.7 Mechanisms

This section inspects potential channels that could help explain why rainfall shocks negatively affect children's performance in school, and the role of access to health insurance in mitigating the effects. To do so, I move from school-level data to individual and household-level data, described in greater detail in Section 2.3. I can now construct a measure of access to social health insurance that exploits individual variation: years of exposure to Seguro Popular. The number of years a child had access to SP depends on the child's age and the introduction date of the program in the child's municipality of residence (subject to eligibility). I assess the impact of rainfall shocks and access to SP among children aged 6 to 14 and their families, and who were interviewed during the third wave of the Mexican Family Life Survey (between 2009 and 2011). I also estimate a model of household fixed effects to assess the impact of rainfall shocks and health insurance on household consumption by including the consumption information available in the previous survey (years 2005-2006). Notice that at the household level, exposure to SP only varies by its introduction date in the municipality of residence.

In the MxFLS it is possible to infer whether a household is eligible to SP by inspecting their availability and access to formal health insurance (in which case the household is deemed ineligible). In the survey, individuals respond to all the different health insurance schemes they benefit from, which include insurance from the Social Security: IMSS, ISSTE, PEMEX, and other minor schemes; and other private plans (either privately purchased or offered by their employer). As long as one household member has access to any form of formal health insurance, this one extends to the rest of the family, and I define such a household ineligible to Seguro Popular. All other households in which none of the members have access to formal health insurance are deemed eligible to SP (48% of all households in the sample). I focus on eligibility rather than affiliation to SP to avoid a potential self-selection bias. On the other hand, rainfall shocks are now measured at the municipality level, as opposed to shocks at the locality level, as the latter information is deemed confidential and is not disclosed.

2.7.1 Specification

To capture the impact of rainfall shocks on educational inputs and any potential mitigating effect arising from access to health insurance I estimate the following equation:

$$y_{im} = \beta_1 R_m + \beta_2 SP(years)_{im} + \beta_3 SP(years)_{im} R_m + \zeta' X_{im} + \delta_t + \mu_z + \epsilon_{im} \quad (2.4)$$

Where y_{im} are indicators of the health and time use of children, R_m is a rainfall shock dummy reflecting whether the precipitation gathered in the municipality of residence in the 12 months preceding the interview date was above or below one standard deviation from the historical regional mean, $SP(years)_{im}$ controls for the number of years a child had Seguro Popular available in her municipality (which depends on the child's age and the introduction date of SP in the municipality), and $SP(years)_{im}R_m$ is the interaction of the two terms. Similarly as before, β_1 and β_3 are the coefficients of interest. X_{im} is a set of children, family, and regional covariates[33], δ_t and μ_z are dummies for month and year of interview respectively, and ϵ_{ms} is the error term. Similarly, to capture the effect of rainfall shocks on household's economic resources I estimate the following equation:

$$log(C_{imt}) = \beta_1 R_{mt} + \beta_2 SP(years)_{mt} + \beta_3 SP(years)_{mt} R_{mt} + \\ \Omega' H_{imt} + \delta_t + \mu_z + \gamma_i + \upsilon_{imt} \quad (2.5)$$

Where $log(C_{imt})$ is the logarithm of the equivalised household expenditures in non-durable goods[34], $SP(years)_{mt}$ is now defined at the household level (and depends only on the date that SP was introduced in the municipality of residence), H_{imt} is

[33]The child's gender and age (categorical dummies), whether the child speaks an indigenous language, attends a public school, and assists an evening shift, the age, gender, and marital status of the household head, the total number of individuals in the household, dummies of mother's and father's education (primary school, secondary school, and high school or higher), whether the households owns the house, has piped water inside, or toilet, whether the household cooks with wood or coal, dummies for the quality of the roof and floor, and type of location (urban or rural).

[34]That is, excluding expenses on electronic appliances, furniture, property, and acquisition of vehicles. I construct the expenditures equivalence scale for Mexican households following Teruel et al. (2005), and assign a factor of 0.77 to children from 0 to 5 years old, 0.80 to children from 6 to 12 years old, 0.74 to children from 13 to 18 years old, and 1 to adults above 18 years of age.

a vector of household characteristics relating to household composition, wealth, and information about the household head[35], δ_t and μ_z are dummies for month and year of interview respectively, γ_i are household fixed effects, and υ_{imt} is the error term.

2.7.2 Results: Mechanisms

Table 2.9 shows the results of estimating equation (2.4). Robust standard errors are shown in parenthesis, while clustered errors at the municipality level are displayed between brackets. Column 2 shows that rainfall shocks increase the probability of children being sick in the four weeks prior to the interview date by 5 percentage points (an increase in the probability of 61%). However, the availability of SP in the municipality reduces this probability by 1.2 percentage points per year of exposure.[36] Similarly, rainfall shocks increase the probability of children looking after elderly, sick people, or other children, by 7 pp (44% increase, column 4), and doing domestic chores by 9.3 pp (17% increase, column 6). However, and similarly, the expansion and availability of financial protection in health reduces the demand for children's time in domestic tasks when hit by climatic shocks. The difference in the estimates between the specification that includes basic controls (columns 1, 3, and 5) and the specification that includes a broader set of controls (columns 2, 4 and 6) are small, in line with rainfall shocks being orthogonal to children and households' characteristics.

As discussed previously, the new healthcare scheme was targeted at those individuals outside of the social security system, and therefore uninsured. Table 2.10 shows

[35]The full list of household characteristics are: the age, gender, education, and marital status of the household head, the total number of individuals living in the household, the number of children under age 5, the number of individuals between 6 and 10 years of age, between 11 and 18 years old, between 19 and 45 years old, between 46 and 60 years old, and more than 60 years old, whether the households owns the house, has piped water inside, toilet, whether the household cooks with wood or coal, dummies for the quality of the roof and floor, type of location (urban or rural), an interviewer-reported variable on the accuracy of reported expenditures (dummy for excellent accuracy), and a dummy controlling for whether the household expenditures questionnaire was filled by the same respondent in the different waves.

[36]The sickness variable's exact definition is the inability of children to carry any of their normal daily activities due to sickness in the last four weeks. Therefore, the variable should also capture temporary school absence if the interview took place during the academic year.

the results of estimating equation (2.4) separately by eligibility status (SP eligible – with no formal insurance –, and SP ineligible – with access to formal insurance).[37] We can see that the point estimates for the probability of sickness, caring for others, and doing domestic chores of children in eligible families are higher in magnitude in the event of negative shocks, as well as the mitigating effect from availability of SP (Panel A). On the other hand, there are no statistically significant effects on health status and time use for those children in families ineligible for the new healthcare scheme (Panel B). While a rainfall shock increases by 6.6 percentage points the probability of being sick among children from eligible households (column 2 of Panel A), each additional year of access to SP reduces by 1.5 percentage points this probability (significant at the 5% level). Similarly, the probability of children carrying out household chores increases by 14.1 pp during adverse rainfall shocks (column 6 of Panel A). However, an additional year of SP eligibility reduces the effect by 3.5 pp (significant at the 1% level). Dividing the sample by rural and urban locations generates a similar picture (Appendix Table C.13), where the benefits from SP availability in the event of rainfall shocks are mainly concentrated in rural areas (where the share of eligible individuals is higher and adverse weather presumably has more pervasive consequences on children and their families that in urban areas).

Finally, I assess whether the experience of negative climatic shocks affects the economic resources of the household (measured as equivalised household consumption expenditures in non-durable goods). In the consumption regression (equation [2.5]), I exclude the households in the top and bottom percentile in equivalised household expenditures. Column 6 of Table 2.11 shows that the experience of a rainfall shock reduces by 16% the equivalised household consumption level among households eligible to SP (with no formal insurance). However, each additional year of financial protection in health reduces the negative effect by 4% (significant at the 10% level).

[37] I define insurance status at the household level, as the insurability of one of the family members extends to the rest of the family.

The point estimates of these effects are similar for households in rural areas (column 10). In rural areas, a negative rainfall shock reduces household consumption by 18%, similar to the reduction estimated in Bobonis (2009) for a sample of rural households in Mexico (16.7%). However, an additional year of SP availability reduces this effect by 3%. On the other hand, rainfall shocks do not translate into any significant reduction in household consumption among families with access to formal health insurance or living in urban areas (in which case there are no additional benefits from the expansion in health coverage).

2.8 Conclusion

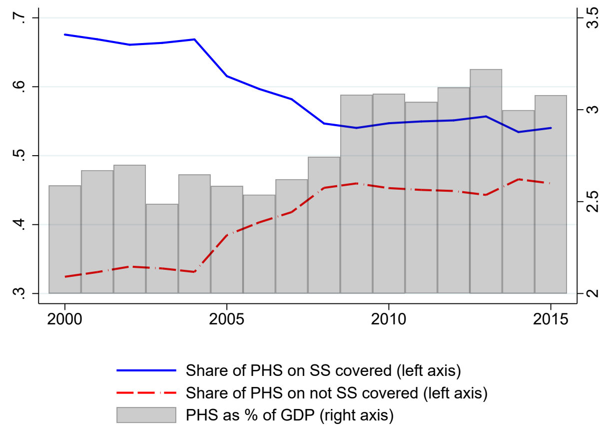
As the world moves closer to achieving the Millennium Developmental Goal of universal primary completion, significant challenges to ensure effective learning in the classroom remain. Poverty and marginalization continue to be significant predictors of human capital accumulation among children, and negative shocks experienced during childhood threaten to aggravate the existent inequalities by households' ability to cope with them. This study shows that a state intervention to reduce inequality in healthcare access protected the educational achievement of primary school children in the event of negative shocks. The expansion of social healthcare, instrumented with the reform of the Mexican health system and the creation of a health program addressed to the population ineligible for social health insurance, offset the negative effect of rainfall shocks on cognitive achievement by serving as a safety net for children and their families.

This result points towards synergies from public investments in education and health, and from higher returns to educational investments when the ability of families to endure shocks is increased. In this regard, the study shows that the expansion in health coverage mitigated the negative effect of rainfall shocks on children's health among program-eligible households, reduced the demand for children's time, and protected household's consumption from fluctuations accruing from rainfall disturbances. The results add to a new stream of research that investigates whether shocks to human capital during childhood can be mitigated through different policies or interventions, by showing the capacity of universal health coverage in buffering negative environmental shocks.

As climate disturbances are felt the most in regions with weaker infrastructure and higher dependence on climate, the discouraging evolution of weather patterns is likely to aggravate the existing gap in cognitive achievement by socio-economic disadvantage. However, estimates show larger positive effects from universal healthcare in more marginalized areas. The results presented here are also relevant amid the growing number of countries expanding healthcare coverage and should be considered when carrying out a cost-benefit analysis of public investments in health. Nevertheless, the extent to which the expansion in social health insurance is accompanied by improvements in health care infrastructure, including its efficiency, will determine the capacity of national health systems in protecting individuals and families from financial and other health-related shocks.

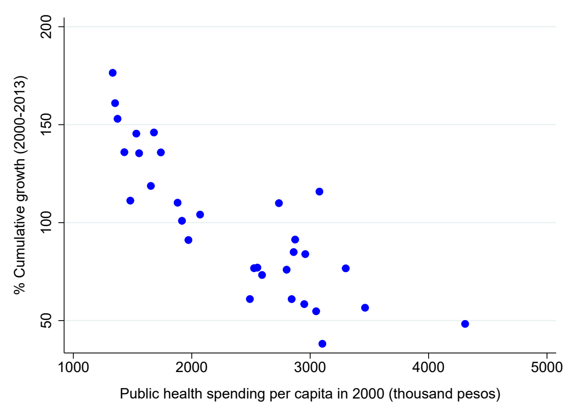
2.9 Figures

Figure 2.1: Evolution of public health spending. Total and by insurance status



Note: PHS: Public Health Spending. SS: Social Security.
Source: General Directorate of Health Information, Ministry of Health.

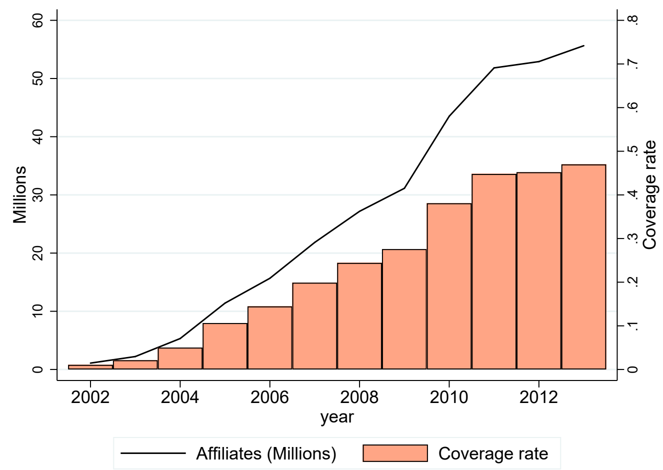
Figure 2.2: Regional convergence in per capita public health spending



Note: Cumulative growth refers to the increase in public health spending per capita. The graph excludes Mexico City, for which the public health spending per capita in the year 2000 was of 9,144 pesos, and where public health spending grew by 35% between the year 2000 and 2013. Each dot conveys the information for the remaining 31 states of Mexico.

Source: Directorate of Health Information, Ministry of Health.

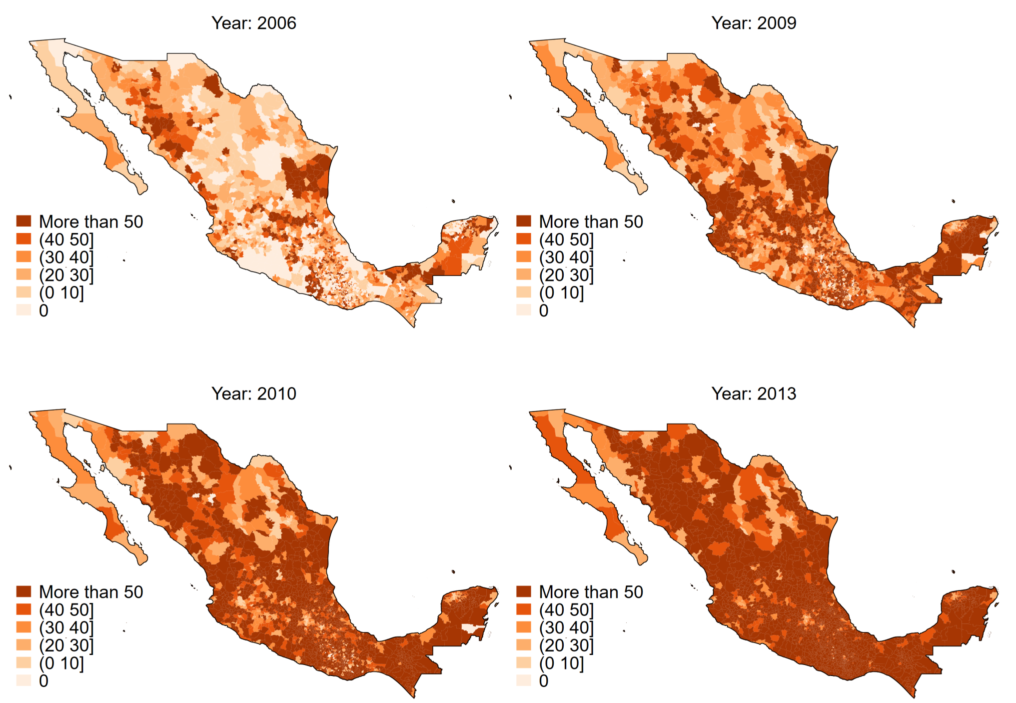
Figure 2.3: National Affiliation to Seguro Popular



Note: The coverage rate is defined as the number of affiliates divided by the total population.

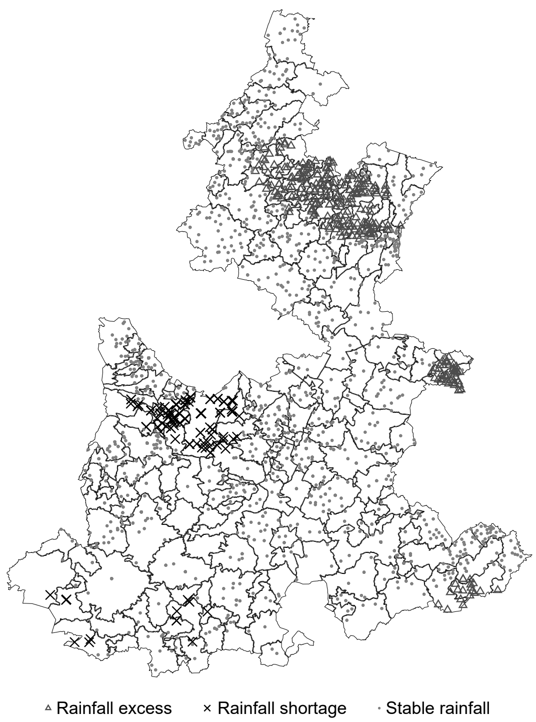
Source: Ministry of Social Security.

Figure 2.4: Geographical evolution of Seguro Popular coverage rate (%)



Note: The coverage rate is defined as the number of affiliates divided by the population size in each municipality.

Figure 2.5: Pre-exam locality-level rainfall in the state of Puebla (2006)



Note: Each mark in the map depicts a locality in which there is at least one school evaluated in ENLACE. Rainfall excess is defined as precipitation in the 12 months preceding the test evaluation above one standard deviation from the regional historical mean, rainfall shortage is defined as precipitation levels below one standard deviation, and stable precipitation as rainfall within one standard deviation.

2.10 Tables

Table 2.1: Summary statistics: Sample of schools (ENLACE)

	Mean	SD
Mathematics results		
Math score	524.36	71.12
Math (% Inadequate)	20.38	16.30
Math (% Fair)	49.27	14.40
Math (% Good+)	30.35	21.63
Verbal results		
Verbal score	516.35	63.84
Verbal (% Inadequate)	19.93	15.56
Verbal (% Fair)	49.59	13.96
Verbal (% Good+)	30.48	21.24
School characteristics		
Share of girls	0.49	0.07
Students per teacher	26.51	8.07
Head of school also teaches	0.29	0.46
Students evaluated	136.86	114.42
Dropout rate (pp)	3.41	4.11
Very low marginalization	0.41	0.49
Low marginalization	0.18	0.38
Medium marginalization	0.12	0.33
High marginalization	0.24	0.43
Very high marginalization	0.04	0.21
School programs		
Safe School	0.17	0.38
Extending School Hours	0.02	0.12
Quality Schools	0.26	0.44
Seguro Popular coverage		
SP coverage rate (pp)	34.33	24.22
SP coverage increase (pp)	36.31	17.34
Rainfall shocks		
Rain shock (total)	0.29	0.45
Rain excess	0.14	0.35
Rain shortage	0.14	0.35
# schools	49,751	
# periods (years 2006-2013)	8	
Observations	398,008	

Table 2.2: Summary statistics: Sample of children (MxFLS)

	Mean	SD
Child variables		
Age	10.11	2.60
Female	0.50	0.50
Indigenous language	0.16	0.36
Sick	0.08	0.27
Attending school	0.96	0.19
Caring for others	0.16	0.37
Household chores	0.56	0.50
Work for pay	0.03	0.16
Work family business	0.01	0.09
Work in agriculture	0.03	0.18
SP exposure (years)	4.58	1.66
Rainfall shock	0.29	0.45
Mother's education		
No education (mother)	0.14	0.35
Primary (mother)	0.38	0.48
Secondary (mother)	0.31	0.46
High school + (mother)	0.17	0.38
Father's education		
No education (father)	0.30	0.46
Primary (father)	0.30	0.46
Secondary (father)	0.23	0.42
High school + (father)	0.17	0.37
Household variables		
Male hh head	0.78	0.42
Age hh head	44.59	13.07
Married hh head	0.70	0.46
Household size	6.02	2.45
Owns house	0.66	0.47
Tubed water	0.25	0.43
Toilet	0.75	0.43
Cooks with wood or coal	0.39	0.49
Favorable floor material	0.36	0.48
Favorable roof material	0.77	0.42
Rural	0.46	0.50
Observations	5,720	

Table 2.3: Test score results: Mathematics

	(1) Math score SD	(2) Math (Inadequate) pp	(3) Math (Fair) pp	(4) Math (Good+) pp
Rainfall shock	−0.022***	0.647***	−0.253*	−0.394**
	(0.008)	(0.148)	(0.139)	(0.171)
SP (coverage rate)	0.020***	−0.692***	0.490***	0.203**
	(0.004)	(0.089)	(0.081)	(0.085)
Rainfall shock X SP	0.007***	−0.206***	0.091***	0.115***
	(0.002)	(0.033)	(0.034)	(0.036)
Students per teacher	−0.007***	0.113***	0.022***	−0.135***
	(0.001)	(0.013)	(0.007)	(0.014)
Head of school also teaches	−0.053***	0.954***	−0.192	−0.762***
	(0.006)	(0.110)	(0.118)	(0.141)
Share of girls	0.283***	−6.058***	0.915*	5.142***
	(0.026)	(0.492)	(0.531)	(0.593)
Safe School program	−0.002	0.389**	−1.166***	0.777***
	(0.009)	(0.154)	(0.158)	(0.205)
Extending School Hours program	0.084***	−1.356***	−0.304	1.660***
	(0.015)	(0.229)	(0.252)	(0.324)
Quality Schools program	0.015***	−0.547***	0.304***	0.243**
	(0.005)	(0.081)	(0.078)	(0.102)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	398,008	398,008	398,008	398,008
# schools	49,751	49,751	49,751	49,751

Note: Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above or below 1 standard deviation from the regional historical mean (since 1950). SP (coverage rate) is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size and scaled up by a factor of 10 so that a value of 10 represents full coverage. Rainfall shock X SP is the interaction of the two terms. The share of girls is defined from 0 to 1, and Safe School, Extending School Hours, and Quality Schools programs are dummy variables indicating whether the school participates in any of these programs. Controls include 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table 2.4: Test score results: Verbal

	(1) Verbal score SD	(2) Verbal (Inadequate) pp	(3) Verbal (Fair) pp	(4) Verbal (Good+) pp
Rainfall shock	−0.020***	0.482***	−0.176	−0.307*
	(0.007)	(0.129)	(0.151)	(0.157)
SP (coverage rate)	0.013***	−0.558***	0.526***	0.032
	(0.004)	(0.078)	(0.076)	(0.073)
Rainfall shock X SP	0.006***	−0.149***	0.058*	0.091***
	(0.001)	(0.027)	(0.033)	(0.033)
Students per teacher	−0.006***	0.105***	−0.000	−0.105***
	(0.001)	(0.011)	(0.006)	(0.011)
Head of school also teaches	−0.052***	0.939***	−0.289***	−0.650***
	(0.006)	(0.104)	(0.108)	(0.128)
Share of girls	0.528***	−9.821***	−0.269	10.091***
	(0.024)	(0.453)	(0.497)	(0.519)
Safe School program	0.006	0.343**	−1.349***	1.006***
	(0.009)	(0.135)	(0.141)	(0.192)
Extending School Hours program	0.075***	−1.342***	−0.200	1.542***
	(0.015)	(0.217)	(0.222)	(0.310)
Quality Schools program	0.013***	−0.447***	0.273***	0.174*
	(0.005)	(0.072)	(0.073)	(0.094)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	398,008	398,008	398,008	398,008
# schools	49,751	49,751	49,751	49,751

Note: Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above or below 1 standard deviation from the regional historical mean (since 1950). SP (coverage rate) is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size and scaled up by a factor of 10 so that a value of 10 represents full coverage. Rainfall shock X SP is the interaction of the two terms. The share of girls is defined from 0 to 1, and Safe School, Extending School Hours, and Quality Schools programs are dummy variables indicating whether the school participates in any of these programs. Controls include 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table 2.5: Test score results: Marginalized schools

	(1) Score (SD)	(2) Inadequate (pp)	(3) Fair (pp)	(4) Good+ (pp)
Panel A: Mathematics				
Rainfall shock	−0.022**	0.615***	−0.442**	−0.173
	(0.010)	(0.215)	(0.217)	(0.216)
Rainfall shock X SP	0.006***	−0.187***	0.119***	0.068*
	(0.002)	(0.039)	(0.044)	(0.040)
Panel B: Verbal				
Rainfall shock	−0.020**	0.454**	−0.411**	−0.042
	(0.010)	(0.200)	(0.205)	(0.198)
Rainfall shock X SP	0.006***	−0.140***	0.098**	0.042
	(0.002)	(0.036)	(0.041)	(0.038)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	185,112	185,112	185,112	185,112
# schools	23,139	23,139	23,139	23,139

Note: Marginalized schools are those established in a locality considered to be experiencing some degree of marginalization (medium, high, or very high) according to the National Population Council (CONAPO). Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above or below 1 standard deviation from the regional historical mean (since 1950). Rainfall shock X SP is the interaction term of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table 2.6: Test scores results: Non-marginalized schools

	(1) Score (SD)	(2) Inadequate (pp)	(3) Fair (pp)	(4) Good+ (pp)
Panel A: Mathematics				
Rainfall shock	−0.012	0.201*	0.108	−0.309
	(0.009)	(0.117)	(0.134)	(0.202)
Rainfall shock X SP	0.004	−0.033	−0.079**	0.111*
	(0.003)	(0.034)	(0.039)	(0.057)
Panel B: Verbal				
Rainfall shock	−0.012	0.195*	0.093	−0.288
	(0.009)	(0.110)	(0.118)	(0.181)
Rainfall shock X SP	0.004	−0.029	−0.062*	0.091*
	(0.003)	(0.033)	(0.036)	(0.053)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	212,896	212,896	212,896	212,896
# schools	26,612	26,612	26,612	26,612

Note: Non-marginalized schools are those established in a locality considered to be experiencing a low degree of marginalization (low or very low) according to the National Population Council (CONAPO). Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above or below 1 standard deviation from the regional historical mean (since 1950). Rainfall shock X SP is the interaction term of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table 2.7: ENLACE results in Mathematics: Robustness checks

	(1) Math score SD	(2) Math score SD	(3) Math score SD	(4) Math score SD	(5) Math score SD	(6) Math score SD	(7) Math score SD	(8) Math score SD	(9) Math score SD	(10) Math score SD
Rainfall shock	−0.022***	−0.022***	−0.024***	−0.017**	−0.014**		−0.023***	−0.022*	−0.022***	−0.028***
	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)		(0.008)	(0.013)	(0.008)	(0.008)
SP (coverage rate)	0.020***	0.020***	0.021***	0.001	−0.005	0.014***	0.019***	0.020***	0.018***	0.020***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
Rainfall shock X SP	0.007***	0.007***	0.007***	0.006***	0.005***		0.007***	0.007**	0.007***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)		(0.002)	(0.003)	(0.002)	(0.002)
Rainfall shock X Op		−0.000								
		(0.001)								
Lead Rainfall shock						−0.004				
						(0.008)				
Lead Rainfall shock X SP						0.002				
						(0.002)				
Lagged Rainfall shock							−0.010			
							(0.007)			
Lagged Rainfall shock X SP							0.004**			
							(0.002)			
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Political Alignment	No	No	Yes	Yes	Yes	No	No	No	No	No
Pre-SP mun.charac. X Trends	No	No	No	Yes	Yes	No	No	No	No	No
Pre-SP elegibility X Trends	No	No	No	No	Yes	No	No	No	No	No
Spatial corrected standard errors	No	No	No	No	No	No	No	Yes	No	No
Observations	398,008	398,008	398,008	398,008	398,008	348,257	398,008	398,008	375,256	396,800
# schools	49,751	49,751	49,751	49,751	49,751	49,751	49,751	49,751	46,907	49,600

Note: Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above or below 1 standard deviation from the regional historical mean (since 1950). SP (coverage rate) is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size and scaled up by a factor of 10 so that a value of 10 represents full coverage. Rainfall shock X SP is the interaction of the two terms. Rainfall shock X Op is the interaction of the rainfall shock with the municipality per capita expenses (in 1,000 pesos) in the Progresa/Oportunidades program. Controls include the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate. Column 1 displays the main coefficient estimates. Column 2 includes the interaction term of rainfall shock with the municipality expenses per capita in the Oportunidades/Progresa program. Column 3 adds a control for political alignment. In column 4 I further interact pre-program municipality characteristics correlated with the rollout of Seguro Popular with trends (see Table C.9), except for the share of eligible individuals. Column 5 further includes the share of eligible individuals interacted with a trend. Column 6 conducts a placebo test of the effect of future rainfall shocks on current test outcomes. Column 7 includes one lag of the rainfall shock and its interaction with the SP coverage rate. Column 8 displays Conley standard spatial errors calculated using a radius of 200km around each locality centroid. Column 9 excludes those localities in which there is no variation in rainfall shocks (either never or always experienced a rainfall shock). Column 10 replaces school-locality level rainfall shocks with shocks measured at the municipality level. Except in column 8, robust standard errors clustered at the municipality level in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.8: ENLACE results in Verbal: Robustness checks

	(1) Verbal score SD	(2) Verbal score SD	(3) Verbal score SD	(4) Verbal score SD	(5) Verbal score SD	(6) Verbal score SD	(7) Verbal score SD	(8) Verbal score SD	(9) Verbal score SD	(10) Verbal score SD
Rainfall shock	−0.020***	−0.020***	−0.022***	−0.016**	−0.014**		−0.020***	−0.020*	−0.019***	−0.026***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)		(0.007)	(0.010)	(0.007)	(0.007)
SP (coverage rate)	0.013***	0.013***	0.014***	0.000	−0.004	0.008**	0.012***	0.013***	0.011***	0.013***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)
Rainfall shock X SP	0.006***	0.006***	0.006***	0.005***	0.004***		0.006***	0.006**	0.006***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)		(0.001)	(0.002)	(0.001)	(0.002)
Rainfall shock X Op		−0.000								
		(0.001)								
Lead Rainfall shock						−0.000				
						(0.007)				
Lead Rainfall shock X SP						0.001				
						(0.002)				
Lagged Rainfall shock							−0.009			
							(0.006)			
Lagged Rainfall shock X SP							0.004**			
							(0.002)			
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Political Alignment	No	No	Yes	Yes	Yes	No	No	No	No	No
Pre-SP mun.charac. X Trends	No	No	No	Yes	Yes	No	No	No	No	No
Pre-SP elegibility X Trends	No	No	No	No	Yes	No	No	No	No	No
Spatial corrected standard errors	No	No	No	No	No	No	No	Yes	No	No
Observations	398,008	398,008	398,008	398,008	398,008	348,257	398,008	398,008	375,256	396,800
# schools	49,751	49,751	49,751	49,751	49,751	49,751	49,751	49,751	46,907	49,600

Note: Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above or below 1 standard deviation from the regional historical mean (since 1950). SP (coverage rate) is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size and scaled up by a factor of 10 so that a value of 10 represents full coverage. Rainfall shock X SP is the interaction of the two terms. Rainfall shock X Op is the interaction of the rainfall shock with the municipality per capita expenses (in 1,000 pesos) in the Progresa/Oportunidades program. Controls include the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate. Column 1 displays the main coefficient estimates. Column 2 includes the interaction term of rainfall shock with the municipality expenses per capita in the Oportunidades/Progresa program. Column 3 adds a control for political alignment. In column 4 I further interact pre-program municipality characteristics correlated with the rollout of Seguro Popular with trends (see Table C.9), except for the share of eligible individuals. Column 5 further includes the share of eligible individuals interacted with a trend. Column 6 conducts a placebo test of the effect of future rainfall shocks on current test outcomes. Column 7 includes one lag of the rainfall shock and its interaction with the SP coverage rate. Column 8 displays Conley standard spatial errors calculated using a radius of 200km around each locality centroid. Column 9 excludes those localities in which there is no variation in rainfall shocks (either never or always experienced a rainfall shock). Column 10 replaces school-locality level rainfall shocks with shocks measured at the municipality level. Except in column 8, robust standard errors clustered at the municipality level in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.9: Children's health and time use

	Sick		Caring		Chores	
	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall shock	0.056	0.050	0.065	0.070	0.090	0.093
	(0.022)***	(0.022)**	(0.029)**	(0.030)**	(0.038)**	(0.039)**
	[0.030]*	[0.029]*	[0.052]	[0.050]	[0.053]*	[0.054]*
Rainfall shock X SP(years)	−0.013	−0.012	−0.015	−0.016	−0.026	−0.026
	(0.004)***	(0.005)***	(0.006)**	(0.006)***	(0.008)***	(0.008)***
	[0.006]**	[0.006]**	[0.009]*	[0.009]*	[0.010]**	[0.011]**
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	Yes	No	Yes	No	Yes
Mean depvar	0.082	0.082	0.159	0.159	0.559	0.558
Observations	5.792	5.720	5.859	5.786	5.859	5.786
R^2	0.011	0.017	0.045	0.063	0.143	0.149

Note: Sick is a binary variable equal to one if the child stopped doing any of her daily activities due to sickness in the past four weeks. Caring is a dummy variable recording whether the child took care of elderly or sick people and/or other children in the last week. Chores is a dummy variable equal to one if the child did domestic chores in the past week. Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the municipality of residence during the 12 months preceding the interview date was above or below 1 standard deviation from the regional historical mean (since 1950). Rainfall shock X SP(years) is the interaction term of Rainfall shock with the number of years a child had Seguro Popular available. The basic controls are the number of years a child had Seguro Popular available, dummies for year and month of interview, child's age, and gender. Additional controls include whether the child speaks an indigenous language, four categories of father's and mother's education: no education, secondary, and high school or higher, the age, gender, and marital status of the household head, ownership status of dwelling, rural location, whether the household has piped water into the house, toilet, cooks with wood or coal, and indicators of the quality of the materials of the floor and roof.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. Robust standard errors clustered at the municipality level in brackets.

Table 2.10: Children's health and time use by eligibility to Seguro Popular

	Sick		Caring		Chores	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: SP Eligible						
Rainfall shock	0.067	0.066	0.098	0.088	0.145	0.141
	(0.027)**	(0.029)**	(0.041)**	(0.041)**	(0.051)***	(0.052)***
	[0.036]*	[0.037]*	[0.079]	[0.073]	[0.067]**	[0.067]**
Rainfall shock X SP(years)	−0.016	−0.015	−0.020	−0.018	−0.036	−0.035
	(0.006)***	(0.006)**	(0.008)**	(0.009)**	(0.011)***	(0.011)***
	[0.007]**	[0.007]**	[0.015]	[0.015]	[0.013]***	[0.013]***
Observations	2936	2900	2970	2933	2970	2933
R^2	0.021	0.028	0.055	0.080	0.163	0.176
Panel B: Not SP Eligible						
Rainfall shock	0.043	0.031	0.033	0.032	0.043	0.040
	(0.035)	(0.036)	(0.043)	(0.045)	(0.058)	(0.060)
	[0.042]	[0.042]	[0.049]	[0.049]	[0.069]	[0.071]
Rainfall shock X SP(years)	−0.011	−0.008	−0.010	−0.009	−0.019	−0.017
	(0.007)	(0.007)	(0.009)	(0.009)	(0.012)	(0.012)
	[0.008]	[0.008]	[0.009]	[0.009]	[0.014]	[0.014]
Observations	2,827	2,797	2,859	2,829	2,859	2,829
R^2	0.012	0.023	0.043	0.072	0.138	0.144
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	Yes	No	Yes	No	Yes

Note: A child is eligible to SP if family does not have any other form of health insurance. Sick is a binary variable equal to one if the child stopped doing any of her daily activities due to sickness in the past four weeks. Caring is a dummy variable recording whether the child took care of elderly or sick people and/or other children in the last week. Chores is a dummy variable equal to one if the child did domestic chores in the past week. Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the municipality of residence during the 12 months preceding the interview date was above or below 1 standard deviation from the regional historical mean. Rainfall shock X SP(years) is the interaction term of Rainfall shock with the number of years a child had Seguro Popular available. The basic controls are the number of years a child had Seguro Popular available, dummies for year and month of interview, child's age, and gender. Additional controls include whether the child speaks an indigenous language, four categories of father's and mother's education: no education, secondary, and high school or higher, the age, gender, and marital status of the household head, ownership status of dwelling, rural location, whether the household has piped water into the house, toilet, cooks with wood or coal, and indicators of the quality of the materials of the floor and roof.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. Robust standard errors clustered at the municipality level in brackets.

Table 2.11: Equivalised household expenditures (in logs)

	All		Not SP Eligible		SP Eligible		Urban		Rural	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rainfall shock	−0.084	−0.089	−0.041	−0.014	−0.129	−0.161	−0.052	−0.053	−0.153	−0.180
	(0.041)**	(0.041)**	(0.058)	(0.058)	(0.059)**	(0.058)***	(0.057)	(0.058)	(0.068)**	(0.068)***
	[0.060]	[0.059]	[0.070]	[0.071]	[0.099]	[0.097]*	[0.062]	[0.064]	[0.075]*	[0.068]**
Rainfall shock X SP(years)	0.015	0.014	0.002	0.005	0.036	0.040	0.007	−0.001	0.021	0.030
	(0.011)	(0.012)	(0.016)	(0.017)	(0.018)**	(0.018)**	(0.015)	(0.016)	(0.017)	(0.017)*
	[0.014]	[0.015]	[0.018]	[0.019]	[0.018]	[0.017]*	[0.020]	[0.020]	[0.028]	[0.027]
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	4,703	4,602	2,388	2,338	2,300	2,249	2,507	2,446	2,196	2,156
R^2	0.038	0.076	0.052	0.127	0.060	0.098	0.057	0.106	0.053	0.094

Note: Household expenditures consist of all expenses in non-durable goods. The expenditures equivalence scale used is the one estimated by Teruel et al. (2005). A household is eligible to SP if the family does not have any other form of health insurance. Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the municipality of residence during the 12 months preceding the interview date was above or below 1 standard deviation from the regional historical mean. Rainfall shock X SP(years) is the interaction term of Rainfall shock with the number of years a household had Seguro Popular available. The basic controls are the number of years a household had Seguro Popular available and dummies for year and month of interview. Additional controls include the age, gender, education, and marital status of the household head, household size and variables of household composition (number of individuals between 6 and 10 years of age, between 11 and 18 years old, between 19 and 45 years old, between 46 and 60 years old, and more than 60 years old), ownership status of dwelling, rural location, whether the household has piped water in the building, toilet, cooks with wood or coal, quality of the materials of floor and roof, an interviewer-reported variable on the accuracy of reported expenditures (dummy for excellent accuracy), and a dummy controlling for whether the household expenditures were reported by the same respondent in the different waves.

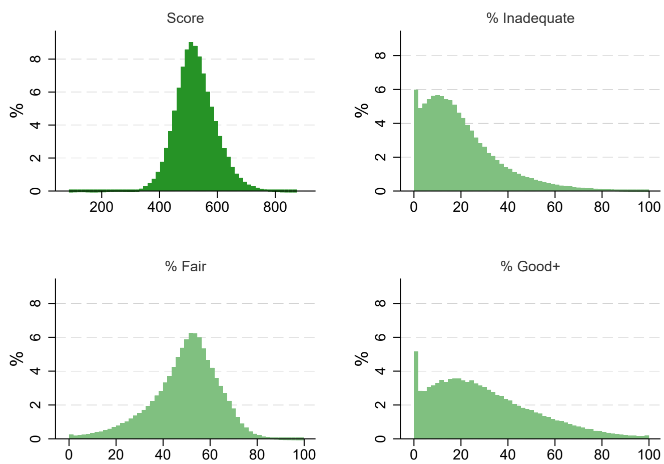
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. Robust standard errors clustered at the municipality level in brackets.

Appendix C

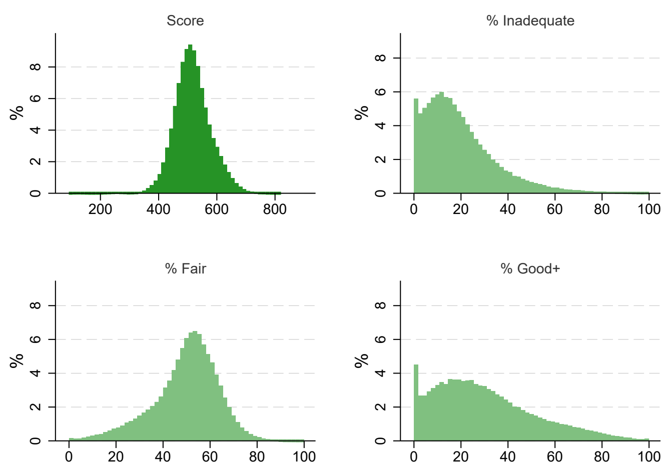
Appendix Figures and Tables

Figure C.1: Distribution of test scores (ENLACE data)

(a) Mathematics

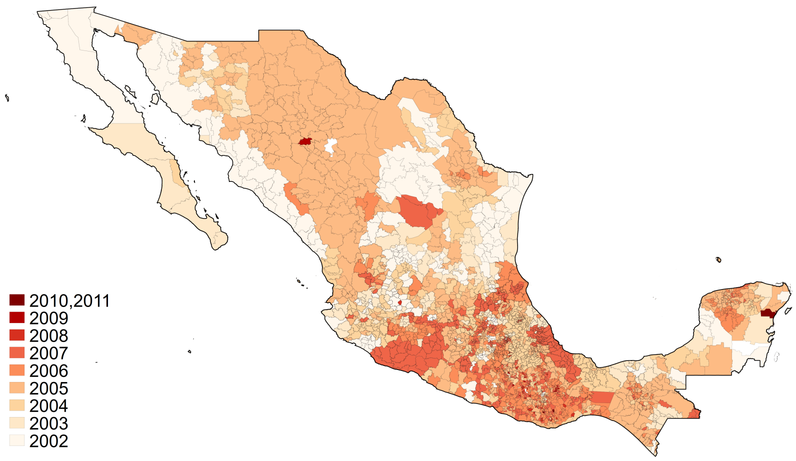


(b) Verbal



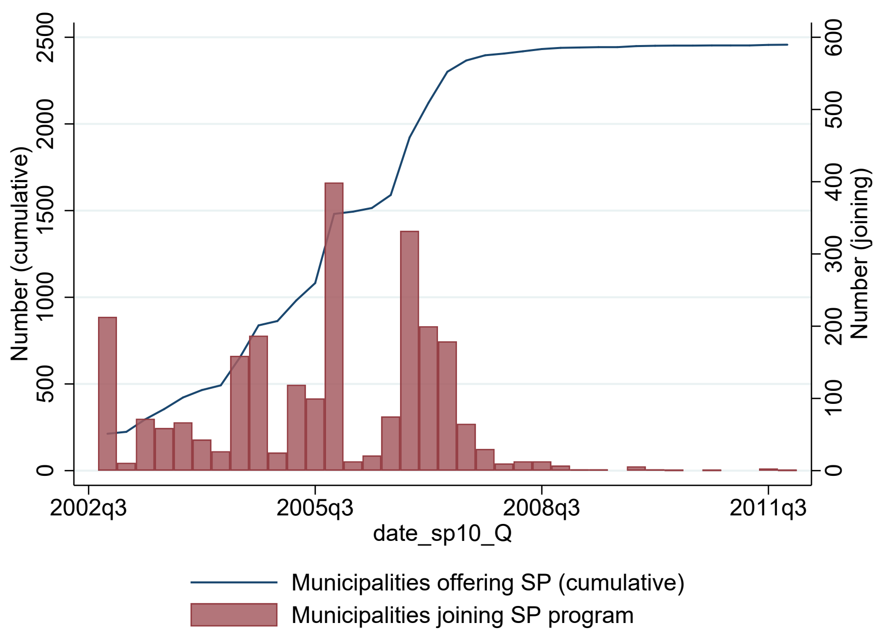
Source: Evaluación Nacional de Logros Académicos (ENLACE). Ministry of Education (SEP).

Figure C.2: Implementation year of Seguro Popular



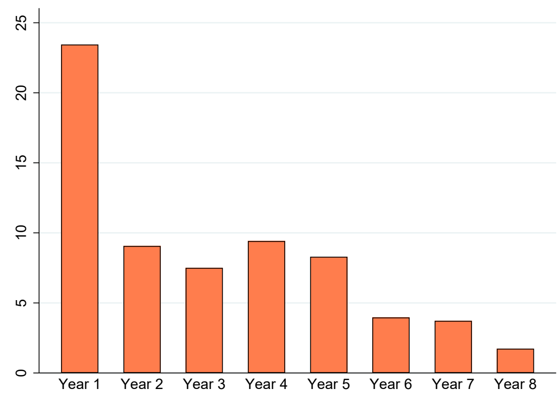
Note: The year of implementation is defined as the first year in which there were at least 10 individuals enrolled in Seguro Popular in a given municipality.

Figure C.3: Quarterly evolution of Seguro Popular implementation



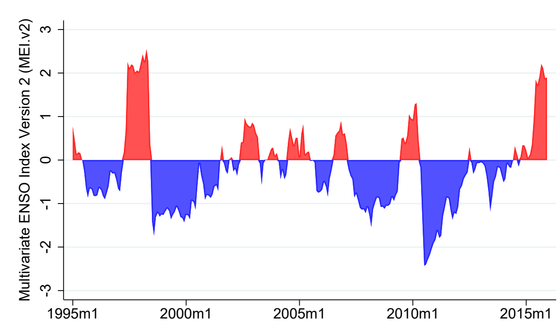
Note: The quarter of Seguro Popular implementation is defined as the first quarter in which there were at least 10 individuals enrolled in the program in a given municipality.

Figure C.4: Coverage rate expansion after Seguro Popular implementation



Note: The coverage rate is defined in percentage points. Year 1 displays the Seguro Popular coverage rate after the first year of implementation, the rest of bars display the increase in the coverage rate in each of the consecutive years.

Figure C.5: Variation in the probability of ENSO-induced climatology



Note: The multivariate ENSO (El Niño/Southern Oscillation) index (MEI.v2) measures the probability of ENSO-induced climate variation with the leading combined Empirical Orthogonal Function (EOF) of five different variables over the tropical Pacific basin: sea level pressure, sea surface temperature, zonal and meridional components of the surface wind, and outgoing longwave radiation.

Source: NOAA.

Table C.1: Test score results in Mathematics: Rainfall shock intensity

	(1) Math score SD	(2) Math (Inadequate) pp	(3) Math (Fair) pp	(4) Math (Good+) pp
Rainfall shock(1-2sd)	−0.015**	0.456***	−0.179	−0.278*
	(0.008)	(0.145)	(0.135)	(0.169)
Rainfall shock(2-3sd)	−0.058**	1.571***	−0.359	−1.212**
	(0.026)	(0.520)	(0.351)	(0.529)
Rainfall shock(+3sd)	−0.147***	4.026***	−1.768**	−2.257**
	(0.046)	(1.018)	(0.688)	(0.950)
Rainfall shock(1-2sd) X SP	0.005***	−0.138***	0.056*	0.082**
	(0.002)	(0.033)	(0.032)	(0.037)
Rainfall shock(2-3sd) X SP	0.018***	−0.485***	0.206***	0.280***
	(0.004)	(0.090)	(0.074)	(0.092)
Rainfall shock(+3sd) X SP	0.033***	−0.886***	0.414***	0.472***
	(0.008)	(0.168)	(0.145)	(0.162)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	398,008	398,008	398,008	398,008
# schools	49,751	49,751	49,751	49,751

Note: Rainfall shock(x) denotes whether the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE was between 1-2 standard deviations, 2-3 standard deviations or more than 3 standard deviations away from the regional historical mean (since 1950). Rainfall shock(x) X SP is the interaction term of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.2: Test score results in Verbal: Rainfall shock intensity

	(1) Verbal score SD	(2) Verbal (Inadequate) pp	(3) Verbal (Fair) pp	(4) Verbal (Good+) pp
Rainfall shock(1-2sd)	−0.014**	0.358***	−0.151	−0.207
	(0.007)	(0.129)	(0.151)	(0.153)
Rainfall shock(2-3sd)	−0.044*	1.062**	−0.065	−0.998**
	(0.022)	(0.445)	(0.319)	(0.448)
Rainfall shock(+3sd)	−0.109***	2.564***	−0.614	−1.950**
	(0.042)	(0.851)	(0.678)	(0.908)
Rainfall shock(1-2sd) X SP	0.004**	−0.103***	0.040	0.063*
	(0.002)	(0.029)	(0.033)	(0.033)
Rainfall shock(2-3sd) X SP	0.014***	−0.325***	0.076	0.249***
	(0.004)	(0.076)	(0.065)	(0.083)
Rainfall shock(+3sd) X SP	0.026***	−0.604***	0.259*	0.345**
	(0.007)	(0.143)	(0.138)	(0.155)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	398,008	398,008	398,008	398,008
# schools	49,751	49,751	49,751	49,751

Note: Rainfall shock(x) denotes whether the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE was between 1-2 standard deviations, 2-3 standard deviations or more than 3 standard deviations away from the regional historical mean (since 1950). SP (coverage rate) is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Rainfall shock(x) X SP is the interaction term of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.3: Test score results: Asymmetry of shocks

	(1) Score (SD)	(2) Inadequate (pp)	(3) Fair (pp)	(4) Good+ (pp)
Panel A: Mathematics				
Excess Rainfall shock	0.001	0.236	−0.109	−0.126
	(0.011)	(0.197)	(0.184)	(0.227)
Shortage Rainfall shock	−0.047***	1.059***	−0.401*	−0.659**
	(0.013)	(0.277)	(0.239)	(0.268)
Excess Rainfall shock X SP	−0.001	−0.010	0.027	−0.016
	(0.002)	(0.046)	(0.044)	(0.050)
Shortage Rainfall shock X SP	0.015***	−0.394***	0.154***	0.240***
	(0.002)	(0.050)	(0.052)	(0.056)
Panel B: Verbal				
Excess Rainfall shock	−0.002	0.265*	−0.070	−0.195
	(0.010)	(0.158)	(0.175)	(0.207)
Shortage Rainfall shock	−0.039***	0.682***	−0.277	−0.406*
	(0.012)	(0.255)	(0.247)	(0.221)
Excess Rainfall shock X SP	0.000	−0.022	0.001	0.021
	(0.002)	(0.037)	(0.039)	(0.044)
Shortage Rainfall shock X SP	0.012***	−0.267***	0.111**	0.156***
	(0.002)	(0.045)	(0.052)	(0.047)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	398,008	398,008	398,008	398,008
# schools	49,751	49,751	49,751	49,751

Note: Excess Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE exceeded in 1 standard deviation the regional historical mean (since 1950), and Shortage Rainfall shock is a dummy that equals 1 when the precipitation was 1 standard deviation below. Excess Rainfall shock X SP and Shortage Rainfall shock X SP are the interaction terms of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.4: Test score results in Mathematics: Intensity and asymmetry of rainfall shocks

	(1) Math score SD	(2) Math (Inadequate) pp	(3) Math (Fair) pp	(4) Math (Good+) pp
Rainfall(Flood)	−0.042	0.911*	0.213	−1.124*
	(0.028)	(0.531)	(0.363)	(0.580)
Rainfall(Above normal)	0.008	0.092	−0.113	0.021
	(0.010)	(0.183)	(0.180)	(0.215)
Rainfall(Below normal)	−0.040***	0.786***	−0.193	−0.593**
	(0.013)	(0.279)	(0.235)	(0.274)
Rainfall(Drought)	−0.082	4.381***	−3.934***	−0.448
	(0.055)	(0.931)	(0.840)	(1.120)
Rainfall(Flood) X SP	0.009*	−0.208*	0.057	0.151
	(0.005)	(0.107)	(0.086)	(0.111)
Rainfall(Above normal) X SP	−0.003	0.039	0.007	−0.046
	(0.002)	(0.044)	(0.042)	(0.051)
Rainfall(Below normal) X SP	0.012***	−0.297***	0.089*	0.208***
	(0.003)	(0.053)	(0.050)	(0.057)
Rainfall(Drought) X SP	0.029***	−1.088***	0.761***	0.327**
	(0.008)	(0.133)	(0.139)	(0.165)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	398,008	398,008	398,008	398,008
# schools	49,751	49,751	49,751	49,751

Note: Rainfall(Flood) = 1 if precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above 2 standard deviations from the regional historical mean (since 1950), Rainfall (Above normal) between 1 and 2 standard deviations, Rainfall (Below normal) between -1 and -2 standard deviations, and Rainfall Drought below -2 standard deviations. Rainfall(x) X SP is the interaction term of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.5: Test score results in Verbal: Intensity and asymmetry of rainfall shocks

	(1) Verbal score SD	(2) Verbal (Inadequate) pp	(3) Verbal (Fair) pp	(4) Verbal (Good+) pp
Rainfall(Flood)	−0.033	0.797*	0.046	−0.843*
	(0.025)	(0.472)	(0.342)	(0.485)
Rainfall(Above normal)	0.004	0.156	−0.052	−0.104
	(0.010)	(0.147)	(0.175)	(0.196)
Rainfall(Below normal)	−0.033***	0.535**	−0.226	−0.309
	(0.012)	(0.260)	(0.247)	(0.225)
Rainfall(Drought)	−0.050	1.984**	−1.042	−0.944
	(0.049)	(0.811)	(0.863)	(1.033)
Rainfall(Flood) X SP	0.008*	−0.173*	0.063	0.110
	(0.005)	(0.092)	(0.079)	(0.099)
Rainfall(Above normal) X SP	−0.001	0.015	−0.024	0.009
	(0.002)	(0.035)	(0.039)	(0.044)
Rainfall(Below normal) X SP	0.009***	−0.210***	0.094*	0.117**
	(0.002)	(0.049)	(0.052)	(0.048)
Rainfall(Drought) X SP	0.021***	−0.606***	0.255*	0.351**
	(0.007)	(0.122)	(0.138)	(0.150)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	398,008	398,008	398,008	398,008
# schools	49,751	49,751	49,751	49,751

Note: Rainfall(Flood) = 1 if precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above 2 standard deviations from the regional historical mean (since 1950), Rainfall (Above normal) between 1 and 2 standard deviations, Rainfall (Below normal) between -1 and -2 standard deviations, and Rainfall Drought below -2 standard deviations. Rainfall(x) X SP is the interaction term of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.6: Test score results: Rural localities

	(1) Score (SD)	(2) Inadequate (pp)	(3) Fair (pp)	(4) Good+ (pp)
Panel A: Mathematics				
Rainfall shock	−0.016	0.610***	−0.524**	−0.086
	(0.011)	(0.234)	(0.224)	(0.230)
Rainfall shock X SP	0.006***	−0.206***	0.144***	0.063
	(0.002)	(0.042)	(0.046)	(0.043)
Panel B: Verbal				
Rainfall shock	−0.015	0.428**	−0.453**	0.025
	(0.011)	(0.217)	(0.214)	(0.212)
Rainfall shock X SP	0.005***	−0.151***	0.115***	0.036
	(0.002)	(0.039)	(0.043)	(0.040)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	162,536	162,536	162,536	162,536
# schools	20,317	20,317	20,317	20,317

Note: Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above or below 1 standard deviation from the regional historical mean (since 1950). Rainfall shock X SP is the interaction term of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.7: Test score results: Small urban localities

	(1) Score (SD)	(2) Inadequate (pp)	(3) Fair (pp)	(4) Good+ (pp)
Panel A: Mathematics				
Rainfall shock	−0.015	0.164	0.069	−0.233
	(0.011)	(0.175)	(0.183)	(0.248)
Rainfall shock X SP	0.003	−0.022	−0.048	0.070
	(0.003)	(0.039)	(0.042)	(0.057)
Panel B: Verbal				
Rainfall shock	−0.013	0.115	0.079	−0.194
	(0.011)	(0.168)	(0.170)	(0.238)
Rainfall shock X SP	0.003	−0.019	−0.045	0.064
	(0.003)	(0.037)	(0.040)	(0.054)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	83,880	83,880	83,880	83,880
# schools	10,485	10,485	10,485	10,485

Note: Small urban localities are urban localities with less than 50,000 inhabitants. Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above or below 1 standard deviation from the regional historical mean (since 1950). Rainfall shock X SP is the interaction term of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.8: Test score results: Large urban localities

	(1) Score (SD)	(2) Inadequate (pp)	(3) Fair (pp)	(4) Good+ (pp)
Panel A: Mathematics				
Rainfall shock	0.002	0.053	0.190	−0.243
	(0.013)	(0.149)	(0.217)	(0.300)
Rainfall shock X SP	0.002	0.004	−0.152	0.147
	(0.006)	(0.072)	(0.093)	(0.130)
Panel B: Verbal				
Rainfall shock	0.006	0.012	0.064	−0.077
	(0.013)	(0.151)	(0.185)	(0.274)
Rainfall shock X SP	−0.001	0.045	−0.091	0.046
	(0.006)	(0.074)	(0.082)	(0.128)
School FE	Yes	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	150,968	150,968	150,968	150,968
# schools	18,871	18,871	18,871	18,871

Note: Large urban localities are urban localities with more than 50,000 inhabitants. Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above or below 1 standard deviation from the regional historical mean (since 1950). Rainfall shock X SP is the interaction term of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.9: Determinants of timing of Seguro Popular implementation

	Quarter of SP implementation			
	(1)	(2)	(3)	(4)
Population (log)	−1.047	−1.210	−1.047	−1.210
	(0.112)***	(0.106)***	(0.112)***	(0.106)***
Marginalization Index	0.413	0.268	0.413	0.268
	(0.173)**	(0.157)*	(0.173)**	(0.157)*
Share of elegible individuals	2.485	−2.171	2.484	−2.172
	(0.643)***	(0.624)***	(0.643)***	(0.624)***
Political party alignment	−3.152	−1.494	−3.152	−1.494
	(0.295)***	(0.305)***	(0.295)***	(0.305)***
Doctors per elegible (100,000)				
In Outpatient Units	−0.007	−0.004	−0.007	−0.004
	(0.001)***	(0.001)***	(0.001)***	(0.001)***
In Inpatient Units	−0.004	−0.002	−0.004	−0.002
	(0.001)***	(0.001)**	(0.001)***	(0.001)**
Evolution in Primary Education				
Pass rate growth 96-01 (annual %)	0.324	0.285		
	(0.214)	(0.197)		
Completion rate growth 96-01 (annual %)			0.325	0.287
			(0.214)	(0.197)
Primary educ. info missing	2.497	0.400	2.497	0.402
	(0.365)***	(1.277)	(0.365)***	(1.277)
State FE	No	Yes	No	Yes
Observations	2,426	2,426	2,426	2,426
R^2	0.314	0.549	0.314	0.549

Note: The timing of implementation is measured in quarters. All variables are defined at the municipality level (the unit of implementation). The population, marginalization index, and the share of eligible individuals are measured in the year 2000. The number of doctors is measured in the year 2001 (the first available). The pre-program indicators of the evolution in primary education are measured as the annual growth rate observed between 1996 and 2001.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.10: Determinants of Seguro Popular coverage rate expansion

	First Year		Second Year		Third Year	
	(1)	(2)	(3)	(4)	(5)	(6)
Population (log)	−3.884	−3.883	−1.008	−1.008	−0.260	−0.261
	(0.417)***	(0.417)***	(0.283)***	(0.283)***	(0.245)	(0.245)
Marginalization Index	2.068	2.067	0.931	0.932	−0.767	−0.767
	(0.780)***	(0.780)***	(0.575)	(0.575)	(0.490)	(0.490)
Share of elegible individuals	33.247	33.242	7.976	7.977	4.993	4.994
	(2.295)***	(2.295)***	(1.900)***	(1.899)***	(1.553)***	(1.552)***
Political party alignment	0.673	0.673	−0.372	−0.372	−0.846	−0.847
	(0.939)	(0.939)	(0.522)	(0.522)	(0.529)	(0.529)
Doctors per elegible (100,000)						
In Outpatient Units	0.030	0.030	−0.004	−0.004	−0.005	−0.005
	(0.007)***	(0.007)***	(0.003)	(0.003)	(0.003)	(0.003)
In Inpatient Units	0.008	0.008	−0.004	−0.004	0.003	0.003
	(0.005)*	(0.005)*	(0.002)	(0.002)	(0.002)	(0.002)
Evolution in Primary Education						
Pass rate growth 96-01 (annual %)	0.993		0.545		−0.357	
	(0.878)		(0.624)		(0.480)	
Completion rate growth 96-01 (annual %)		1.009		0.541		−0.360
		(0.877)		(0.624)		(0.480)
Primary educ. info missing	−4.067	−4.053	5.227	5.224	3.510	3.508
	(4.480)	(4.479)	(4.516)	(4.515)	(3.074)	(3.074)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,426	2,426	2,426	2,426	2,426	2,426
R^2	0.384	0.384	0.132	0.132	0.121	0.121

Note: The coverage rate is defined in percentage points. Dependent variable in columns "First Year" is the increase in the coverage rate in the first year of SP implementation; "Second Year", the increase in the coverage rate in the second year; "Third Year", the increase in the coverage rate in the third year. All variables are defined at the municipality level (the unit of implementation). The population, marginalization index, and the share of eligible individuals are measured in the year 2000. The number of doctors is measured in the year 2001 (the first available). The pre-program indicators of the evolution in primary education are measured as the annual growth rate observed between 1996 and 2001.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.11: Test score trends and SP expansion

	Mathematics		**Verbal**	
	(1) Test score SD	(2) Test score SD	(3) Test score SD	(4) Test score SD
SP coverage increase (07-08)	−0.000	−0.001	0.000	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
State FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
# schools	13,285	20,946	13,285	20,946

Note: Dependent variable: Variation in test scores between 2006 and 2007 (difference in standardized test scores). Independent variable: variation in the SP coverage rate between 2007 and 2008 (in percentage points). Columns 1 and 3: sample of municipalities with SP coverage rate below 5% in 2007. Columns 2 and 4: sample of municipalities with SP coverage rate below 10% in 2007. Controls include the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.12: Endogenous responses

	(1) Dropout rate (pp)	(2) Students evaluated
Rainfall shock	0.006	0.339
	(0.043)	(0.338)
Rainfall shock X SP	−0.005	−0.080
	(0.008)	(0.063)
School FE	Yes	Yes
State-Year FE	Yes	Yes
Controls	Yes	Yes
Mean depvar	3.41	136.86
Observations	391,841	398,008
# schools	49,428	49,751

Note: The dropout rate records the proportion of students leaving the school during the academic year (in percentage points). Students evaluated records the number of students sitting the ENLACE evaluation. Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the school-locality during the 12 months preceding the evaluation date of ENLACE is above or below 1 standard deviation from the regional historical mean (since 1950). Rainfall shock X SP is the interaction term of the rainfall shock with the SP coverage rate (which is calculated by dividing the number of affiliates to Seguro Popular in the municipality by its population size, and scaled up by a factor of 10 so that a value of 10 represents full coverage). Controls include the SP coverage rate, the number of students per teacher, the number of students per group, the share of girls, whether the head of the school also teaches, whether the school participates in the Safe School, Extending School Hours, or Quality Schools programs, 5 dummies of marginalization level of the school, the share of students with unreliable test results, 7 dummies of municipality size, municipality per capita expenses in the Progresa/Oportunidades program, and the municipality homicide rate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the municipality level in parentheses.

Table C.13: Children's health and time use by area type

	Sick		Caring		Chores	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Rural						
Rainfall shock	0.065	0.064	0.136	0.139	0.093	0.124
	(0.028)**	(0.029)**	(0.042)***	(0.042)***	(0.053)*	(0.054)**
	[0.042]	[0.040]	[0.083]	[0.080]*	[0.070]	[0.071]*
Rainfall shock X SP(years)	−0.016	−0.015	−0.027	−0.028	−0.026	−0.032
	(0.006)***	(0.006)**	(0.008)***	(0.008)***	(0.011)**	(0.011)***
	[0.008]*	[0.008]*	[0.014]*	[0.014]*	[0.013]*	[0.013]**
Observations	2644	2620	2676	2652	2676	2652
R^2	0.026	0.031	0.052	0.075	0.167	0.179
Panel B: Urban						
Rainfall shock	0.054	0.045	−0.020	−0.005	0.102	0.070
	(0.034)	(0.036)	(0.043)	(0.044)	(0.056)*	(0.058)
	[0.043]	[0.043]	[0.047]	[0.050]	[0.080]	[0.079]
Rainfall shock X SP(years)	−0.011	−0.010	0.001	−0.001	−0.029	−0.022
	(0.007)	(0.007)	(0.009)	(0.009)	(0.012)**	(0.012)*
Observations	3148	3100	3183	3134	3183	3134
R^2	0.011	0.021	0.052	0.070	0.138	0.149
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	Yes	No	Yes	No	Yes

Note: Sick is a binary variable equal to one if the child stopped doing any of her daily activities due to sickness in the past four weeks. Caring is a dummy variable recording whether the child took care of elderly or sick people and/or other children in the last week. Chores is a dummy variable equal to one if the child did domestic chores in the past week. Rainfall shock is a dummy variable that equals 1 when the precipitation gathered in the municipality of residence during the 12 months preceding the interview date was above or below 1 standard deviation from the regional historical mean (since 1950). Rainfall shock X SP(years) is the interaction term of Rainfall shock with the number of years a child had Seguro Popular available. The basic controls are the number of years a child had Seguro Popular available, dummies for year and month of interview, child's age, and gender. Additional controls include whether the child speaks an indigenous language, four categories of father's and mother's education: no education, secondary, and high school or higher, the age, gender, and marital status of the household head, ownership status of dwelling, whether the household has piped water into the house, toilet, cooks with wood or coal, and indicators of the quality of the materials of the floor and roof. Robust standard errors in parenthesis.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. Robust standard errors clustered at the municipality level in brackets.

Chapter 3

From Daughters to Mothers: Fertility, Schooling, and Upward Human Capital Spillovers

3.1 Introduction

The literature on the returns to children from parental investments is extensive. But, do parents benefit from the human capital of their children?

Becker's seminal 1960 paper on the economic analysis of fertility introduced children as a commodity produced in the household from which parents derive utility from both quantity (number of children) and quality (broadly defined as how much is spent on them). The study introduced the quality-quantity trade-off in fertility choice – further refined and formalized in Becker and Lewis (1973) – by which parents decide between how many children to have and how much to spend on the average child.[1] Although the hypothesis opened up a new stream of empirical research aiming to determine the existence and size of the trade-off (Angrist et al., 2010; Black et al.,

[1]Such trade-off arises as child quantity increases the shadow price of quality, and similarly, child quality increases the shadow price of quantity.

2005; Hanushek, 1992; Rosenzweig and Wolpin, 1980, among others), the relative benefits arising to parents from their offspring quantity and quality received scarce attention.

Inspecting whether parents benefit from the quantity and quality of their children could be useful to better understand the evolution of fertility choices and parental investments in children. For instance, Ager and Herz (2019) note that the decrease in agricultural wages lowered the value of child labor and fertility levels in the American South. This result is in line with the early work in Caldwell (1976), who hypothesized a decrease in fertility levels arising from falling wealth transfers from children to their parents. On the other hand, Chiswick (1988) shows that investments in the quality of children are higher among those children from ethnicities with higher returns to education in the US. Similarly, recent work on parental subjective expectations shows that parents with higher expected returns to education invest more in their children (Attanasio et al., 2019a; Boneva and Rauh, 2018). These studies suggest, taken together, that parents' fertility and investment behavior respond to market returns to human capital, in line with the theoretical predictions outlined in Galor (2012). As a result, the observed decline in fertility levels, and the remarkable increase in global educational attainment, might be partly explained by the effect that improvements in the returns to education had on the present discounted value of different combinations of children's quantity and quality. While previous research has discussed the relationship between returns to human capital and fertility choices using models of parental utility maximization (Becker et al., 1990; Galor, 2012; Galor and Weil, 2000; Hazan and Berdugo, 2002, among others), this study inspects returns to parents in the form of measurable health outcomes in later life.

Moreover, while there is well-documented evidence that poverty transmits across generations (Bird, 2013; Black and Devereux, 2010), and that part of the poverty persistence is due to high fertility among poor households lowering average investments made in children (Moav, 2004), little is known about the extent to which parents in larger families are affected by the lower human capital of their offspring. Parents decide on their optimal number of children and the level of investments they are willing to make depending on their preferences, expected outcomes, resources, and the like. But why do the poor have larger families? While some of the motivations regarding fertility choices among the poor might not be so different than that of the non-poor, they are more likely to be shaped by a combination of social, cultural, religious, and other economic considerations. For instance, reduced participation of girls in education lowers the age at birth of the first child and increases total fertility (McCrary and Royer, 2011; Schultz, 1997), early marriage and disempowerment limits the control women have over desired fertility (Raj et al., 2009), limited knowledge of and restricted access to contraception leads to higher conception rates (Bailey, 2010), and higher levels of child mortality are associated with fertility increases to compensate for the lower expected probability of children's survival (Ben-Porath, 1976; Doepke, 2005). Moreover, parents from more impoverished backgrounds might have higher preferences for a larger sibship size as a source of income from child labor (Caldwell, 1982) and protection at an old-age (Rosenzweig and Evenson, 1977). In labor-intensive subsistence economies where returns to skills are low, parents maximize at higher levels of children's quantity. However, if returns to human capital are sufficiently high and a larger sibship size lowers investments in children, high fertility could be detrimental to both children and their parents. This would be the case to the extent that human capital enables children to provide better support to their aging parents (Oreopoulos and Salvanes, 2011). Insofar as the relative return to the quantity and quality of children is unknown, so are the long-term parental consequences of fertility choices, parental investment in children, and of government policies aiming to influence them.

Most of the research investigating the impact of fertility on long-term parental outcomes have focused on measures of later life health. Results from correlational studies have not been able to establish a clear pattern as to how fertility affects parental health outcomes in later life (Schultz, 2007).[2] The new evidence brought about by causal studies also produces mixed results. Instrumenting fertility levels with China's Great Famine and the gender composition of the first pair of children, Guodong and Xiaoyan (2009) find a positive link between the number of surviving children and parents' physical and cognitive health. Kruk and Reinhold (2014) instrument fertility with the occurrence of a multiple birth and the gender composition of the first two births and find that higher fertility increases depression levels among elderly Europeans.[3] Exploiting China's One Child Policy, Islam and Smyth (2015) show that individuals with more children have lower levels of self-reported health but find no effect on other health measures.[4] On the other hand, Chen and Fang (2018) show that the campaign "Later, longer, fewer"[5] to reduce fertility levels in China improved parents' physical health but harmed their mental wellbeing.

However, and following Becker's hypothesis, changes in offspring quantity are likely to affect the average human capital that children accumulate – making it difficult to disentangle the effect of quantity from that of offspring quality. While the number of studies investigating the impact of offspring quality on long-term parental outcomes is small (partly due to the limited availability of data to test the relationship), there is enough evidence to argue that it matters. Studies on the effect of children's human capital on parental health outcomes have shown a positive correlation between offspring education and parental survival (Zimmer et al. (2007) in Taiwan, Torssander

[2] For instance, Buber and Engelhardt (2008) find a positive association between fertility and mental health in continental Europe, Read et al. (2011) show that higher fertility is linked with higher activity limitations due to health motives in the UK, Spence (2008) finds no relation between total fertility and functional limitations or depressive symptoms in the US, and Hank (2010) estimates a negative correlation between the number of children and maternal health in East Germany, and a positive one in West Germany.

[3] Austria, Germany, Sweden, the Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Czechia, Poland, and Belgium.

[4] Activities of Daily Limitation (ADL), mental health, BMI, and blood pressure.

[5] (Wan, xi, shao). A campaign that initiated in 1970, prior to the One Child Policy.

(2013) in Sweden, Friedman and Mare (2014) in the US, and De Neve and Harling (2017) in South Africa). More recently, there is causal evidence of children's education increasing parents' life expectancy in Sweden (Lundborg and Majlesi, 2018) and Tanzania (De Neve and Fink, 2018), reducing depression in Europe[6] (Everding, 2019), and improving the lung and cognitive function of parents in China (Ma, 2019). This paper adds and expands on previous studies by examining parents' long-term health outcomes as a function of both their fertility decisions (number of children) and their investments in child quality (children's education level). It also reveals important differences by the gender of the parent.[7]

I leverage two sources of exogenous variation affecting, in turn, the number of children parents have, and the level of human capital children accumulate. I address the endogeneity of family size by exploiting son preference among Chinese households and the quasi-random assignment of the firstborn child's gender. In line with J. Lee (2008) for South Korea and Kugler and Kumar (2017) for India, I show that the occurrence of a firstborn daughter predicts a larger sibship size (0.29 bigger on average), with no significant differences between rural and urban households, parental education, or across different parental cohorts.[8] Moreover, as in previous studies (Abrevaya, 2009; Almond and Edlund, 2008; Bhalotra and Cochrane, 2010; Das Gupta, 2005), I show evidence against sex-selection of the firstborn and rule out any direct effect of firstborn's sex on parental health.

To account for the endogeneity of parental investments in children's human capital, I leverage the staggered implementation of China's 1986 compulsory schooling law, which increased from 6 to 9 years the minimum schooling period. Ma (2019) uses

[6]Austria, Belgium, Czech Republic, Denmark, France, Greece, Italy, the Netherlands, Poland, Portugal, and Spain.

[7]As discussed below, the schooling reform that I use to effectively instrument for the education of the child only raised the educational attainment of girls. Therefore, the analysis of the impacts on parents of (exogenous variation in) child quality is restricted to the case of daughters.

[8]Similarly, Guodong and Xiaoyan (2009) find that at least one boy between the first two children lowers total fertility by 0.29 children in the Chinese Longitudinal Healthy Longevity Survey (CLHLS).

the same school reform to obtain exogenous variation in children's human capital. However, in contrast to Ma (2019), I additionally exploit the initial gender gap in the level of completed education before the date of implementation (of 1.6 years), which favored boys. While the extension in the minimum compulsory schooling did not affect educational attainment among sons, it created an upward shift in the education level of daughters (of 0.63 years), initiating the convergence of girls' education to that of boys. Moreover, the differential effect of the reform by children's gender (validated with the use of two independent datasets) allows me to exploit the sample of sons as a placebo group for the effect of the schooling reform on parental health.

Chinese society has traditionally relied heavily on family ties, which makes this country an interesting case study to measure the effect of fertility decisions on parental outcomes. Although improvements in the availability of pensions and public health insurance have been observed in the past years, the still relatively low social protection offered to elders, the large share of the old age population living in poverty or with low income, and the rapid aging of its population accentuate the dependence of Chinese aging parents on their children. Anecdotal evidence of the challenge that an aging population poses in the country include the introduction in 2013 of the "Law of the Protection of the Rights and Interest of the Elderly", mandating children to visit and look after their aging parents.[9] Moreover, the data show that 63% of parents in China expect to rely mainly on their children for financial support during old age, compared to 29% of those expecting to rely on a pension or retirement salary.

In this study, I estimate the effect that offspring quantity and children's education have on indices of parental physical, mental, and cognitive health among a representative sample of Chinese residents aged 45 and older interviewed in the China Health and Retirement Survey (CHARLS).[10] I find that while fertility does not have

[9]Presidential Decree No.72. Central Government portal, December 28, 2012, http://www.gov.cn/flfg/2012-12/28/content_2305570.htm (accessed on November 6, 2020).
[10]Cognitive health is the ability to clearly think, learn, and remember.

any statistically significant direct long-term effect on parental health, the reform-induced increase in daughters' education improved mothers' physical health by 0.14 standard deviations (two-thirds of the gender gap in physical health), and increased parental cognitive achievement by 0.16 standard deviations (29% of the cognitive premium from primary school completion) - an effect driven by the sample of mothers. These results are robust to specifications that account for children and parental cohort fixed effects, regional trends, the intensity in the regulation and sanctions of the One Child Policy, household wealth, confounders at different regional levels, and to different methods of constructing the health indices.

An inspection of some of the potential mechanisms at play shows that while the extension in the minimum years of compulsory schooling did not change labor force participation among daughters, it increased the share of girls working in clerical occupations (while decreasing the share of girls employed in agriculture). While the reform also induced an increase in parental expectations regarding future financial help from their daughters, there seems not to be a significant effect on current financial transfers, nor on the contact intensity or functional help received by their children. The physical improvement that mothers experience from higher-educated daughters could be explained by an increase in the quality of such parental contact. This is the mechanism observed in Lundborg and Majlesi (2018), who document an increase in parental life expectancy arising from better information on the production function of health among children. Although one can imagine that an increase in the schooling of daughters improved mothers' cognition either through direct teaching (to read and write for instance) or from a higher exposure to more educated individuals, in practice this hypothesis is hard to test. The larger estimated effects observed among the sample of mothers are likely to be partly explained by their lower initial levels of human capital. However, descriptive evidence also shows that mothers are more likely to rely on their children for help and care in later life than fathers, who instead expect more care from their spouses.

This study documents higher measurable health returns to parents from investments in children than from increased fertility. This is particularly relevant to the extent that higher fertility is detrimental to children's human capital, as shown by Li et al. (2008), Rosenzweig and Zhang (2009), and also in this study, in the Chinese context.[11] Moreover, the study shows that the pecuniary return to education seems not to be the driver of the observed results. This distinction is important when assessing the external validity of the findings, since returns to education have been increasing in China since 1990.[12]

The results also suggest an underestimation in previous studies of the effect of policies promoting higher education among girls as a means to reduce gender inequality, as they typically fail to account for the positive externalities accruing to their mothers. More generally, this study shows there are potential gains for parents across the developing world from increasing daughters' schooling. This result is not trivial, as parents continue to be one of the main barriers preventing girls in many countries from pursuing further education (due to security concerns and cultural norms, among others). This paper also provides a potential new explanation for the findings in many studies that higher investments in children are made when additional economic resources are given to mothers (Rubalcava et al., 2009; Thomas, 1990), and for stronger intergenerational intra-female resource transfers (Baranov et al., 2020; Duflo, 2003). While the hypothesis so far has been that mothers have a stronger

[11] While the analysis abstracts from the short-term effects of parental fertility choices, which could be relevant if households face inter-temporal budget constraints and children are used as a productive asset in the household, these are indirectly accounted for when assessing long-term outcomes.

[12] Up until 1990 (when the youngest cohort of children in the study sample were born), the returns to education in China were very low by international standards (4% or less for an additional year of schooling) (Fleisher et al., 2005; Fleisher and Wang, 2004). However, as the collective economy declined, the weight of state-owned enterprises reduced, and the productivity and efficiency of the economy improved, so did the return to education. In 2001, it was estimated to be at 10.2% for an additional year of schooling (Zhang et al., 2005), and it is estimated at 20% in contemporary China (Fang et al., 2012).

preference for child quality, this study shows that part of this preference can be explained by mothers benefiting more than fathers from their offspring in later life. This additional expected return would be mechanical if mothers expect to outlive their husbands (the common pattern observed across the world [WHO, 2019]), and significant if mothers are less capable of generating resources of their own (or are more vulnerable) independently of their civil status. In this regard, the data show that mothers are more likely to rely on their children for financial old-age support and for help with functional limitations than fathers (who, on the contrary, enjoy better access to a pension and retirement salary and expect more help from their spouses).[13]

Evaluating the return to offspring quantity and quality is not only critical to understanding fertility behavior and parental investments, but also to assess potential externalities accruing to parents from policies promoting reduced fertility levels, banning child labor, or expanding compulsory schooling as a means to increase children's human capital. Such policies disregard the effect that a smaller sibship size might have on the aging quality of parents. If reduced fertility levels were beneficial for children but compromised long-term parental health outcomes or parents' sustenance in old-age, such policies would generate a moral dilemma. However, this study shows that both children and parents' human capital benefit from reduced fertility levels and higher investments in children.[14] To the best of my knowledge, this is the first study that attempts to disentangle the relative return from offspring's quantity and quality.

The paper is structured as follows. Section 3.2 describes the household survey data and examines descriptive evidence relating fertility decisions with parental long-

[13]While I show no effect from increased daughters' education on current financial transfers, the results show an increase in future expected financial transfers. Similarly, although the contact intensity seems not to be affected by higher levels of education among daughters, a potential improvement in the quality of such contact should have an impact on the quality of old-age support.

[14]However, I find that an additional child is associated with an increase of 0.02 standard deviations in the total net monetary transfers that parents receive from their children in later life.

term health outcomes. Section 3.3 discusses the challenges to identification and the empirical strategy implemented. Section 3.4 presents the results, followed by a series of robustness investigations in Section 3.5. In Section 3.6 I provide an analysis of potential mechanisms to help explain the findings, and Section 3.7 offers some concluding remarks.

3.2 Data

This study draws on information from the China Health and Retirement Longitudinal Study (CHARLS). The CHARLS is a longitudinal household survey modeled on the Health and Retirement Study in the US (HRS).[15] It contains information from a representative sample of Chinese residents aged 45 and older and their spouses, living in about 10,000 households in 28 out of the 33 provincial-level regions in which the country is divided (Zhao et al., 2014). The survey provides a large array of items regarding socio-economic and health circumstances. In this study, I use the information collected in 2013 (second wave), which contains a fertility history module that records, for all children born to respondents and independently of their current residency status, their year of birth, and completed education level. In addition, the fertility history module includes measures of interaction and support between parents and their children.

3.2.1 Dataset construction and measures of aging quality

With the fertility history module, it is possible to construct a dataset of parent-child observations by matching every child to their respective parents in the main survey. In a given household, only one of the respondents provides answers to the fertility questionnaire. Adopted or foster children are also included in the survey, but I focus

[15] Also, on the English Longitudinal Study of Ageing in the UK (ELSA), and the Survey of Health, Ageing and Retirement in continental Europe (SHARE).

the analysis on biological children (representing close to 99% of all child observations). If a given child is reported to be the biological child of both parents in the household, I match the child observation to both parents.[16] Otherwise, I only match the child observation to the biological parent responding to the fertility questionnaire.[17]

Using all survey modules I construct four datasets: a) the child dataset, where the level of observation is the child; b) the parent dataset, recording one observation per parent; c) the household fertility dataset, where the level of observation is the respondent to the fertility history module and therefore only includes one record per household; and d) the parent-child dataset, which contains one observation per parent-child relation. In the latter, survey weights are adjusted to account for differentials in fertility levels (otherwise, higher-fertility parents would be overrepresented in the sample). That is, since a parent with three children would appear three times in the data, I re-weight the survey weight of that parent by one third so that the sum of weights is equal to the original survey weight. I further restrict the sample to those parents for whom all children are old enough to have completed their education (23 years old and older). Arguably, these parents have also completed their fertility.[18]

Summary statistics for parents and their children are shown in Table 3.1 and Table 3.2, respectively. Table 3.1 shows that parents are, on average, 62 years of age (born between 1910 and 1968). Mothers have about 2.7 years less schooling than fathers on average, and 42% of them have no formal education (as opposed to 12% of fathers).[19] The average number of children per parent is about 2.6, and around half the parents in the sample have three or more children. In Table 3.2, we see that children of the main respondents are around 38 years old on average (born between 1922 and 1990). The level of education completed among sons is about 1.2 years higher than the one

[16]This is the case in 97% of all child observations among married individuals.

[17]Parents that are divorced, separated, never married, or cohabiting, represent only around 1.3% of the parental observations. The incidence of widowhood is of 11%.

[18]Remember that the sample of respondents is aged 45 and older.

[19]The years of schooling of both children and parents are computed from the level of completed education.

completed by daughters, showing that the inter-generational gender gap in education has closed by 56 percentage points between parents and their children. Moreover, the share of illiterate daughters (with no education), has almost halved with respect to that of their mothers (22% versus 42%), but the primary completion rate still lies 11 percentage points below that of sons, at 78%. Around 35% of sons live in the parental house, while this percentage is 10% among the sample of daughters. Nevertheless, around 76% of all children reside in the same district in which their parents live.

To measure parental health outcomes, I construct a series of indices using Inverse Covariance Weighting (Anderson, 2008) of different measures reflecting parental physical, mental, and cognitive health in later life.[20] The physical health index is constructed from a series of self-reported functional limitations (with varying degrees of severity) in activities of daily living (ADL): jogging; walking 1 km; walking 100 meters; getting up from a chair after sitting for a long period; climbing several flights of stairs without resting; stooping, kneeling, or crouching; reaching or extending the arms above shoulder level; lifting or carrying weights like a heavy bag of groceries; picking up a small coin from a table; and a self-assessed measure of own health status.[21] The mental health index is constructed using the variables from the 10-item CES-D instrument, commonly used to screen for depression among older adults (Andresen et al., 1994). This shorter version of the full questionnaire (20-items CES-D), asks for the frequency over the past week of having felt bothered, depressed, fearful, lonely, hopeful about the future, happy, effortful, experiencing restless sleep, having trouble to keep focused on the task at hand, or the feeling of not being able to get going in a 4-point Likert scale.[22] In addition, a variable of general life satisfaction

[20] The index gives more weight to those variables with lower covariance with the rest of the index components (that is, those variables that provide more "new" information).

[21] The levels of severity in functional limitations are a) No, I do not have any difficulty; b) I have difficulty but can still do it; c) Yes, I have Difficulty and Need Help; and d) I cannot do it. Self-assessed health is rated from very poor to very good in a 5-point scale.

[22] a) Rarely or none of the time ($<$ 1 day); b) Some or a little of the time (1- 2 days); c) Occasionally or a moderate amount of the time (3 - 4 days); and d) Most or all of the time (5 - 7 days).

is also included with answers ranging from completely satisfied to not at all satisfied on a 5-point scale. Finally, the cognitive health index is constructed using variables that measure cognitive functioning and that include the ability to do the mathematical operation of subtracting 7 from 100 (dummy equal to 1 if correct answer), the ability to recall words previously presented to the respondent (total number of recalled words), the ability to replicate a drawing (dummy equal to 1 if able to draw the picture), and self-rated memory ability on a 5-point scale ranging from poor to excellent. Appendix Table D.1 shows summary statistics for all the health measures evaluated separately by parents' gender.

Figure 3.1 shows the evolution of the different indices of parental health by gender and age of the parent. Note that these measures are derived from cross-sectional data, and so the age of the parent in the interview year is collinear to the parents' birth cohort. As a result, the evolution of the different health indicators is influenced by secular cohort trends, and by the positive survival selection of respondents. In general terms, physical and cognitive health is worse for the older cohorts. The pattern for mental health is less clear. While mental health shows a slow but monotonic decline by age among men, for women, it reaches its lowest point at the age of 61 before it starts improving thereafter.[23] Nonetheless, mothers obtain lower scores than fathers in all the constructed health indices for any given cohort and perform worse in each of the individual health components evaluated (see Appendix Table D.1). In what follows, I inspect the correlation between parental health in later life and different attributes of parents and their children.

[23]When inspecting the evolution of the individual health components, I observe that the improvement in mental health among mothers is due to an improvement in the measures of life satisfaction, feelings of depression, bothersome, and focus on the tasks at hand.

3.2.2 Associations between aging quality and parental characteristics

Table 3.3 shows correlations between the parental health indices and characteristics of parents and their children. The results display a clear and positive education gradient in physical, mental, and cognitive health. Parents with completed primary school score 0.06 standard deviations higher in the physical health domain than parents with no education (column 1), and those with completed high school or higher score 0.17 standard deviations above (significant at the 1% level). Similarly, column 3 shows that parents finishing primary education score 0.06 standard deviations higher in mental health than parents with no education (significant at the 10% level), and those with high school studies or higher obtain a mental health premium of 0.18 standard deviations. As expected, the level of education is an even stronger predictor of cognitive achievement in old age. Completing primary education is associated with a cognition score 0.54 standard deviations higher than having no education (column 5) while graduating from high school or higher is associated with a 0.82 standard deviation increase in cognitive health (both significant at the 1% level). As discussed earlier, women present on average lower levels of health in all domains, with the gender gap in health being larger than the rural-urban gap in health.

The results in Table 3.3 also show that even after controlling for parents' education, there remains a strong and positive correlation between children's years of education and parental health in all domains (columns 1, 3, and 5). As for the effect of fertility on parental health outcomes, higher fertility is associated with negative health outcomes. However, conditional on children's education, only physical health is statistically and significatively correlated with offspring quantity (-0.02 standard deviations in the physical health score for each additional child, column 1). When excluding children's education from the regression to account for the potential trade-off between offspring quantity and quality (columns 2,4, and 6), the results show a stronger negative association between total fertility and physical health (-0.027 standard deviations per additional child), and cognitive attainment (-0.029 standard deviations), both significant at the 1% level. This result suggests that while there might be a direct effect of total fertility on parental health outcomes, there seems to be an additional indirect (negative) effect operating through higher fertility lowering the educational attainment among children. Columns 2, 4, and 6 of Appendix Table D.2 show that in this sample of Chinese households, an additional child lowers between 0.43 and 0.54 the average years of education of the sibship. The trade-off between sibship quantity and quality in China has also been shown in Li et al. (2008) using population census, and in Rosenzweig and Zhang (2009) using the Chinese Child Twins Survey (CCTS). Moreover, the positive correlation between children's education and parental health is observed for both sons' and daughters' education (see Appendix Table D.3).

When inspecting the correlation between offspring quantity and parental health separating the effect by parents' gender (Appendix Table D.4), we see that the negative effect of fertility on physical health is more pronounced among the sample of mothers (column 4), with each additional child lowering by 0.032 standard deviations the score of the physical health index (significant at the 5% level). On the other hand, the negative association between fertility and parental cognitive attainment is driven by the sample of fathers (column 10). Some other interesting observations from splitting the sample by parents' gender are that the education gradient in cognitive achievement is more pronounced among women (column 11) than men (column 9), and that the rural-urban gap in parental health is almost entirely explained by the gap between rural and urban women (except for cognitive health, in which rural men also score lower than their counterparts in urban areas (0.09 standard deviation lower and significant at the 1% level, column 9). Assessing the relationship between children's education and fertility on parental health outcomes through the use of categorical instead of continuous variables does not change the discussion of the correlational results (see Appendix Table D.5).[24]

3.3 Empirical strategy

Fertility and investments in children are potentially endogenous to the parental health outcomes considered. Parents decide how many children to have and the level of investments towards their human capital. This section discusses the strategy to estimate the causal effect of offspring quantity and children's education on parental health outcomes.

3.3.1 Exogenous variation in the number of children

To address the potential endogeneity of parental choice over the desired number of children, I exploit son preference among Chinese households. In China, as in other countries in the South and East of Asia, in North Africa, and the Middle East, the higher role reserved for men in both the family and society makes the preference for giving birth to boys higher than that of girls. If parents have a predilection for sons over daughters, and to the extent that the sex of the firstborn child is random, the occurrence of a female firstborn would create an exogenous shift in the probability of having another child (with parents hoping to give birth to a son in the next delivery). I make use of the quasi-randomness in firstborn's sex assignment (Abrevaya, 2009; Almond and Edlund, 2008; Bhalotra and Cochrane, 2010; Das Gupta, 2005), and instrument sibship size with the occurrence of a firstborn daughter.

The following equation models the effect of having a female firstborn on total

[24] Using dummy variables of whether children completed primary education, middle school, high school, or college instead of using children's years of education; and dummy variables of whether parents have two children, three, for, or five or more children instead of using the number of children.

fertility:

$$S_h = \alpha + \rho Girl_h^{fb} + \psi' X + \varphi_a + \mu_p + \varepsilon_h \tag{3.1}$$

Where S_h is the sibship size of household h, $Girl_h^{fb}$ is a dummy variable that equals one when the firstborn child is a girl, and X is a vector of characteristics of the parent interviewed in the fertility history module; consisting of parent's gender, education level, parent's ethnicity, and a dummy for rural household. The equation also includes parent birth cohort fixed effects (φ_a), province fixed effects (μ_p), and an error term (ε_h).

The results of estimating equation (3.1) are shown in Table 3.4. Families in which the first child is a girl end up with a sibship size 0.29 larger on average than parents for whom their firstborn is a boy (Column 1). This result is similar to the one estimated by Kugler and Kumar (2017) and Jensen (2005) for India, and slightly higher than the one estimated by J. Lee (2008) for South Korea.[25] Moreover, the preference for sons among Chinese parents seems not to significantly differ by parental characteristics, as the interaction of having a female firstborn with parental education (Column 2); with rural location (Column 3); and with parents from older cohorts (Column 4), are all statistically insignificant.

As in previous research, I assume that there is no parental sex-selection for first births (Abrevaya, 2009; Almond and Edlund, 2008; Bhalotra and Cochrane, 2010; Das Gupta, 2005). Appendix Table D.6 shows estimates of an OLS regression that predicts the occurrence of a female firstborn with different parental characteristics. The only variable statistically associated with female firstborn occurrence is belonging to Han ethnicity (at the 10% level). All other variables are statistically insignificant,

[25] Kugler and Kumar (2017) estimate that completed fertility increases by 0.22 when the firstborn is a girl, the estimate is of 0.47 in Jensen (2005), and of 0.18 in J. Lee (2008). Similarly, Guodong and Xiaoyan (2009) find that at least one boy between the first two children lowers total fertility by 0.29 children in the Chinese Longitudinal Healthy Longevity Survey (CLHLS).

and the model explains almost none of the variation in sex of the firstborn. Moreover, to rule out concerns about sex of firstborn affecting parental health in later life other than through an increase in offspring quantity, Appendix Table D.7 shows the results of a regression in which parental health is regressed against the sex of the firstborn child controlling for the number of children. The results show that giving birth to a girl in the first delivery does not have any statistically significant direct effect on parental health among fathers (Panel B), nor mothers (Panel C). This result is in favor of the assumption being made that the sex of the firstborn child only affects parents' later life health through its effect on total fertility.[26]

3.3.2 Exogenous variation in children's education

To address the potential endogeneity of offspring quality, I make use of the implementation of China's national compulsory schooling law of 1986. The new regulation increased the minimum schooling period from 6 to 9 years (Ming, 1986; Pepper, 1990). Under the new law, all children were required to attend school until the age of 14. Therefore, children aged 15 or older at the time of the law becoming effective in their province of residence were never affected by the new regulation and they are used as a control group in the analysis. Moreover, the introduction of the new extended minimum schooling period was staggered across the territory (see Figure 3.2). Figure 3.3 displays the evolution of the average years of children's completed education as a function of their cohort of birth and province of residence, centered around the implementation date (vertical solid red line).

Period 1 on the x-axis displays the level of education attained by those children aged 14 in the first year of the newly introduced minimum compulsory schooling. Period 2 shows the average education of children that were aged 13, and so on.

[26]At least in the short-run, however, there is evidence that Chinese mothers spend longer time outside of the labor market, and that household cigarette consumption reduces more significatively, following the birth of a son instead of a daughter (Wang, 2019).

Similarly, period 0 reflects the average years of education of those children that missed by one year being affected by the education reform (aged 15 at the introduction date). While the figure shows there is no discontinuity in the level of education achieved among boys around the cut-off (whose educational attainment on average was already close to 9 years), there is a clear jump in the completed years of education among girls (for whom the education level was more than two years below the new compulsory minimum). Figure 3.4 displays the coefficient estimates of the size and significance of the discontinuity, net of birth cohort and province effects, and depicts a similar picture. All in all, the schooling reform initiated the convergence of daughter's education towards that of sons.

I assess the effect of extending the minimum compulsory schooling on children's education by estimating the following equation:

$$E_{icp} = \alpha + \beta Treat_{cp} + \sigma' Z + \theta_c + \mu_p + \varepsilon_i \qquad (3.2)$$

Where E_{icp} are the completed years of education of child i, belonging to cohort c, and born in province p, $Treat_{cp}$ is a dummy equal to one if the child was affected by the introduction of the schooling reform and is a function of the child's birth cohort and province of birth, Z is a vector of characteristics of the parent responding to the fertility questionnaire and child characteristics that include parent's education level, parent's ethnicity and gender, dummies of offspring quantity, and a dummy for whether the child was born in a rural area. Child cohort fixed effects are depicted by θ_c, province fixed effects by μ_p, and ε_i is the error term. In line with the figures discussed above, Table 3.5 shows that while the introduction of the extended minimum compulsory schooling did not affect schooling attainment among sons (column 4), it increased by 0.63 years the education level among daughters (significant at the 5% level, column 6).

As explained below in more detail, I will exploit the differential effect of the education reform by children's gender to argue in favor of the causality of my estimates of the effect of extending the minimum compulsory schooling on long-term parental health.

3.3.3 Causal effect of fertility and children's education on parental outcomes

To estimate the causal effect of children's education on parental health in later life I estimate the following reduced form equation for sons and daughters separately:

$$y_j = \alpha + \beta Treat_{icp} + \Phi' M + \varphi_a + \theta_c + \mu_p + \varepsilon_i \tag{3.3}$$

Where y_j are the long-term health indices in physical, mental, and cognitive health of parent j, $Treat_{icp}$ is a dummy variable that equals one for those children of parent j affected by the school reform, M is a vector of parent and child characteristics that include the education level of the parent, whether married, the parent's gender and ethnicity, and a dummy variable for rural area. φ_a are parent cohort fixed effects, θ_c are children cohort fixed effects, μ_p are province fixed effects, and ε_i is the error term. As the extended minimum compulsory schooling only affected the education level among daughters, I use the sample of sons as a placebo group for the effect of the education reform on parental health outcomes. Moreover, I will also discuss the results obtained from a two-stage instrumental variable regression of the effect of daughters' education on parental long-term health using the schooling reform as the instrument.

To evaluate the effect of fertility on long-term parental health outcomes I first estimate a similar reduced form equation using the occurrence of a female firstborn:

$$y_j = \gamma_0 + \gamma_1 Girl_j^{fb} + \Omega' J + \varphi_a + \mu_p + \varepsilon_j \tag{3.4}$$

In equation (3.4), y_j denotes the different constructed measures of parental health (physical, mental, and cognitive health) of parent j, and $Girl_j^{fb}$ denotes whether the firstborn child of parent j is a girl. Similar to the notation previously described, φ_a depict parent cohort fixed effects, μ_p are province fixed effects, and ε_j are the error terms. Moreover, J is a vector of characteristics that include the parent's education level, gender, marital status and ethnicity, and a dummy for rural area. Given the preference for sons among Chinese households (Table 3.4), the assumption of quasi-randomness in sex of firstborn (Appendix Table D.6), and the null direct effect of sex of firstborn on parental health (Appendix Table D.7), the coefficient estimate on $Girl_j^{fb}$ will show the effect of an increase in desired fertility on parental long-term health due to the occurrence of a female firstborn. I will also discuss the results of a two-stage instrumental variable regression of the effect of offspring quantity on parental health outcomes when using the incidence of a female firstborn as the instrument.

3.4 Results

The results of estimating equation (3.3) are shown in Table 3.6. Panel A displays the effect of the reform-induced increase in daughters' education on parental health outcomes. We see that while the increase in education among daughters does not have any statistically significant effect on long-term parental physical health (Column 2), nor on mental health (Column 4), the extended minimum schooling period increased by 0.16 standard deviations parental cognition, significant at the 5% level (Column 6). This estimate is equivalent to 29% of the cognitive premium from primary school completion (see Column 5 of Table 3.3).

Given that the school reform did not increase educational attainment among sons, we should not expect to see any impact of the reform on parental health arising from treated sons. Panel B of Table 3.6 shows the results of a placebo test of the effect of the education reform on parental health arising from exposed or treated sons. Reassuringly, the results confirm the hypothesis of no effects.

In Table 3.7 I show the results of estimating equation (3.3) splitting the sample by parents' gender. We see that the observed increase in parental cognition arising from treated daughters is driven by the sample of mothers (0.21 standard deviations and significant at the 5%, column 6). The estimated coefficient of the effect on fathers, although positive, is no longer significant.[27] The difference in the estimated effect across parents' gender might be explained by the marked gender gap in the cognitive health score, which favors fathers (see Figure 3.1), or it may arise from the greater interaction of mothers with children and, especially daughters. Moreover, we can now see that the reform-induced increase in daughters' education improved mothers' physical health by 0.14 standard deviations (Column 2), an effect equivalent to two-thirds of the gender gap in physical health (see Column 1 of Table 3.3). In Column 1 of Table 3.7 we see that, although not statistically significant, there is a negative and sizeable relationship between daughters' exposed to the school reform and fathers' physical health (-0.109 standard deviations).

Appendix Table D.8 shows the results of estimating the effect of daughters' education on parental health in a two-stage instrumental variable regression using the exposure to the schooling reform as the instrument. The finding that higher education among daughters is beneficial for mothers' physical and cognitive health persists (Panel C). While the magnitude of the effects is consistent with the one estimated using a reduced form equation (Tables 3.6 and 3.7), the coefficients are slightly less precisely estimated. Moreover, when splitting the sample by parent's gender (Panel B and Panel C), the F-statistic of the excluded instrument test in the first-stage reduces considerably in size (drops below the rule of thumb of 10 in all specifications).

[27]However, it is not statistically different than the one estimated for mothers.

The results of estimating equation (3.4) showing the effect of a firstborn daughter on parental health outcomes are shown in Table 3.8. Columns 1, 3, and 5, do not control for the average years of children's education, while Columns 2, 4, and 6, do. This distinction is made to account for the potential effect that higher fertility, induced by a female firstborn, might have on the educational attainment of children. Panel A displays the results when pooling all parents together and shows that the occurrence of a female firstborn does not have any statistically significant effect on long-term parental health regardless of the specification used. The estimated magnitude of the effect is similar across the different specifications and tends to be close to zero. The same can be said when splitting the sample by parents' gender, Panels B (fathers), and C (mothers).

A null effect of total fertility on long-term parental outcomes is also documented in Appendix Table D.9 using a two-stage instrumental variable regression in which total fertility is instrumented with the incidence of a female firstborn. A common pattern observed is that the specification that controls for children's education produces more positive effects on parental health than the specification that does not condition on children's education. For instance, while an additional child improves fathers' physical health by 0.047 standard deviations conditional on offspring's education (Panel B, Column 1), this magnitude reduces to 0.033 when accounting for the possibility that higher fertility reduces average educational investments in children (Panel B, Column 2). The same can be said for all other outcomes and the sample of mothers (Panel C). Moreover, there is a consistently negative relationship between higher fertility and mental health for both fathers and mothers (columns 3 and 4). However, while higher fertility is also associated with lower physical and cognitive health among the sample of mothers when children's education is not controlled for (columns 2 and 6 of Panel C), the relationship between offspring quantity and fathers' physical and cognitive health is positive (columns 2 and 6 of Panel B). Nevertheless, the estimated coefficients are not statistically significantly different from zero. The F-statistic of the excluded instrument test in the first-stage is high, with values ranging from 79 to 183.

In Appendix E, I discuss the strategy and the results of estimating the causal effect of both the number of children and children's education on parental health at once. While doing so requires some adjustments in the estimation specification due to the extension in the minimum compulsory schooling only affecting daughters, results confirm a null effect of fertility on parental long-term health, and an increase in mothers' cognition arising from the higher educational attainment of their daughters.

Two important implications arise from the findings. The first concerns the implementation of policies to foster education among children, including the expansion of minimum compulsory schooling. The results provide support for policies promoting higher education among girls as a means to reduce gender gaps, and suggest underestimated impacts of educational programs targeting girls as studies typically fail to account for the positive externalities accruing to their mothers. The second involves the effect of fertility levels on parental long-term outcomes. While this study shows a null direct effect of offspring quantity on parental health in later life in a context where social protection of the elderly is limited, higher fertility could be detrimental to parents in the long run to the extent that it hampers children's quality. This study does not fully address the complexity of parental returns to fertility and investment decision in children – this involves more complex considerations regarding the optimal distribution of total resources over children, the non-linearity of returns to quality, and the minimum investment levels in quality that offset the shadow price of quantity. Nonetheless, my results show that parents (mothers) obtained higher long-term health returns from offspring quality (daughters' quality) than from children quantity.

3.5 Robustness and other considerations

This section reviews the strategy implemented and provides additional evidence to validate the estimated results.

Different specifications

I conduct a series of robustness tests to probe the sensitivity of the results to changes in the estimated specification. Appendix Table D.10 examines robustness of the results of the effect of the schooling reform on parental health. The first four columns show estimates of the effect on parental physical health. Column 1 (Trends), includes province-specific time trends of both child and parent birth cohorts. This specification accounts for trends in parental health outcomes and children's education not captured by birth cohort and province fixed effects. Column 2 (OCP), includes province-year measures of the intensity of the enforcement of the One Child Policy measured by fines, bonuses, and premium punishments of excess fertility obtained from Ebenstein (2010). This specification captures potential behavioral effects of the introduction of the OCP on fertility choices among parents that were still of fertile age.[28] In column 3 (Village FE), I replace province fixed effects with village fixed effects. Finally, column 4 (Wealth) includes measures of household wealth in the regressions.[29] The estimates show that the positive effect on maternal physical health from increased schooling among daughters (columns 1 to 4 of Panel B) and on maternal cognitive attainment (columns 9 to 12 of Panel B) are robust to all specification changes. So is the null effect on parental health arising from sons affected by the education reform (Panels C and D).

[28] The birth cohorts of the children in my sample range between 1922 and 1990. The One Child Policy was first introduced in 1979/1980.

[29] Household wealth is measured in the current period (as it is not known at the time of fertility and investment decisions in children). The household wealth variables are: whether the building is made of concrete, whether there is running water inside the residence, the existence of in-house bath or shower facilities, of a telephone connection, availability of coal gas or natural gas, and whether the main source of cooking fuel is coal, crop residue, or wood.

Appendix Table D.11 shows the reduced form effect of a female firstborn on parental health implementing the same specification changes as in Table D.10. The previously estimated null effect of fertility on parental later life health is maintained, with coefficient estimates gravitating around zero across the different specifications.

Alternative methods to construct indices

In Appendix Table D.12 I assess the effect of the education reform on parental health using alternative methods to construct the health indices. The results displayed in the column header "PCA" are estimated using parental health indices obtained using a principal component variable (PCA). In the column header "SEM", the indices are estimated using a latent variable indicator constructed from structural equation modeling. Both indices use the same set of health variables as index components.[30] As can be seen in Panel B of Table D.12, independent of the method used to construct the indices, the results show a significant and positive effect on maternal physical health and cognitive attainment arising from daughters affected by the education reform. The magnitude of the effects, although slightly smaller, are very similar to the ones estimated using Inverse Covariance Weighting (Table 3.7). The estimated null effect of having a female firstborn (increase in desired fertility) on parental health is also insensitive to the use of alternative methods to construct the health indices (see Appendix Table D.13).

Parents with missing health outcomes

Although the data are rich in the number of variables available to measure different later life health outcomes, the presence of missing values is substantially large. As a result, the constructed indices of parental physical, mental, and cognitive health

[30] See Appendix Table D.1 for a detailed list of the health components used to construct the indices.

outcomes are missing for a significant share of survey respondents (ranging from 14% to 23%). In Appendix Table D.14 I assess whether child exposure to the education reform or the sex of the firstborn child predict a missing value in the parental health index. If this were the case, there would be a problem of sample selection. Results show that both the school reform treatment and the sex of the firstborn are orthogonal to the probability of not observing the health of a parent due to missing values in the index components.

Data validation

In the main analysis, I show the effect of the extension in the minimum compulsory schooling on children's education using information from the fertility histories in CHARLS. Using an independent dataset (China Family Panel Studies), I can validate the estimated effect with information provided by adults that were of school-age at the time of the reform (instead of recall information from parents). The China Family Panel Studies (CFPS), as the CHARLS survey, is a longitudinal and nationally representative sample of Chinese families and individuals (Xie and Hu, 2014). The results of estimating an OLS regression of the effect of being exposed to the education reform on the years of completed education are reported in Appendix Table D.15. These results confirm the previously estimated increase in the educational attainment of girls (columns 3 and 6), and the statistically insignificant impact it had among the sample of boys (columns 2 and 5). The estimated increase in the schooling of girls using the CFPS dataset is 0.75 years and significant at the 1% level, slightly larger than the magnitude estimated using the fertility histories from CHARLS (0.63 years).

The One Child Policy as an instrument for family size

Another potential instrument for family size could be the One Child Policy (OCP). Implemented in China towards the end of 1979 and the beginning of 1980, it sought to reduce its population size by limiting the number of children families could have. The policy was gradually implemented and had to overcome resistance by parents (Scharping, 2013). It also introduced some exceptions for ethnic groups, and some changes were implemented in the mid 1980's to allow for a second child in rural areas when the firstborn child was a girl (Hardee-Cleaveland and Banister, 1988; Qian, 1997). However, Appendix Figure D.1 shows that completed fertility across cohorts of Chinese women had already been decreasing well before the implementation of the OCP (as also shown in Almond et al., 2019). While total fertility of the women in my sample born before 1937 was above four children, for women born between 1955 and 1965 (aged between 14 and 24 years of age at the OCP implementation) completed fertility remained stable at around two children.[31] Moreover, Appendix Figure D.2 shows that the percentage of families with only one child had been increasing for ten years before the implementation of the OCP. In 1985 (6 years after the introduction of the OCP), the probability of being an only child in the cohort was around 30%, well below the scenario of a single child.[32] Moreover, no clear discontinuity in the probability of being an only child around the policy implementation date is observed (vertical red lines).[33] Appendix Figure D.2 also shows that although the only child incidence had been increasing for both boys and girls in the years prior to the OCP, this was more accentuated among boys during the whole study period. This suggests that, in line with the preferred instrument, parents whose firstborn was a girl were more likely to have a second child, both before and after the introduction of the OCP.

[31] The birth cohort of mothers in my sample range from 1911 to 1968.

[32] The figure is weighted by the inverse of the number of siblings in the family so that all siblings sum as one observation. Otherwise, multiple-children families would drive down the incidence of "only child" in the cohort.

[33] Two vertical red lines are displayed to account for the time lapse between the time of conception and birth.

3.6 Mechanisms

Finding the causal mechanism relating higher human capital among children and improvements in parental health in later life is not straightforward. For instance, although one can hypothesize that the increased schooling among daughters created upward cognitive spillovers to mothers either through direct teaching (to read and write for instance) or through more interactions with higher educated individuals, in practice, it is hard to prove. On the other hand, an improvement in daughters' education could have positively affected mothers' physical health either from better knowledge about the production function of health or through additional availability of economic resources. In what follows, I investigate possible explanations of the effect of the school reform on long-term parental health outcomes.

Children's labor market experience

In Figure 3.5 I inspect the effect of extending the minimum compulsory schooling on two labor market indicators: a) labor market participation, and b) occupation type. The hypothesis is that better outcomes of children in the labor market would presumably benefit their parents through additional economic resources. The estimated effect of the education reform on daughters is displayed in the left-side and in red. In blue and on the right side of the figure is the estimated effect for boys (the placebo group). The figure shows a rather small and insignificant effect of the extension of the minimum compulsory schooling on daughters' labor market participation (which was already high, see Table 3.2) of 2.2 pp. However, the reform had a statistically and significant impact on their occupation type. More pronounced is the increase in the share of females working in clerical occupations (3.8 pp or 54%, significant at the 1% level). While not statistically significant, the increase in the share of daughters working in clerical occupations would mostly come from a reduction of 1.9 pp in the share of girls working in agriculture (the sector that employs most of the daughters (45%), see Table 3.2). Therefore, a first potential explanation of the improvement in physical and cognitive health of mothers could be due to the direct effect of increased schooling and improved labor market experiences among their daughters. As expected, the education reform did not affect labor market outcomes among sons.

Support given to parents

To investigate the mechanism through which daughter's education benefits their parents I also examine whether the extension in the minimum compulsory schooling affected the support received by parents either financially, through child-parent contact, or some other form of functional help. This information is obtained from the fertility history module, and therefore there is only one record per child and household (i.e., information on support from children is not available for mothers and fathers separately). Figure 3.5 shows that the education reform increased by 10 pp the probability that parents expect to receive future financial help from a treated daughter (significant at the 5% level). However, there is no effect on current net monetary transfers received (neither total nor regular).[34] Although not statistically significant, parents are less likely to have regular contact from a treated daughter but more likely to receive functional help in case of need. Moreover, there is an estimated positive but not significant coefficient on the probability of parents relying on children for functional help in the future when these have been affected by the schooling reform. However, the functional help measure is imprecise because it is not child-specific, and therefore cannot be separated by children's gender.

Overall, the evidence does not point to a mechanism of increased financial resources from the offspring or an increase in the contact intensity with children in later life.

[34] Total net transfers refer to the total amount of monetary net transfers received in the past year, while regular net transfers refer to the amount of the total net transfers that have some level of periodicity.

While education might have provided daughters' with better information on the production function of health and therefore the quality of parental contact could have improved (the mechanism identified in Lundborg and Majlesi (2018) for the effect of children's education on parental survival), this explanation remains a hypothesis. However, it is plausible that the increase in daughters' schooling would have generated a pure spillover effect on parents' cognition and especially on mothers' cognition (see the large gender gap in cognition observed in Figure 3.1 favoring fathers).

Sibship size and mechanisms

For consistency, and although the findings show that fertility does not have any causal impact on parental health, Figure 3.6 shows the effect of a female firstborn on the same labor market indicators of children and support received by parents introduced above. The only statistically and significant effect, although very small, is that the occurrence of a female firstborn influences the total net transfers received by parents (0.006 standard deviations higher, significant at the 10% level). If evaluated using a two-stage instrumental variable regression, this increase is estimated to be at 0.02 standard deviations per additional child, significant at the 10% level (not shown). This result is in line with studies discussing higher fertility in developing countries as a means to receive financial support during old age (Rosenzweig and Evenson, 1977).

Stronger effects among mothers

The increase in daughters' education shows a stronger impact on maternal health. This could be explained by a higher preference of daughters for mothers, or as a consequence of the lower initial levels of human capital among mothers (see Figure 3.1, Table 3.1, and Appendix Table D.1). The summary statistics shown in Table 3.9 offer another potential explanation. The table displays information regarding intra-family help and caring arrangements. Panel A summarizes information regarding the need and identity of the helper/career in activity limitations experienced by parents. These include limitations in doing household chores, preparing hot meals, shopping, making telephone calls, and taking medications. The information is provided by parents' gender, for all households and for "two-partners households", separately.[35] In line with their lower levels of health, mothers are more likely to be experiencing activity limitations than fathers (11 pp more likely), but both parents are as likely to receive help in case of need. However, we can see that while fathers are more likely to rely on their spouses for help, the share of mothers relying on their children is higher than that of fathers. In "two-partners households", mothers are 8 pp more likely to rely only on their children for help than fathers, while fathers are 8 pp more likely to rely on their spouse only than mothers.

Because some of the activity limitations listed in Panel A are prone to be gender-biased, Panel B displays information relating help received with functional limitations (help with dressing, bathing, eating, getting in and out of bed, and using the toilet) that are gender-neutral. In "two-partners households", mothers are 3 pp more likely to be experiencing a limitation that requires help and 11 pp less likely to receive help than fathers in case of need. Similarly, as in Panel A, mothers with functional limitations in "two-partners households" are 11 pp more likely to rely only on children for help than fathers are, and 7 pp less likely to rely only on their spouse.

Although the table is very descriptive in nature, the information presented suggests that part of the explanation of the larger effect of daughters' education on maternal health is the larger dependence mothers have on their children. In this scenario, and to the extent that higher education makes children better able to support their parents in later life, mothers would experience a more direct benefit from investing

[35]"Two-partners households" are defined as those households in which the respondent is married and living with the spouse (82.4%), or in cohabitation (0.05%). The remaining respondents are either widowed (11.5%) or married but not living with the spouse, separated, divorced or never married (6%). Fathers are more likely to be living in a two-partners household than mothers (88.8% versus 77.7%), while mothers are more likely to be living without a partner than fathers (22.3% versus 12.2%).

in the education of their children.

3.7 Conclusion

This study examines whether parents benefit from their children to better understand fertility decisions and parental investments in children. Differently from previous studies, which use models of parental utility maximization, I estimate long-term health returns to offspring quantity and quality. Learning about the returns to fertility choices allows me to evaluate the extent to which poor families, especially in the developing world, are affected by high fertility and low investments in children. This differs from previous studies on the intergenerational transmission of poverty, which do not take into account the extent to which parents are affected by the lower human capital of their offspring.

Using the higher preference of Chinese households for sons and the quasi-random assignment of the sex of the firstborn to instrument for sibship size, I find that higher fertility does not have any direct causal effect on long-term parental health. This result suggests that policies aiming to reduce fertility levels as a means to increase investments in children would not harm parents' health in the long run. On the other hand, a reform-induced increase in the education level of daughters improved parental cognitive attainment (especially among mothers), and maternal physical health in later life. This result documents positive spillovers from increased investments in girls to reduce gender inequalities, and provide further support towards policies that target educational investments among girls (such as the "Keeping Girls in School Act" of 2019, a bill approved by the US to reduce barriers that adolescents girls face in accessing primary and secondary education in low and middle-income countries). More generally, this study documents that parents, often a barrier for girls' schooling in many countries, could benefit from better-educated daughters.

The research design of this study takes advantage of the null effect among sons from the education reform to support the estimated causal effect of daughters' schooling on parental health. However, the obvious limitation is the inability to draw conclusions with respect to the rate of return to investments made on sons versus investments made on daughters.[36] Testing whether aging parents obtain higher benefits from raising sons over daughters could help rationalize the gender investment gap in children observed in many countries of the world (something that we still know very little about) or document a self-fulfilling prophecy, by which parents gain more from sons simply because they invest more on them (Mocan and Yu, 2017).[37,38]

On the other hand, daughters are a large source of informal care across the world. To the extent that education improves caregiving (either through resources or information), there is scope for higher aging quality for parents with better-educated daughters. Nevertheless, in this study, I am only able to say that the correlation between children's education and parental health is larger for sons than for daughters (Appendix Table D.3). If we believe that the bias in the estimated effect of children's education on long-term parental health outcomes in an OLS regression does not differ by child's gender, we would conclude that in China the return to investments made on daughters is between 70% and 86% of the return to investments made on sons. Anecdotally, this figure is similar to the estimated gender wage gap in the country (Xiu and Gunderson, 2013).

[36]However, there are both economic and cultural returns to raising sons and raising daughters, and these might be relevant to parents at different levels.

[37]At least Rosenzweig and Schultz (1982) show that in districts of India where women's expected employment in the labor market is relatively high, daughters receive a larger share of the family resources relative to sons.

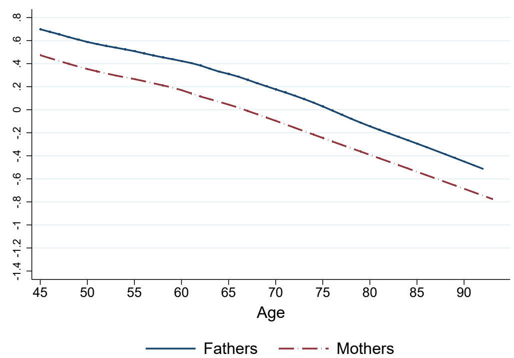
[38]Mocan and Yu (2017) find that children born during the dragon year in China (a year though to bring good fortune and greatness) obtain higher test scores in middle school and are more likely to complete college education. However, these results are explained by the higher expectations and investment levels these children receive from their parents. Moreover, they show that the gender gap in children's height more than halves for cohorts born during this particular year of the zodiac calendar. In Table 3.2 of this study, it can also be observed that parents continue to transfer more resources to their sons than to their daughters during adulthood, with 73% of daughters (versus 63% of sons) providing positive net monetary transfers to their parents in later life.

To conclude, these results also support the hypothesis that parents obtain information through their children, in line with Nakasone and Torero (2016), who show that a school intervention in Peru providing knowledge on agricultural practices to children triggered behavioral changes among their parents. The policy implication of the findings is the potential scope to target difficult to reach individuals through their children (either in school or in the labor market), and possibly through other easier to find relatives that they might interact with. These include health information campaigns, environmental sensitization programs, or the promotion of civic attitudes and values.

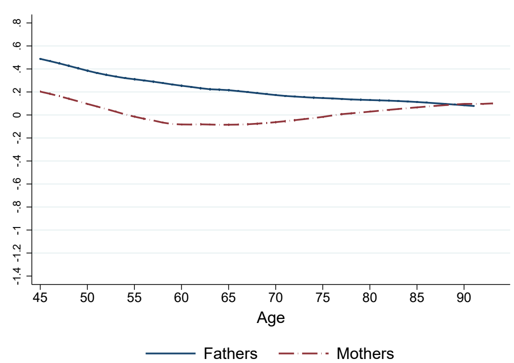
3.8 Figures

Figure 3.1: Aging and parental health outcomes

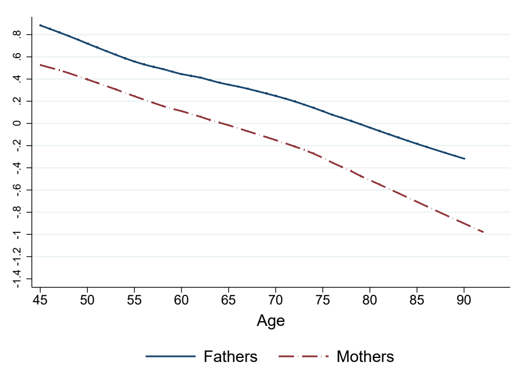
(a) Physical Health Index



(b) Mental Health Index

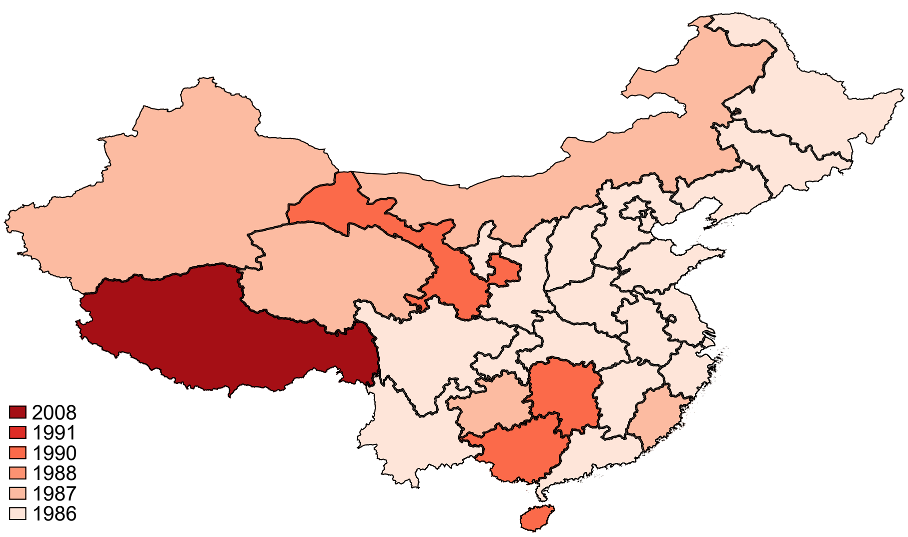


(c) Cognitive Health Index



Note: Relationship between parents' age and indices of physical, mental, and cognitive health using lowess smoothing. See Table D.1 for a summary of the components integrating each of the health indices.

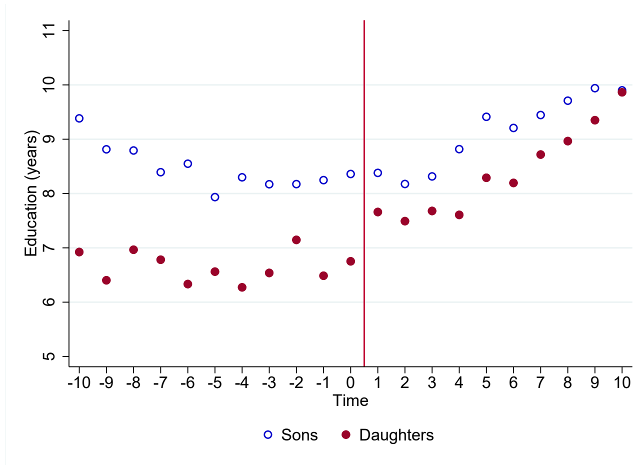
Figure 3.2: Introduction year of the extended minimum compulsory schooling period



Note: Provincial-level introduction year of the extended minimum compulsory schooling approved in 1986.

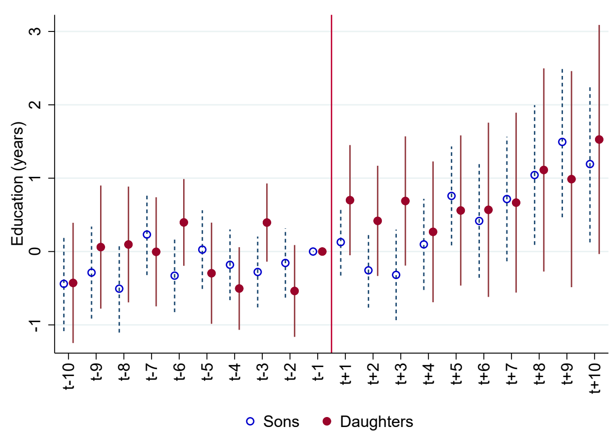
Source: Guo et al. (2017).

Figure 3.3: Evolution of the average years of completed education



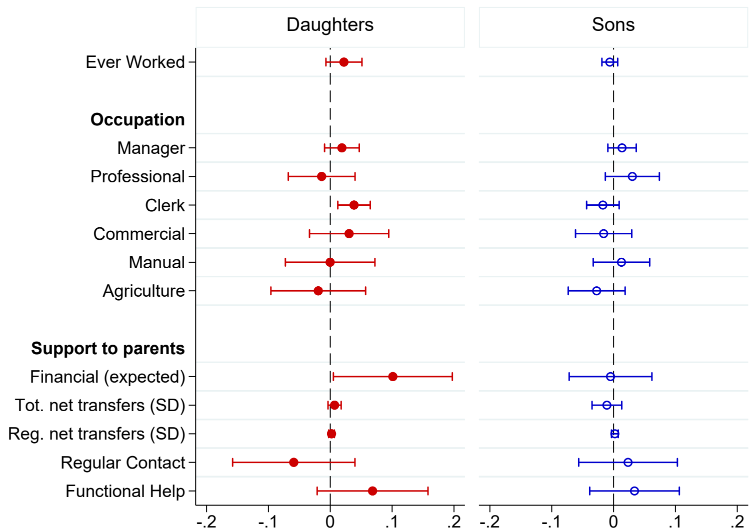
Note: Scatterplot of the average years of completed education among sons and daughters centered around the implementation year of the extension in the minimum years of compulsory schooling (solid vertical red line). Time is expressed as lags and leads from the implementation year and it is a function of children's birth cohort and province of residence. Period 0 reflects the average years of education of those children that missed by one year being affected by the education reform.

Figure 3.4: Effect of the compulsory schooling law on years of education



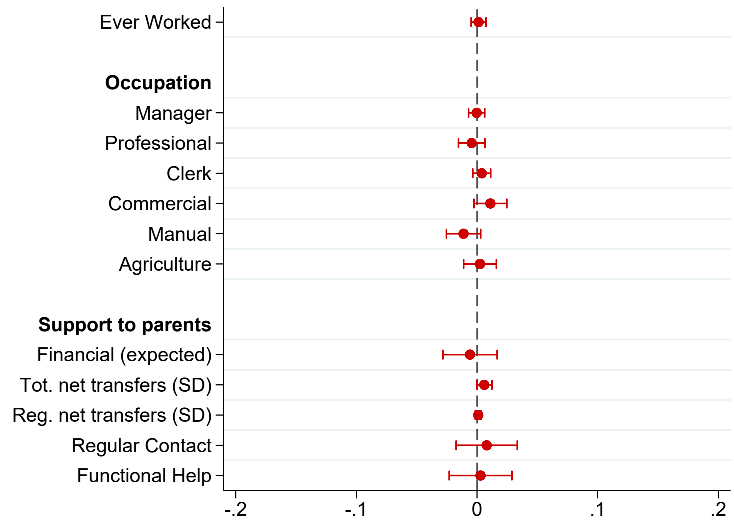
Note: Plot of average years of completed education among sons and daughters netting out children birth cohort and province fixed effects centered around the implementation year of the extension in the minimum years of compulsory schooling (solid vertical red line). Time is expressed as lags and leads from the implementation year and it is a function of children's birth cohort and province of residence. Confidence intervals are set at the 90% level.

Figure 3.5: Extended schooling and potential mechanisms



Note: Each of the coefficients shown in the figure is estimated in a separate OLS regression of the effect of the extension in the minimum compulsory schooling on labor marker indicators of children and on support given to their parents. Sample of respondents to the fertility histories. The dependent variables (except for Functional Help) are measured at the child level. Functional Help is measured at the sibhsip level. The regressions control for the education (5 categories) and sex of the parent responding to the the fertility questionnaire, a dummy variable for belonging to the Han ethnicity, a dummy variable for living in a rural area, child and parent cohort fixed effects, and province fixed effects. Regular contact is defined as seeing or having contact with the child at least once per week. Tot. net transfers (SD) refer to the total standardized amount of net monetary transfers received from the child, while Reg. net transfers (SD) refer to the fraction of the total net transfers that have some level of periodicity. Standard errors are clustered at the child cohort-province level in the children labor market participation and occupation regressions, and at the parent cohort-province level in the regressions of support received by parents. Confidence intervals are displayed at the 95% confidence level.

Figure 3.6: Fertility and potential mechanisms



Note: Each of the coefficients shown in the figure is estimated in a separate OLS regression of the effect of having a female firstborn on labor marker indicators of children and on support given to their parents. Sample of respondents to the fertility histories. The dependent variables Ever Worked and Occupation type are measured at the child level. The dependent variables of support to parents are measured at the sibhip level. The regressions control for the education (5 categories) and sex of the parent responding to the the fertility questionnaire, a dummy variable for belonging to Han ethnicity, a dummy variable for living in a rural area, parent cohort fixed effects, and province fixed effects. Regular contact is defined as seeing or having contact with at least one of their children at least once per week. Tot. net transfers (SD) refer to the total standardized amount of net monetary transfers received from children, while Reg. net transfers (SD) refer to the fraction of the total net transfers that have some level of periodicity. Standard errors are clustered at the child cohort-province level in the children labor market participation and occupation regressions, and at the parent cohort-province level in the regressions of support received by parents. Confidence intervals are displayed at the 95% confidence level.

3.9 Tables

Table 3.1: Summary statistics of parents

	Fathers		Mothers	
	Mean	SD	Mean	SD
Years of education	6.06	4.63	3.38	4.44
Primary completed	0.70	0.46	0.40	0.49
Middle school completed	0.42	0.49	0.23	0.42
Age	62.07	9.12	61.48	10.02
Birth Year	1950.93	9.12	1951.52	10.02
Education (categorical)				
No Education	0.12	0.33	0.42	0.49
Incomplete primary	0.18	0.38	0.18	0.38
Primary school	0.27	0.45	0.17	0.38
Middle School	0.26	0.44	0.15	0.35
High School or more	0.17	0.38	0.08	0.28
Fertility				
Sibship size	2.55	1.29	2.71	1.40
Single child	0.21	0.41	0.19	0.39
Two children	0.36	0.48	0.34	0.47
Three children	0.23	0.42	0.23	0.42
Four children	0.12	0.32	0.13	0.34
Five or more children	0.08	0.28	0.11	0.32
Share of boys in sibship	0.56	0.33	0.56	0.33
Firstborn female	0.46	0.50	0.46	0.50
Financial old-age support				
Children	0.59	0.49	0.67	0.47
Savings	0.05	0.21	0.03	0.18
Pension/Retirement Salary	0.33	0.47	0.26	0.44
Other	0.04	0.19	0.04	0.19
Other support				
Regular contact with children	0.78	0.41	0.80	0.40
Has functional limitation	0.25	0.43	0.37	0.48
- Received help	0.83	0.38	0.79	0.41
Expects care from children	0.67	0.47	0.69	0.46
Observations	5,756		6,465	

Table 3.2: Summary statistics of children

	Sons		Daughters	
	Mean	SD	Mean	SD
Years of education	9.21	3.77	8.05	4.50
Primary completed	0.89	0.31	0.78	0.41
Middle school completed	0.66	0.47	0.54	0.50
Ever worked	0.97	0.16	0.94	0.23
Age	38.13	9.66	38.62	9.48
Birht Year	1974.87	9.66	1974.38	9.49
Education (categorical)				
No Education	0.11	0.31	0.22	0.41
Primary school	0.23	0.42	0.24	0.42
Middle school	0.37	0.48	0.30	0.46
High School	0.16	0.37	0.14	0.34
College	0.12	0.33	0.11	0.31
Occupation				
Managerial	0.08	0.27	0.05	0.22
Professional	0.21	0.41	0.10	0.31
Clerical	0.07	0.25	0.07	0.25
Services	0.29	0.45	0.32	0.47
Agriculture	0.36	0.48	0.45	0.50
Residency				
Parental household	0.35	0.48	0.10	0.30
Parental village	0.29	0.46	0.18	0.39
Parental district	0.13	0.33	0.47	0.50
Other	0.23	0.42	0.24	0.43
Support to parents				
Financial (parent expectation)	0.62	0.49	0.39	0.49
Positive net transfers	0.63	0.48	0.73	0.44
Regular contact with parents	0.62	0.48	0.55	0.50
Observations	10,369		8,753	

Table 3.3: Variation in parental health indicators

	Physical Health Index		Mental Health Index		Cognitive Health Index	
	(1)	(2)	(3)	(4)	(5)	(6)
Incomplete primary	0.011	0.023	−0.051	−0.035	0.351***	0.360***
	(0.029)	(0.028)	(0.033)	(0.033)	(0.034)	(0.034)
Primary school	0.057**	0.079***	0.061*	0.094***	0.540***	0.561***
	(0.028)	(0.028)	(0.032)	(0.032)	(0.032)	(0.032)
Middle School	0.108***	0.144***	0.117***	0.170***	0.664***	0.707***
	(0.030)	(0.030)	(0.034)	(0.033)	(0.033)	(0.033)
High School or more	0.175***	0.230***	0.179***	0.261***	0.816***	0.880***
	(0.032)	(0.031)	(0.042)	(0.040)	(0.036)	(0.035)
Married	0.028	0.031	0.214***	0.228***	0.041	0.058*
	(0.033)	(0.032)	(0.040)	(0.040)	(0.034)	(0.034)
Female	−0.208***	−0.198***	−0.230***	−0.213***	−0.188***	−0.172***
	(0.018)	(0.018)	(0.021)	(0.021)	(0.019)	(0.019)
Han Ethnicity	0.012	0.014	−0.052	−0.049	0.037	0.036
	(0.038)	(0.038)	(0.047)	(0.048)	(0.043)	(0.044)
Rural	−0.061***	−0.084***	−0.094***	−0.127***	−0.128***	−0.155***
	(0.019)	(0.019)	(0.024)	(0.023)	(0.020)	(0.020)
Children's education (years)	0.015***		0.022***		0.019***	
	(0.002)		(0.003)		(0.002)	
Number of children	−0.019*	−0.027***	−0.004	−0.016	−0.016	−0.029***
	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)	(0.010)
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	27,164	27,678	26,152	26,636	23,895	24,367
R^2	0.129	0.125	0.088	0.082	0.261	0.256

Note: The table shows results from OLS regressions of associations between indices of parental physical, mental, and cognitive health, and characteristics of parents and their children. See Table D.1 for a summary of the components integrating each of the health indices.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table 3.4: Effect of a firstborn girl on completed fertility

	Total Fertility			
	(1)	(2)	(3)	(4)
FirstChildGirl	0.293***	0.291***	0.241***	0.284***
	(0.029)	(0.032)	(0.043)	(0.029)
FirstChildGirl X LowEduc		0.004		
		(0.057)		
FirstChildGirl X Rural			0.084	
			(0.056)	
FirstChildGirl X OlderCohort				0.017
				(0.059)
Incomplete primary	−0.078	−0.078	−0.078	−0.078
	(0.050)	(0.050)	(0.050)	(0.050)
Primary school	−0.116**	−0.114**	−0.116**	−0.116**
	(0.047)	(0.053)	(0.047)	(0.047)
Middle School	−0.185***	−0.183***	−0.185***	−0.185***
	(0.047)	(0.053)	(0.047)	(0.047)
High School or more	−0.343***	−0.342***	−0.343***	−0.344***
	(0.052)	(0.058)	(0.052)	(0.052)
Han Ethnicity	−0.238***	−0.238***	−0.236***	−0.238***
	(0.074)	(0.074)	(0.074)	(0.074)
Rural	0.459***	0.459***	0.420***	0.459***
	(0.034)	(0.034)	(0.043)	(0.034)
Cohort FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Observations	7,087	7,087	7,087	7,087
R^2	0.445	0.445	0.445	0.445

Note: The table shows results from OLS regressions on the effect of a firsborn girl on total fertility (dependent variable). FirstChildGirl is a binary variable that is equal to 1 when the firstborn child is a girl. Low education is defined as having no education or not having completed primary school. Older cohort is defined as being older than the sample median (63 years old). There is one observation per household and the regressions control for the sex of the respondent to the fertility history module.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table 3.5: Effect of extended compulsory schooling on years of education

	All		Sons		Daughters	
	(1)	(2)	(3)	(4)	(5)	(6)
Treated	0.289	0.343**	−0.091	0.097	0.845***	0.628**
	(0.186)	(0.173)	(0.209)	(0.196)	(0.308)	(0.284)
Daughter	−1.029***	−0.937***				
	(0.064)	(0.059)				
Incomplete primary		0.526***		0.510***		0.524***
		(0.073)		(0.092)		(0.117)
Primary school		1.344***		1.211***		1.513***
		(0.075)		(0.092)		(0.118)
Middle School		2.244***		2.089***		2.482***
		(0.089)		(0.111)		(0.135)
High School or more		3.666***		3.413***		3.953***
		(0.110)		(0.146)		(0.158)
Two children		−0.612***		−0.776***		−0.543***
		(0.100)		(0.124)		(0.164)
Three children		−1.131***		−1.240***		−1.148***
		(0.110)		(0.141)		(0.172)
Four children		−1.577***		−1.449***		−1.839***
		(0.120)		(0.151)		(0.184)
Five or more children		−2.176***		−1.844***		−2.605***
		(0.124)		(0.158)		(0.193)
Han Ethnicity		0.441***		0.367**		0.471**
		(0.140)		(0.167)		(0.208)
Rural		−1.565***		−1.132***		−2.045***
		(0.062)		(0.077)		(0.095)
Child Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19,037	18,957	10,334	10,292	8,703	8,665
R^2	0.176	0.322	0.124	0.251	0.217	0.396

Note: The table shows results from OLS regressions in which the dependent variable is child's education and the independent variable Treated is a binary variable equal to 1 if the child was affected by the extension in the minimum compulsory schooling. All regressions control for the sex of the respondent to the fertility histories.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the child cohort-province level in parentheses.

Table 3.6: Children's education and parental outcomes

	Physical Health Index		Mental Health Index		Cognitive Health Index	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Daughters						
Treated	0.036	0.025	−0.010	−0.017	0.191***	0.162**
	(0.051)	(0.050)	(0.070)	(0.069)	(0.071)	(0.063)
Observations	12,750	12,705	12,269	12,224	11,178	11,148
R^2	0.078	0.111	0.036	0.075	0.110	0.250
Panel B: Sons						
Treated	0.017	0.021	0.030	0.040	−0.069	−0.033
	(0.048)	(0.047)	(0.070)	(0.068)	(0.055)	(0.050)
Observations	15,018	14,970	14,446	14,408	13,238	13,215
R^2	0.091	0.123	0.041	0.083	0.104	0.244
Panel C: All						
Treated	0.012	0.010	0.007	0.007	0.057	0.056
	(0.033)	(0.032)	(0.050)	(0.048)	(0.048)	(0.042)
Observations	27,771	27,675	26,719	26,632	24,420	24,363
R^2	0.092	0.124	0.042	0.082	0.116	0.255
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes

Note: OLS regression estimates where the dependent variables are indices of parental physical, mental, and cognitive health. See Table D.1 for a summary of the components integrating each of the health indices. The independent variable Treated is a dummy variable equal to 1 if the child was affected by the extension in the minimum compulsory schooling. Controls include parent's education (5 categories), marital status, parent's gender, a dummy for Han ethnicity, and a dummy for rural area. Panel A: Sample of all parents and daughters. Panel B: Sample of all parents and sons. Panel C: Sample of all children and parents.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table 3.7: Children's education and parental outcomes: Fathers vs Mothers

	Physical Health Index		Mental Health Index		Cognitive Health Index	
	(1) Fathers	(2) Mothers	(3) Fathers	(4) Mothers	(5) Fathers	(6) Mothers
Panel A: Daughters						
Treated	−0.109	0.144**	0.010	−0.047	0.118	0.210**
	(0.083)	(0.063)	(0.103)	(0.094)	(0.076)	(0.089)
Observations	5,941	6,764	5,770	6,454	5,559	5,589
R^2	0.099	0.101	0.072	0.061	0.193	0.258
Panel B: Sons						
Treated	0.086	−0.043	−0.008	0.088	−0.069	0.018
	(0.072)	(0.062)	(0.084)	(0.103)	(0.069)	(0.073)
Observations	6,932	8,038	6,767	7,641	6,487	6,728
R^2	0.107	0.115	0.067	0.078	0.176	0.265
Panel C: All						
Treated	−0.012	0.027	−0.035	0.044	0.019	0.106*
	(0.045)	(0.043)	(0.060)	(0.072)	(0.056)	(0.055)
Observations	12,873	14,802	12,537	14,095	12,046	12,317
R^2	0.107	0.119	0.073	0.076	0.195	0.276
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note: OLS regression estimates where the dependent variables are indices of parental physical, mental, and cognitive health. See Table D.1 for a summary of the components integrating each of the health indices. The independent variable Treated is a dummy variable equal to 1 if the child was affected by the extension in the minimum compulsory schooling. Controls include parent's education (5 categories), marital status, a dummy for Han ethnicity, and a dummy for rural area. Panel A: Sample of daughters and their respective parent as displayed in the column header. Panel B: Sample of sons and their respective parent as displayed in the column header. Panel C: Sample of all children and their respective parent as displayed in the column header.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table 3.8: Fertility and parental outcomes

	Physical Health Index		Mental Health Index		Cognitive Health Index	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: All						
Firstborn female	0.009	0.013	−0.005	−0.001	0.000	0.003
	(0.018)	(0.018)	(0.021)	(0.021)	(0.018)	(0.018)
Observations	10,564	10,469	10,281	10,187	9,568	9,472
R^2	0.117	0.121	0.076	0.084	0.250	0.258
Panel B: Fathers						
Firstborn female	0.010	0.014	−0.006	−0.003	0.007	0.011
	(0.023)	(0.023)	(0.028)	(0.028)	(0.023)	(0.023)
Observations	5,013	4,967	4,912	4,867	4,745	4,699
R^2	0.097	0.101	0.061	0.069	0.186	0.202
Panel C: Mothers						
Firstborn female	−0.000	0.004	−0.007	−0.003	−0.011	−0.010
	(0.025)	(0.025)	(0.030)	(0.030)	(0.025)	(0.026)
Observations	5,551	5,502	5,369	5,320	4,823	4,773
R^2	0.106	0.111	0.065	0.072	0.266	0.269
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Children's education	No	Yes	No	Yes	No	Yes

Note: The table shows OLS estimates of the effect of having a firstborn girl on indices of parental physical, mental, and cognitive health. See Table D.1 for a summary of the components integrating each of the health indices. Controls include parent's education (5 categories), marital status, a dummy variable for belonging to Han ethnicity, and a dummy variable for living in a rural area. Panel A: Sample of all parents (regressions control for the sex of the parent). Panel B: Sample of fathers. Panel C: Sample of mothers.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table 3.9: Help and caring arrangements

	All households			Two-partners households		
	Fathers	Mothers	Difference	Fathers	Mothers	Difference
Panel A: Activity Limitations						
Has some limitation	0.19	0.29	0.11***	0.18	0.25	0.07***
- Receives help	0.75	0.78	0.03	0.76	0.77	0.02
Helper/Carer Identity						
Spouse only	0.67	0.47	−0.20***	0.79	0.71	−0.08***
Child only	0.22	0.43	0.21***	0.12	0.20	0.08***
Other relatives only	0.04	0.05	0.00	0.02	0.02	0.00
Spouse and children	0.05	0.03	−0.01	0.05	0.05	−0.00
Other	0.02	0.02	0.00	0.02	0.02	0.00
Observations	5,728	6,432		5,026	4,989	
Panel B: Functional Limitations						
Has some limitation	0.16	0.21	0.05***	0.15	0.18	0.03***
- Receives help	0.37	0.31	−0.07**	0.39	0.28	−0.11***
Helper/Carer Identity						
Spouse only	0.71	0.43	−0.28***	0.80	0.73	−0.07
Child only	0.16	0.49	0.33***	0.07	0.17	0.11***
Other relatives only	0.02	0.03	0.01	0.01	0.03	0.01
Spouse and children	0.09	0.04	−0.06**	0.11	0.06	−0.04
Other	0.02	0.01	−0.00	0.02	0.01	−0.01
Observations	5,728	6,432		5,026	4,989	

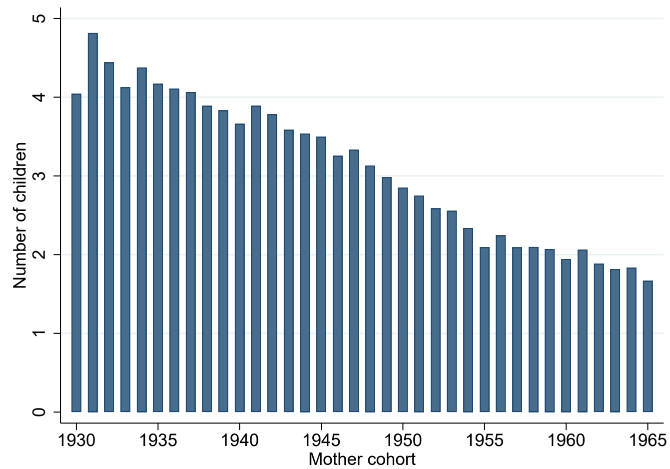
Note: The table displays information regarding parental limitations and intra-family help and caring arrangements. In Panel A, Activity Limitations consist of limitations doing household chores, preparing hot meals, shopping, making telephone calls, and taking medications. In Panel B, Functional Limitations consist of limitations in dressing, bathing, eating, getting in and out of bed, and using the toilet. Two-partners households are defined as those households in which the respondent is married and living with the spouse, or in cohabitation; as opposed to being widowed, married but not living with the spouse, separated, divorced, or never married.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Appendix D

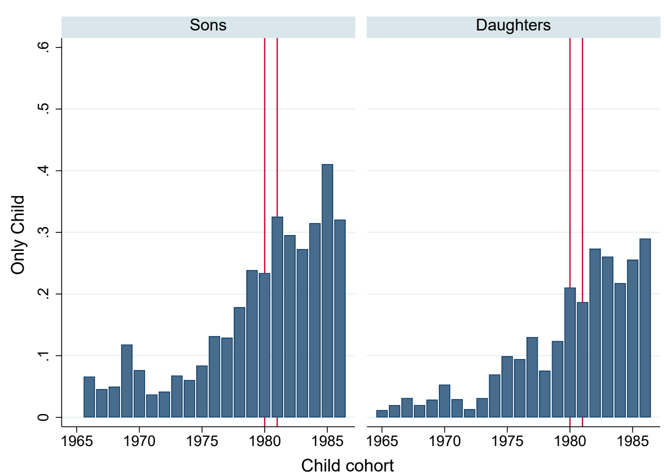
Appendix Figures and Tables

Figure D.1: Completed Fertility



Note: Evolution of completed fertility by mothers' birth cohort.

Figure D.2: Only child incidence



Note: Evolution in the probability of being an only child by child's birth cohort. Observations are weighted by the inverse of the number of siblings in the family so that all siblings sum as one observation. Solid red vertical lines marks the introduction of the One Child Policy. Two vertical red lines are displayed to account for the time lapse between time of conception and birth.

Table D.1: Summary statistics of health components

	Fathers				Mothers			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Physical health								
Functional limitations								
Jogging	2.88	1.37	1	4	2.34	1.41	1	4
Walking 1km	3.73	0.78	1	4	3.53	0.99	1	4
Walking 100 meters	3.89	0.51	1	4	3.82	0.63	1	4
Standing up	3.73	0.56	1	4	3.60	0.62	1	4
Climbing stairs	3.42	0.96	1	4	3.11	1.10	1	4
Stooping/Kneeling/Crouching	3.55	0.84	1	4	3.35	0.98	1	4
Reaching above shoulder level	3.80	0.69	1	4	3.73	0.78	1	4
Lifting weight	3.80	0.70	1	4	3.55	1.00	1	4
Picking up small coin	3.92	0.44	1	4	3.90	0.49	1	4
Self-assessed health	2.72	1.01	1	5	2.58	1.00	1	5
Mental Health								
CES-D-10								
Bothered	3.41	0.93	1	4	3.13	1.08	1	4
Focused on task at hand	3.38	0.97	1	4	3.19	1.07	1	4
Depressed	3.41	0.90	1	4	3.15	1.06	1	4
Effortful	3.31	1.04	1	4	3.12	1.13	1	4
Fearful	3.84	0.56	1	4	3.66	0.79	1	4
Sleep restless	3.15	1.14	1	4	2.79	1.22	1	4
Lonely	3.67	0.77	1	4	3.51	0.93	1	4
Cannot get on	3.81	0.61	1	4	3.67	0.80	1	4
Happy	2.66	1.23	1	4	2.60	1.22	1	4
Hopeful	2.46	1.29	1	4	2.41	1.28	1	4
Life satisfaction	3.16	0.69	1	5	3.12	0.77	1	5
Cognitive Health								
Mathematical operation	0.98	0.15	0	1	0.93	0.25	0	1
Drawing	0.75	0.43	0	1	0.53	0.50	0	1
Self-assessed memory	2.03	0.88	1	5	1.82	0.82	1	5
Total words recall	3.20	1.94	0	10	3.05	2.06	0	10
Observations	5,716				6,414			

Note: All outcome values are adjusted so that a higher value represents a better score in the health component evaluated. CES-D-10 stands for Center for Epidemiologic Studies Depression Scale - 10 items Andresen et al. (1994).

Table D.2: Quality-Quantity trade-off

	Sibship education		Sibship education		Sibship education	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
Sibship size	−0.706***	−0.538**	−0.511***	−0.434*	−0.442***	−0.543**
	(0.028)	(0.218)	(0.032)	(0.231)	(0.032)	(0.222)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Parent Cohort FE	No	No	Yes	Yes	Yes	Yes
House Wealth	No	No	No	No	Yes	Yes
Observations	7,134	7,134	7,134	7,134	7,027	7,027
R^2	0.415	0.412	0.433	0.432	0.458	0.457
F-stat		103.0		119.1		125.3

Note: Columns 1, 3, and 5: OLS regression estimates of the effect of sibship size on sibship average education. Columns 2, 4, 6: 2SLS regression estimates of the effect of sibship size on sibship average education where sibship size is instrumented with the occurrence of a female firstborn. Sample of respondents to the fertility histories. Controls: categorical variables of parent's education (not completed primary, primary education, middle school education, high school or higher education), sex, dummy variable for belonging to Han ethnicity, and dummy variable for living in a rural area. House Wealth: dummy variables of whether the building is made of concrete, whether there is running water in the residence, the existence of in-house bath or shower facilities, of a telephone connection, availability of coal gas or natural gas, and whether the main source of cooking fuel is coal, crop residue, or wood. F-stat reports the F-statistic of the excluded instruments test in the first-stage.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.3: Variation in parental health indicators: By children's gender

	Physical Health Index		Mental Health Index		Cognitive Health Index	
	(1) Sons	(2) Daughters	(3) Sons	(4) Daughters	(5) Sons	(6) Daughters
Incomplete primary	−0.005	−0.005	−0.057	−0.072*	0.360***	0.321***
	(0.030)	(0.034)	(0.035)	(0.037)	(0.035)	(0.040)
Primary school	0.056*	0.027	0.051	0.057	0.557***	0.517***
	(0.030)	(0.033)	(0.034)	(0.036)	(0.033)	(0.039)
Middle School	0.116***	0.109***	0.132***	0.097**	0.669***	0.631***
	(0.032)	(0.036)	(0.036)	(0.039)	(0.035)	(0.039)
High School or more	0.167***	0.179***	0.182***	0.147***	0.803***	0.797***
	(0.034)	(0.039)	(0.046)	(0.049)	(0.039)	(0.043)
Married	0.012	−0.023	0.200***	0.202***	0.038	0.049
	(0.035)	(0.037)	(0.042)	(0.042)	(0.035)	(0.041)
Han Ethnicity	0.027	0.015	−0.046	−0.095*	0.050	0.016
	(0.044)	(0.046)	(0.052)	(0.057)	(0.046)	(0.050)
Rural	−0.060***	−0.057**	−0.104***	−0.082***	−0.116***	−0.120***
	(0.020)	(0.023)	(0.026)	(0.028)	(0.022)	(0.024)
Children's education (years)	0.017***	0.014***	0.026***	0.018***	0.022***	0.019***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Number of children	−0.023**	−0.028**	−0.009	−0.007	−0.025**	−0.015
	(0.011)	(0.012)	(0.012)	(0.012)	(0.011)	(0.012)
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,679	12,482	14,136	12,012	12,956	10,935
R^2	0.129	0.117	0.090	0.080	0.251	0.256

Note: The table shows results from OLS regressions of associations between indices of parental physical, mental, and cognitive health, and characteristics of parents and their children (by childrens' gender). See Table D.1 for a summary of the components integrating each of the health indices.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.4: Variation in parental health indicators: By parents' gender

	Physical Health Index				Mental Health Index				Cognitive Health Index			
	(1) Fathers	(2) Fathers	(3) Mothers	(4) Mothers	(5) Fathers	(6) Fathers	(7) Mothers	(8) Mothers	(9) Fathers	(10) Fathers	(11) Mothers	(12) Mothers
Incomplete primary	−0.040	−0.034	0.025	0.046	−0.164***	−0.149***	0.002	0.022	0.262***	0.270***	0.380***	0.390***
	(0.050)	(0.050)	(0.038)	(0.038)	(0.054)	(0.054)	(0.042)	(0.041)	(0.057)	(0.057)	(0.039)	(0.039)
Primary school	0.009	0.030	0.076**	0.097***	−0.022	0.009	0.092**	0.125***	0.460***	0.484***	0.565***	0.585***
	(0.050)	(0.049)	(0.036)	(0.037)	(0.048)	(0.048)	(0.045)	(0.044)	(0.056)	(0.056)	(0.040)	(0.039)
Middle School	0.113**	0.142***	0.050	0.093**	0.041	0.091*	0.132**	0.186***	0.583***	0.635***	0.673***	0.709***
	(0.049)	(0.049)	(0.043)	(0.043)	(0.050)	(0.050)	(0.052)	(0.050)	(0.054)	(0.054)	(0.044)	(0.043)
High School or more	0.174***	0.218***	0.135***	0.202***	0.091	0.164***	0.215***	0.303***	0.698***	0.763***	0.916***	0.983***
	(0.051)	(0.049)	(0.048)	(0.046)	(0.060)	(0.059)	(0.062)	(0.059)	(0.056)	(0.057)	(0.048)	(0.046)
Married	0.068	0.074	0.009	0.014	0.217***	0.232***	0.252***	0.268***	0.063	0.081	0.015	0.032
	(0.055)	(0.054)	(0.041)	(0.041)	(0.072)	(0.072)	(0.046)	(0.046)	(0.063)	(0.063)	(0.045)	(0.045)
Han Ethnicity	0.028	0.028	−0.008	−0.004	−0.055	−0.051	−0.070	−0.068	−0.025	−0.030	0.103*	0.105*
	(0.054)	(0.054)	(0.050)	(0.051)	(0.064)	(0.063)	(0.061)	(0.061)	(0.059)	(0.061)	(0.058)	(0.058)
Rural	−0.007	−0.029	−0.112***	−0.136***	−0.047	−0.076**	−0.137***	−0.172***	−0.094***	−0.120***	−0.161***	−0.190***
	(0.026)	(0.025)	(0.030)	(0.029)	(0.030)	(0.030)	(0.033)	(0.033)	(0.026)	(0.026)	(0.029)	(0.029)
Children's education (years)	0.013***		0.016***		0.021***		0.022***		0.021***		0.018***	
	(0.003)		(0.003)		(0.003)		(0.004)		(0.003)		(0.003)	
Number of children	−0.017	−0.025*	−0.023	−0.032**	−0.008	−0.020	−0.005	−0.016	−0.027**	−0.041***	0.003	−0.010
	(0.015)	(0.014)	(0.014)	(0.015)	(0.014)	(0.014)	(0.016)	(0.015)	(0.013)	(0.013)	(0.015)	(0.015)
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,636	12,875	14,528	14,803	12,316	12,539	13,836	14,097	11,828	12,048	12,067	12,319
R^2	0.109	0.108	0.125	0.121	0.079	0.073	0.081	0.076	0.208	0.198	0.277	0.276

Note: The table shows results from OLS regressions of associations between indices of parental physical, mental, and cognitive health, and characteristics of parents and their children (by parents' gender). See Table D.1 for a summary of the components integrating each of the health indices.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.5: Variation in parental health indicators: Categorical variables

	Physical Health Index		Mental Health Index		Cognitive Health Index	
	(1)	(2)	(3)	(4)	(5)	(6)
Incomplete primary	0.012	0.024	−0.050	−0.034	0.357***	0.360***
	(0.029)	(0.028)	(0.033)	(0.033)	(0.034)	(0.034)
Primary school	0.051*	0.080***	0.056*	0.095***	0.542***	0.562***
	(0.028)	(0.028)	(0.032)	(0.032)	(0.033)	(0.032)
Middle School	0.100***	0.146***	0.111***	0.171***	0.663***	0.707***
	(0.031)	(0.030)	(0.034)	(0.033)	(0.034)	(0.033)
High School or more	0.174***	0.234***	0.175***	0.261***	0.805***	0.879***
	(0.033)	(0.031)	(0.042)	(0.040)	(0.036)	(0.036)
Married	0.024	0.032	0.212***	0.228***	0.044	0.058*
	(0.033)	(0.033)	(0.039)	(0.039)	(0.035)	(0.034)
Female	−0.210***	−0.199***	−0.233***	−0.214***	−0.189***	−0.172***
	(0.018)	(0.018)	(0.021)	(0.021)	(0.019)	(0.019)
Han Ethnicity	0.006	0.016	−0.056	−0.048	0.041	0.036
	(0.038)	(0.038)	(0.047)	(0.048)	(0.043)	(0.044)
Rural	−0.064***	−0.088***	−0.095***	−0.127***	−0.128***	−0.154***
	(0.019)	(0.019)	(0.024)	(0.024)	(0.020)	(0.020)
Children's education						
Primary school	0.122***		0.133***		0.066**	
	(0.029)		(0.033)		(0.031)	
Middle school	0.161***		0.205***		0.107***	
	(0.029)		(0.033)		(0.032)	
High School	0.224***		0.285***		0.162***	
	(0.033)		(0.036)		(0.034)	
College	0.245***		0.327***		0.272***	
	(0.034)		(0.038)		(0.036)	
Number of children						
Two children	−0.002	−0.011	−0.019	−0.031	−0.026	−0.044*
	(0.023)	(0.022)	(0.031)	(0.030)	(0.024)	(0.024)
Three children	−0.015	−0.033	0.002	−0.021	−0.038	−0.069**
	(0.029)	(0.028)	(0.038)	(0.037)	(0.030)	(0.030)
Four children	−0.011	−0.037	−0.030	−0.066	−0.062	−0.100**
	(0.040)	(0.039)	(0.047)	(0.047)	(0.040)	(0.041)
Five or more children	−0.068	−0.105**	−0.008	−0.058	−0.083	−0.132**
	(0.047)	(0.047)	(0.054)	(0.054)	(0.052)	(0.052)
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	27,413	27,678	26,373	26,636	24,109	24,367
R^2	0.129	0.125	0.088	0.082	0.261	0.256

Note: The table shows results from OLS regressions of associations between indices of parental physical, mental, and cognitive health, and characteristics of parents and their children. See Table D.1 for a summary of the components integrating each of the health indices.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.6: Firstborn's sex-selection

	Dep var: Firstborn is a girl	
	(1)	(2)
Incomplete primary	−0.024	−0.018
	(0.019)	(0.019)
Primary school	0.027	0.032
	(0.019)	(0.020)
Middle School	−0.010	−0.005
	(0.022)	(0.022)
High School or more	0.018	0.028
	(0.029)	(0.029)
Rural	−0.012	−0.010
	(0.014)	(0.014)
Han Ethnicity	−0.042*	−0.052*
	(0.025)	(0.028)
Age	0.011	0.011
	(0.008)	(0.008)
Age^2	−0.000	−0.000
	(0.000)	(0.000)
Respondent is female	−0.017	−0.016
	(0.014)	(0.014)
Province FE	No	Yes
Observations	7,087	7,087
R^2	0.002	0.005

Note: OLS estimates of regressing the incidence of a firstborn girl on parental characteristics.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.7: Direct effect of sex of firstborn on parental health

	Physical Health Index	Mental Health Index	Cognitive Health Index
	(1)	(2)	(3)
Panel A: All			
Firstborn female	0.017	0.000	0.010
	(0.018)	(0.021)	(0.018)
Number of children	−0.027***	−0.015	−0.030***
	(0.010)	(0.011)	(0.011)
Observations	10,564	10,281	9,568
R^2	0.118	0.076	0.251
Panel B: Fathers			
Firstborn female	0.018	−0.001	0.021
	(0.024)	(0.028)	(0.024)
Number of children	−0.025*	−0.016	−0.042***
	(0.015)	(0.014)	(0.014)
Observations	5,013	4,912	4,745
R^2	0.098	0.061	0.189
Panel C: Mothers			
Firstborn female	0.008	−0.002	−0.008
	(0.026)	(0.030)	(0.026)
Number of children	−0.030*	−0.015	−0.010
	(0.015)	(0.016)	(0.016)
Observations	5,551	5,369	4,823
R^2	0.107	0.065	0.266
Parent Cohort FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Note: The table shows OLS estimates of the effect of having a firstborn girl conditional on the number of children on indices of parental physical, mental, and cognitive health. See Table D.1 for a summary of the components integrating each of the health indices. Controls include parent's education (5 categories), marital status, a dummy variable for belonging to Han ethnicity, and a dummy variable for living in a rural area. Panel A: Sample of all parents (regressions control for the sex of the parent). Panel B: Sample of fathers. Panel C: Sample of mothers.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.8: Daughters' education and parental outcomes (2SLS)

	Physical Health Index		Mental Health Index		Cognitive Health Index	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: All						
Schooling	0.028	0.024	−0.022	−0.036	0.157**	0.178*
	(0.043)	(0.054)	(0.057)	(0.074)	(0.067)	(0.092)
Observations	12,527	12,482	12,057	12,012	10,965	10,935
F-stat	14.3	11.1	14.5	11.0	15.0	9.4
Panel B: Fathers						
Schooling	−0.071	−0.112	0.010	0.011	0.107	0.116
	(0.081)	(0.114)	(0.083)	(0.106)	(0.072)	(0.088)
Observations	5,838	5,834	5,672	5,670	5,457	5,457
F-stat	6.8	4.9	7.7	6.3	7.1	6.0
Panel C: Mothers						
Schooling	0.108*	0.134*	−0.058	−0.088	0.204**	0.265
	(0.059)	(0.079)	(0.081)	(0.111)	(0.102)	(0.189)
Observations	6,689	6,648	6,385	6,342	5,508	5,478
F-stat	7.9	6.2	7.0	4.9	7.0	3.3
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes

Note: Second stage estimates of two-stage least squares regressions in which the dependent variables are indices of parental physical, mental, and cognitive health, and the endogenous variable Schooling is instrumented with a dummy variable indicating whether the daughter was affected by the extension in the minimum schooling period. See Table D.1 for a summary of the components integrating each of the health indices. Controls include parent's education (5 categories), marital status, a dummy for Han ethnicity, and a dummy for rural area. F-stat reports the F-statistic of the excluded instruments test. Panel A: Sample of all parents and daughters (regressions also control for the sex of the parent). Panel B: Sample of fathers and daughters. Panel C: Sample of mothers and daughters.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.9: Fertility and parental outcomes (2SLS)

	Physical Health Index		Mental Health Index		Cognitive Health Index	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: All						
Number of children	0.043	0.029	−0.004	−0.014	0.009	0.001
	(0.060)	(0.059)	(0.068)	(0.066)	(0.056)	(0.055)
Observations	10,469	10,564	10,187	10,281	9,472	9,568
F-stat	149.6	154.9	169.1	176.1	182.7	181.4
Panel B: Fathers						
Number of children	0.047	0.033	−0.009	−0.019	0.034	0.022
	(0.075)	(0.073)	(0.084)	(0.083)	(0.069)	(0.069)
Observations	4,967	5,013	4,867	4,912	4,699	4,745
F-stat	103.1	105.4	118.7	119.2	117.2	114.5
Panel C: Mothers						
Number of children	0.013	−0.001	−0.011	−0.022	−0.032	−0.036
	(0.089)	(0.086)	(0.098)	(0.096)	(0.083)	(0.082)
Observations	5,502	5,551	5,320	5,369	4,773	4,823
F-stat	79.5	82.6	90.1	94.2	103.3	103.5
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Children's education	Yes	No	Yes	No	Yes	No

Note: Second stage estimates of two-stage least squares regressions in which the dependent variables are indices of parental physical, mental, and cognitive health, and the endogenous variable "Number of children" is instrumented with the occurrence of a firstborn girl. See Table D.1 for a summary of the components integrating each of the health indices. Controls include parent's education (5 categories), marital status, a dummy for Han ethnicity, and a dummy for rural area. F-stat reports the F-statistic of the excluded instruments test. Panel A: Sample of all parents (regressions also control for the sex of the parent). Panel B: Sample of fathers. Panel C: Sample of mothers.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.10: Children's education and parental outcomes: Robustness specifications

	Physical Health Index				Mental Health Index				Cognitive Health Index			
	(1) Trends	(2) OCP	(3) Village FE	(4) Wealth	(5) Trends	(6) OCP	(7) Village FE	(8) Wealth	(9) Trends	(10) OCP	(11) Village FE	(12) Wealth
Panel A: Daughters on Fathers												
Treated	−0.123	−0.116	−0.092	−0.110	0.032	0.028	0.063	0.021	0.127	0.116	0.091	0.122
	(0.087)	(0.084)	(0.081)	(0.083)	(0.101)	(0.104)	(0.097)	(0.103)	(0.079)	(0.077)	(0.073)	(0.077)
Observations	5,941	5,941	5,941	5,898	5,770	5,770	5,770	5,731	5,559	5,559	5,559	5,525
Panel B: Daughters on Mothers												
Treated	0.117*	0.145**	0.188***	0.153**	−0.012	−0.041	−0.038	−0.011	0.204**	0.220**	0.185**	0.228**
	(0.066)	(0.064)	(0.067)	(0.062)	(0.092)	(0.094)	(0.090)	(0.094)	(0.089)	(0.089)	(0.090)	(0.091)
Observations	6,764	6,764	6,764	6,712	6,454	6,454	6,454	6,411	5,589	5,589	5,589	5,547
Panel C: Sons on Fathers												
Treated	0.061	0.083	0.081	0.088	0.030	−0.002	0.071	0.004	−0.076	−0.073	−0.011	−0.075
	(0.078)	(0.074)	(0.072)	(0.072)	(0.084)	(0.085)	(0.080)	(0.085)	(0.072)	(0.070)	(0.064)	(0.068)
Observations	6,932	6,932	6,932	6,885	6,767	6,767	6,767	6,723	6,487	6,487	6,487	6,450
Panel D: Sons on Mothers												
Treated	−0.059	−0.046	−0.038	−0.054	0.107	0.068	0.064	0.080	0.014	−0.006	−0.008	0.018
	(0.064)	(0.062)	(0.059)	(0.062)	(0.102)	(0.104)	(0.095)	(0.102)	(0.077)	(0.075)	(0.073)	(0.073)
Observations	8,038	8,038	8,038	7,970	7,641	7,641	7,641	7,583	6,728	6,728	6,728	6,670
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: OLS regression estimates where the dependent variables are indices of parental physical, mental, and cognitive health. See Table D.1 for a summary of the components integrating each of the health indices. The independent variable Treated is a dummy variable equal to 1 if the child was affected by the extension in the minimum compulsory schooling. Controls include parent's education (5 categories), marital status, a dummy variable for belonging to Han ethnicity, and a dummy variable for living in a rural area. Columns "Trends" include province-specific time trends of both children and parents birth cohorts. Columns "OCP" include province-year measures of the enforcement intensity of the One Child Policy measured by fines, bonus, and premium punishments of excess fertility from Ebenstein (2010). Columns "Village FE" replaces province fixed effects with village fixed effects. Columns "Wealth" include measures of household wealth: dummy variables of whether the building is made of concrete, whether there is running water in the residence, the existence of in-house bath or shower facilities, of a telephone connection, availability of coal gas or natural gas, and whether the main source of cooking fuel is coal, crop residue, or wood. Panel A: Sample of fathers and daughters. Panel B: Sample of mothers and daughters. Panel C: Sample of fathers and sons. Panel D: Sample of mothers and sons.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.11: Fertility and parental outcomes: Robustness specifications

	Physical Health Index				Mental Health Index				Cognitive Health Index			
	(1) Trends	(2) OCP	(3) Village FE	(4) Wealth	(5) Trends	(6) OCP	(7) Village FE	(8) Wealth	(9) Trends	(10) OCP	(11) Village FE	(12) Wealth
Panel A: All												
Firstborn female	0.008	0.009	0.009	0.004	−0.007	−0.004	−0.007	−0.012	−0.001	0.001	−0.013	−0.006
	(0.018)	(0.018)	(0.018)	(0.017)	(0.021)	(0.021)	(0.021)	(0.021)	(0.018)	(0.018)	(0.018)	(0.018)
Observations	10,564	10,564	10,564	10,474	10,281	10,281	10,281	10,197	9,568	9,568	9,568	9,489
Panel B: Fathers												
Firstborn female	0.006	0.011	−0.005	0.004	−0.009	−0.006	−0.005	−0.014	0.005	0.008	−0.011	0.001
	(0.023)	(0.023)	(0.024)	(0.023)	(0.028)	(0.028)	(0.027)	(0.027)	(0.023)	(0.023)	(0.024)	(0.023)
Observations	5,013	5,013	5,013	4,974	4,912	4,912	4,912	4,875	4,745	4,745	4,745	4,712
Panel C: Mothers												
Firstborn female	0.002	0.001	0.005	−0.004	−0.009	−0.007	−0.017	−0.012	−0.013	−0.011	−0.025	−0.017
	(0.025)	(0.025)	(0.025)	(0.025)	(0.030)	(0.030)	(0.030)	(0.030)	(0.025)	(0.025)	(0.026)	(0.026)
Observations	5,551	5,551	5,551	5,500	5,369	5,369	5,369	5,322	4,823	4,823	4,823	4,777
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: OLS estimates of the effect of having a firstborn girl on indices of parental physical, mental, and cognitive health. See Table D.1 for a summary of the components integrating each of the health indices. Controls include parent's education (5 categories), marital status, a dummy for Han ethnicity, and a dummy for rural area. Columns "Trends" include province-specific time trends of parents birth cohorts. Columns "OCP" include province-year measures of the enforcement intensity of the One Child Policy measured by fines, bonus, and premium punishments of excess fertility from Ebenstein (2010). Columns "Village FE" replaces province fixed effects with village fixed effects. Columns "Wealth" include measures of household wealth: dummy variables of whether the building is made of concrete, whether there is running water in the residence, the existence of in-house bath or shower facilities, of a telephone connection, availability of coal gas or natural gas, and whether the main source of cooking fuel is coal, crop residue, or wood. Panel A: Sample of all parents (regressions also control for the sex of the parent). Panel B: Sample of fathers. Panel C: Sample of mothers.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.12: Children's education and parental outcomes: Alternative index construction methods

	Physical Health Index		Mental Health Index		Cognitive Health Index	
	(1) PCA	(2) SEM	(3) PCA	(4) SEM	(5) PCA	(6) SEM
Panel A: Daughters on fathers						
Treated	−0.074	−0.067	0.040	0.028	0.126	0.126
	(0.085)	(0.084)	(0.099)	(0.098)	(0.078)	(0.080)
Observations	5,941	5,941	5,770	5,770	5,559	5,559
Panel B: Daughters on mothers						
Treated	0.136**	0.123*	−0.016	−0.034	0.203**	0.193**
	(0.064)	(0.065)	(0.097)	(0.099)	(0.082)	(0.080)
Observations	6,764	6,764	6,454	6,454	5,589	5,589
Panel C: Sons on fathers						
Treated	0.109	0.108	0.046	0.053	−0.062	−0.056
	(0.072)	(0.071)	(0.084)	(0.085)	(0.070)	(0.071)
Observations	6,932	6,932	6,767	6,767	6,487	6,487
Panel D: Sons on mothers						
Treated	0.030	0.035	0.132	0.125	0.040	0.050
	(0.064)	(0.064)	(0.097)	(0.097)	(0.072)	(0.072)
Observations	8,038	8,038	7,641	7,641	6,728	6,728
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note: OLS regression estimates where the dependent variables are indices of parental physical, mental, and cognitive health. See Table D.1 for a summary of the components integrating each of the health indices. The independent variable Treated is a dummy variable equal to 1 if the child was affected by the extension in the minimum compulsory schooling. In columns "PCA" the health index is a principal component variable constructed using principal component analysis. In Columns "SEM" the health index is a latent variable indicator constructed from structural equation modelling. Controls include parent's education (5 categories), marital status, a dummy for Han ethnicity, and a dummy for rural area. Panel A: Sample of fathers and daughters. Panel B: Sample of mothers and daughters. Panel C: Sample of fathers and sons. Panel D: Sample of mothers and sons.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.13: Fertility and parental outcomes: Alternative index construction methods

	Physical Health Index		Mental Health Index		Cognitive Health Index	
	(1) PCA	(2) SEM	(3) PCA	(4) SEM	(5) PCA	(6) SEM
Panel A: All						
Firstborn female	0.009	0.011	0.011	0.014	0.003	0.005
	(0.017)	(0.017)	(0.021)	(0.021)	(0.018)	(0.018)
Observations	10,564	10,564	10,281	10,281	9,568	9,568
Panel B: Fathers						
Firstborn female	0.007	0.007	−0.001	−0.002	0.007	0.007
	(0.022)	(0.022)	(0.026)	(0.027)	(0.023)	(0.023)
Observations	5,013	5,013	4,912	4,912	4,745	4,745
Panel C: Mothers						
Firstborn female	0.004	0.006	0.019	0.026	−0.007	−0.004
	(0.025)	(0.025)	(0.030)	(0.030)	(0.025)	(0.025)
Observations	5,551	5,551	5,369	5,369	4,823	4,823
Parent Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note: OLS estimates of the effect of having a firstborn girl on indices of parental physical, mental, and cognitive health. See Table D.1 for a detailed description of the components integrating each of the health indices. In columns "PCA" the health index is a principal component variable constructed using principal component analysis. In Columns "SEM" the health index is a latent variable indicator constructed from structural equation modelling. Controls include parent's education (5 categories), marital status, a dummy for Han ethnicity, and a dummy for rural area. Panel A: Sample of all parents (regressions also control for the sex of the parent). Panel B: Sample of fathers. Panel C: Sample of mothers.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.14: Sample selection on the basis of missing health outcomes

	Physical Health Index missing		Mental Health Index missing		Cognitive Health Index missing	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Reform exposure						
Treated	0.017	0.013	0.001	−0.002	−0.003	−0.007
	(0.015)	(0.015)	(0.017)	(0.017)	(0.021)	(0.020)
Observations	32,097	31,953	32,097	31,953	32,097	31,953
Mean depvar	0.140	0.139	0.166	0.165	0.228	0.226
Panel B: Parental fertility						
Firstborn female	−0.009	−0.008	−0.010	−0.008	−0.000	0.003
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
Observations	12,085	12,034	12,085	12,034	12,085	12,034
Mean depvar	0.139	0.138	0.165	0.164	0.226	0.225
Controls	No	Yes	No	Yes	No	Yes

Note: OLS regression estimates where the dependent variable is a dummy variable equal to 1 when the health index of a parent cannot be computed due to missing observations in any of the health components. Panel A: Treated is a dummy variable equal to 1 if the child was affected by the extension in the minimum compulsory schooling. Estimation sample includes all parents and children. Regressions include parent and child birth cohort fixed effects, and province fixed effects. Panel B: Firstborn female is a dummy variable equal to 1 when the firstborn is a girl. Estimation sample includes all parents. Regressions include parent birth cohort fixed effects, and province fixed effects. Controls: parent's education (5 categories), marital status, parent's gender, a dummy for Han ethnicity, and a dummy for rural area.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table D.15: Effect of the compulsory schooling reform: CFPS dataset

	Schooling (years)			Middle school completion		
	(1) All	(2) Boys	(3) Girls	(4) All	(5) Boys	(6) Girls
Treated	0.481***	0.233	0.751***	0.029	−0.008	0.069***
	(0.179)	(0.288)	(0.239)	(0.020)	(0.031)	(0.024)
Girl	−1.585***			−0.129***		
	(0.069)			(0.007)		
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26,121	12,764	13,357	26,121	12,764	13,357
R^2	0.411	0.328	0.474	0.298	0.232	0.357

Note: OLS regression estimates where the dependent variable in columns 1 to 3 is child's completed years of education, and in columns 4 to 6 is a dummy variable for having completed middle school (9 years of schooling). The independent variable Treated is a dummy variable equal to 1 if the child was affected by the extension in the minimum compulsory schooling. Controls include father's and mother's education level (5 categories), a dummy variable for belonging to the Han ethnicity, and a dummy variable for living in a rural area. The dataset used is the China Family Panel Studies (CFPS).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the child cohort-province level in parentheses.

Appendix E

Parental health: fertility vs children's education

To simultaneously estimate the causal effect of offspring quantity and children's education on parental health I need to make some adjustments to the regression specification. The problem arising is that one needs to include both the sample of sons and daughters in the regression for the instrument of "First child female" to work. However, as discussed previously, the extension in the minimum compulsory schooling period only created an exogenous shift in the education level of daughters (the school reform is a weak instrument if used for the whole sample of children). I follow two approaches to overcome this limitation. First, I estimate reduced form effects differentiating whether the child exposed to the school reform was the son, or the daughter. More precisely, I estimate the following equation:

$$y_j = \gamma_0 + \beta_1 TreatSon_{icp} + \beta_2 TreatDaughter_{icp} + \gamma_1 Girl_j^{fb} + \Omega' J + \varphi_a + \theta_c + \mu_p + \varepsilon_i \quad \text{(E.1)}$$

Where y_j represents the different indices of parental health (physical, mental, and cognitive health) of parent j. $TreatSon_{icp}$ is a dummy variable equal to one if the son was affected by the introduction of the schooling reform, $TreatDaughter_{icp}$ is a dummy variable equal to one if the daughter was affected by the reform, and $Girl_j^{fb}$ records whether the firstborn child of parent j is a girl. φ_a are parent cohort fixed effects, θ_c are children cohort fixed effects, μ_p are province fixed effects, and ε_i are error terms. Moreover, J is a vector of characteristics that include the parent's education level, marital status and ethnicity, and a dummy for rural area.

Results are displayed in Table E.1. When all parents are pooled together (Panel A), the estimated effect of having a daughter treated by the school reform is an increase of 0.16 standard deviations in parental cognitive health (significant at the 5% level, Column 3). Again, this effect is larger among the sample of mothers (Column 3 of Panel C). The effect of daughters' education on maternal physical health, although positive, is lower in magnitude than previously estimated and no longer statistically significant. Fertility does not have a statistically significant effect on long-term parental health.

Second, to obtain instrumental variables estimates, and given the no effect of the school reform on the education of sons, I instrument children's education with a variable that takes the value of 1 if the daughter was affected by the school reform, and 0 otherwise. That is, the variable is always 0 for sons. The number of children is instrumented with the occurrence of a female firstborn. I estimate the following two-stage least squares regression with two instrumental variables:

$$S_j = \rho_0 + \rho_1 Girl_j^{fb} + \rho_2 Treat(Daughter)_{icp} + \tau_1' J + \varphi_a + \theta_c + \mu_p + \varepsilon_{1i} \qquad \text{(E.2)}$$

$$E_{icp} = \alpha_0 + \alpha_1 Treat(Daughter)_{icp} + \alpha_2 Girl_j^{fb} + \tau_2' J + \varphi_a + \theta_c + \mu_p + \varepsilon_{2i} \qquad \text{(E.3)}$$

$$y_j = \gamma_0 + \beta \widehat{E}_{icp} + \gamma_1 \widehat{S}_j + \Omega' J + \varphi_a + \theta_c + \mu_p + u_i \qquad \text{(E.4)}$$

In equation E.2, S_j denotes the number of children of parent j, and $Girl_j^{fb}$ denotes whether the firstborn child of parent j is a girl. In equation E.3, E_{icp} denotes the level of education attained by child i born in cohort c and province p, and $Treat(Daughter)_{icp}$ is a dummy variable equal to one when the daughter was affected by the extension in the minimum compulsory schooling. Equations E.2 and E.3 are the first-stage regressions. In equation E.4, y_j represents the different indices of parental health (physical, mental, and cognitive health) of parent j, $\widehat{E}_{icp}$ are the children's education predicted values estimated from equation E.3, and $\widehat{S}_j$ are the number of children predicted value estimated from equation E.2. Similar to the notation previously described, φ_a are parent cohort fixed effects, θ_c are children cohort fixed effects, μ_p are province fixed effects, and ε_{1i}, ε_{2i}, and u_i are the error terms. Moreover, J is a vector of characteristics that include the parent's education level, marital status and ethnicity, and a dummy for rural area.

Consistent with previous results, Panel A in Table E.2 show no statistically significant effects from the number of children on parental health in later life. On the other hand, an additional year in the schooling of daughters increases parents' cognition by 0.14 standard deviations (significant at the 5% level, Column 3).

Table E.1: Quantity vs Quality and parental outcomes

	(1) Physical Health Index	(2) Mental Health Index	(3) Cognitive Health Index
Panel A: All			
Treated Son	0.012	0.016	−0.008
	(0.044)	(0.066)	(0.050)
Treated Daughter	−0.004	−0.006	0.160**
	(0.050)	(0.069)	(0.065)
Firstborn female	0.019	0.007	0.005
	(0.019)	(0.022)	(0.019)
Observations	27,675	26,632	24,363
Panel B: Fathers			
Treated Son	0.042	−0.067	−0.053
	(0.059)	(0.074)	(0.067)
Treated Daughter	−0.101	0.004	0.140*
	(0.072)	(0.097)	(0.082)
Firstborn female	0.021	0.015	0.010
	(0.025)	(0.029)	(0.024)
Observations	12,873	12,537	12,046
Panel C: Mothers			
Treated Son	−0.021	0.095	0.049
	(0.061)	(0.098)	(0.072)
Treated Daughter	0.086	−0.033	0.192**
	(0.065)	(0.096)	(0.087)
Firstborn female	0.011	−0.002	−0.002
	(0.026)	(0.031)	(0.027)
Observations	14,802	14,095	12,317
Controls	Yes	Yes	Yes
Parent Cohort FE	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes

Note: OLS regressions in which the dependent variables are indices of parental physical, mental, and cognitive health; the independent variables "Treated Son" and "Treated Daughter" are dummy variables that take the value of 1 when the son or the daughter, respectively, were affected by the extension in the minimum compulsory schooling; and the independent variable "First child female" takes the value of 1 in the event of a female firstborn. See Table D.1 for a summary of the components integrating each of the health indices. Controls include parent's education (5 categories), marital status, a dummy for Han ethnicity, and a dummy for rural area. Panel A: Sample of all parents and children (regressions also control for the sex of the parent). Panel B: Sample of fathers and all children. Panel C: Sample of mothers and all children.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Table E.2: Quantity vs Quality and parental outcomes: 2SLS

	(1) Physical Health Index	(2) Mental Health Index	(3) Cognitive Health Index
Panel A: All			
Schooling (daughters)	−0.000	−0.014	0.142**
	(0.044)	(0.060)	(0.065)
Number of children	0.075	0.028	−0.071
	(0.080)	(0.082)	(0.080)
Observations	27,161	26,148	23,891
SW F-stat: Schooling	16.1	16.4	17.0
SW F-stat: Sibship size	22.4	29.5	26.1
Panel B: Fathers			
Schooling (daughters)	−0.074	0.010	0.122
	(0.080)	(0.082)	(0.077)
Number of children	0.137	0.037	−0.048
	(0.110)	(0.103)	(0.098)
Observations	12,634	12,314	11,826
SW F-stat: Schooling	7.9	10.1	8.9
SW F-stat: Sibship size	11.0	17.0	12.6
Panel C: Mothers			
Schooling (daughters)	0.060	−0.049	0.167*
	(0.054)	(0.086)	(0.095)
Number of children	−0.004	0.016	−0.097
	(0.108)	(0.117)	(0.111)
Observations	14,527	13,834	12,065
SW F-stat: Schooling	9.4	8.3	7.3
SW F-stat: Sibship size	14.8	18.0	17.3
Controls	Yes	Yes	Yes
Parent Cohort FE	Yes	Yes	Yes
Child Cohort FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes

Note: Second stage estimates of two-stage least squares regressions in which the dependent variables are indices of parental physical, mental, and cognitive health. See Table D.1 for a summary of the components integrating each of the health indices. The endogenous variable "Schooling (daughters)" is instrumented with a binary variable that takes the value of 1 if the daughter was affected by the school reform and a value of 0 otherwise. The endogenous variable "Number of children" is instrumented with the occurrence of a firstborn daughter. SW F-stat reports the F-statistic of the Sanderson and Windmeijer (2016) test of excluded instruments in IV models with multiple endogenous variables. Controls include parent's education (5 categories), marital status, a dummy for Han ethnicity, and a dummy for rural area. Panel A: Sample of all parents and children (regressions also control for the sex of the parent). Panel B: Sample of fathers and all children. Panel C: Sample of mothers and all children.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at the parent cohort-province level in parentheses.

Conclusion

This thesis examines different dimensions of human capital: investment decisions, resilience, and spillovers.

Chapter 1 investigates the origins of investment gaps in children by focusing on differences in parental expectations about the rate of return to investments, preferences for child developmental outcomes, and financial or psychic constraints. The chapter shows that differences in maternal beliefs regarding the technology of skills formation, and in the perceived cost associated with investments in children both contribute to explaining the observed heterogeneity in maternal investments across families. On the other hand, there seems to be no differences in preferences over child developmental outcomes in rural Pakistan. The study provides the first evidence for maternal investments in newborns in a developing country using subjective expectations of the returns, and the first estimates in any context of the link between perceived cost of effort and investment constraints. Policy simulations suggest that increasing mothers' beliefs about returns and alleviating the effort cost can substantially increase average investments in children. However, future research should explore how women's expectations on the productivity of investments can be changed, and identify the most cost-effective approaches to reduce the effort cost among mothers.

Chapter 2 shows that universal healthcare protected the educational achievement of primary school children in Mexico in the event of adverse shocks. The results document synergies from public investments in education and health and suggest higher returns to educational investments when the ability of families to endure shocks is increased. The expansion in health coverage mitigated the negative effect of rainfall shocks on children's health among program-eligible households, reduced the demand for children's time, and reduced fluctuations in household's consumption. The finding contributes to a new stream of research investigating the extent to which shocks to human capital during childhood can be mitigated through different policies or interventions. The result that universal healthcare builds resilience in cognitive development among children exposed to environmental shocks is important, since climate disturbances are increasing in frequency and intensity. Results are also significant given the growing number of countries expanding healthcare coverage among the disadvantaged population, and should be taken into consideration when carrying a cost-benefit analysis of public investments in health.

The third chapter in this thesis inspects human capital spillovers. It examines whether fertility decisions and parental investments in children affect parental health outcomes in later life. This is different from previous studies on fertility choices (which use models of parental utility maximization) and studies on the intergenerational transmission of poverty (which do not consider the extent to which parents are affected by the lower human capital of their offspring). Using the higher preference of Chinese households for sons and the quasi-random assignment of sex of the firstborn to instrument for sibship size, I find that higher fertility does not have any direct effect on parental physical, mental, or cognitive health. On the other hand, increased schooling among daughters stemming from an extension to the minimum compulsory schooling period improved parental cognitive attainment (especially among mothers) and maternal physical health in later life. The results document positive spillovers from investing in girls' education as a means to reduce gender inequalities, and suggest underestimated impacts of educational programs targeting girls when failing to account for the positive externalities accruing to their mothers.

Bibliography

Aarabi, M., Haghighi, H., and Takian, A. (2020). The role of universal health coverage in overcoming the covid-19 pandemic. The BMJ Opinion. Accessed April 29, 2020. Retrieved from https://blogs.bmj.com/bmj/2020/04/20/the-role-of-universal-health-coverage-in-overcoming-the-covid-19-pandemic/

Abrevaya, J. (2009). Are There Missing Girls in the United States? Evidence from Birth Data. *American Economic Journal: Applied Economics*, *1*(2), 1–34.

Adams-Prassl, A., and Andrew, A. (2019). *Preferences and beliefs in the marriage market for young brides*. CEPR Discussion Paper No. DP13567.

Adhvaryu, A., Bharadwaj, P., Fenske, J., Nyshadham, A., and Stanley, R. (2019). *Dust and Death: Evidence from the West African Harmattan* (Working Paper No. 25937). NBER.

Adhvaryu, A., Nyshadham, A., Molina, T., and Tamayo, J. (2018). *Helping children catch up: Early life shocks and the progresa experiment* (Working Paper No. 24848). NBER.

Ager, P., and Herz, B. (2019). Structural Change and the Fertility Transition. *Review of Economics and Statistics*, 1–45.

Aguilar, A., and Vicarelli, M. (2011). El nino and mexican children: Medium-term effects of early-life weather shocks on cognitive and health outcomes. *Cambridge, United States: Harvard University, Department of Economics. Manuscript.*

Alcaraz, C., Chiquiar, D., Orraca, M. J., and Salcedo, A. (2016). The Effect of Publicly Provided Health Insurance on Education Outcomes in Mexico. *The World Bank Economic Review*, *30*(Supplement_1), S145–S156.

Almond, D., Currie, J., and Duque, V. (2018). Childhood circumstances and adult outcomes: Act II. *Journal of Economic Literature*, *56*(4), 1360–1446.

Almond, D., and Edlund, L. (2008). Son-biased sex ratios in the 2000 United States Census. *Proceedings of the National Academy of Sciences*, *105*(15), 5681–5682.

Almond, D., Li, H., and Zhang, S. (2019). Land Reform and Sex Selection in China. *Journal of Political Economy*, *127*(2), 560–585.

Amare, M., Jensen, N. D., Shiferaw, B., and Cissé, J. D. (2018). Rainfall shocks and agricultural productivity: Implication for rural household consumption. *Agricultural Systems*, *166*, 79–89.

Anderson, M. L. (2008). Multiple Inference and Gender Differences in the Effects of Early Intervention: A Reevaluation of the Abecedarian, Perry Preschool, and Early Training Projects. *Journal of the American Statistical Association*, *103*(484), 1481–1495.

Andresen, E. M., Malmgren, J. A., Carter, W. B., and Patrick, D. L. (1994). Screening for Depression in Well Older Adults: Evaluation of a Short Form of the CES-D. *American Journal of Preventive Medicine*, *10*(2), 77–84.

Angrist, J., Lavy, V., and Schlosser, A. (2010). Multiple Experiments for the Causal Link between the Quantity and Quality of Children. *Journal of Labor Economics*, *28*(4), 773–824.

Araujo, M. C., Carneiro, P., Cruz-Aguayo, Y., and Schady, N. (2016). Teacher Quality and Learning Outcomes in Kindergarten. *The Quarterly Journal of Economics*, *131*(3), 1415–1453.

Arcidiacono, P. (2004). Ability sorting and the returns to college major. *Journal of Econometrics*, *121*(1-2), 343–375.

Arcidiacono, P., Hotz, V. J., and Kang, S. (2012). Modeling college major choices using elicited measures of expectations and counterfactuals. *Journal of Econometrics*, *166*(1), 3–16.

Atif, N., Krishna, R. N., Sikander, S., Lazarus, A., Nisar, A., Ahmad, I., … Rahman, A. (2017). Mother-to-mother therapy in India and Pakistan: adaptation and feasibility evaluation of the peer-delivered Thinking Healthy Programme. *BMC Psychiatry*, *17*(1), 79.

Attanasio, O., Boneva, T., and Rauh, C. (2019a). *Parental beliefs about returns to different types of investments in school children* (Working Paper No. 25513). NBER.

Attanasio, O., Cattan, S., Fitzsimons, E., Meghir, C., and Rubio-Codina, M. (2020). Estimating the production function for human capital: results from a randomized controlled trial in Colombia. *American Economic Review*, *110*(1), 48–85.

Attanasio, O., Cunha, F., and Jervis, P. (2019b). *Subjective Parental Beliefs. Their Measurement and Role* (Working Paper No. w26516). NBER.

Attanasio, O., and Kaufmann, K. M. (2014). Education choices and returns to schooling: Mothers' and youths' subjective expectations and their role by gender. *Journal of Development Economics*, *109*, 203–216.

Bailey, M. J. (2010). "Momma's got the pill": How Anthony Comstock and Griswold v. Connecticut Shaped US Childbearing. *American Economic Review*, *100*(1), 98–129.

Baranov, V., Bhalotra, S., Biroli, P., and Maselko, J. (2020). Maternal Depression, Women's Empowerment, and Parental Investment: Evidence from a Randomized Controlled Trial. *American Economic Review*, *110*(3), 824–59.

Barker, D. J. (1990). The fetal and infant origins of adult disease. *BMJ: British Medical Journal*, *301*(6761), 1111.

Barker, D. J. (1995). The fetal and infant origins of disease. *European Journal of Clinical Investigation*, *25*(7), 457–463.

Barrios, S., Bertinelli, L., and Strobl, E. (2010). Trends in Rainfall and Economic Growth in Africa: A Neglected Cause of the African Growth Tragedy. *The Review of Economics and Statistics*, *92*(2), 350–366.

Bateson, P., Barker, D., Clutton-Brock, T., Deb, D., D'Udine, B., Foley, R. A., ... Lahr, M. M., et al. (2004). Developmental plasticity and human health. *Nature*, *430*(6998), 419–421.

Becker, G. S., and Lewis, H. G. (1973). On the Interaction between the Quantity and Quality of Children. *Journal of Political Economy*, *81*(2, Part 2), S279–S288.

Becker, G. S., Murphy, K. M., and Tamura, R. (1990). Human Capital, Fertility, and Economic Growth. *Journal of Political Economy*, *98*(5, Part 2), S12–S37.

Becker, G. S., and Tomes, N. (1979). An equilibrium theory of the distribution of income and intergenerational mobility. *Journal of Political Economy*, *87*(6), 1153–1189.

Becker, G. S., and Tomes, N. (1986). Human capital and the rise and fall of families. *Journal of Labor Economics*, *4*(3, Part 2), S1–S39.

Ben-Porath, Y. (1976). Fertility Response to Child Mortality: Micro Data from Israel. *Journal of Political Economy*, *84*(4, Part 2), S163–S178.

Bhalotra, S., and Cochrane, T. (2010). *Where Have All the Young Girls Gone? Identification of Sex Selection in India* (IZA Discussion Paper No. 5381).

Bhalotra, S., Rocha, R., and Soares, R. R. (2019). *Does Universalization of Healthwork? Evidence from Health Systems Restructuring and Expansion in Brazil* (IZA Discussion Papers No. 12111).

Bird, K. (2013). The intergenerational transmission of poverty: An overview. In *Chronic Poverty* (pp. 60–84). Springer.

Biroli, P., Boneva, T., Raja, A., and Rauh, C. (2018). *Parental beliefs about returns to child health investments* (IZA Discussion Paper No. 11336).

Black, S. E., and Devereux, P. J. (2010). *Recent Developments in Intergenerational Mobility* (Working Paper No. 15889). NBER.

Black, S. E., Devereux, P. J., and Salvanes, K. G. (2005). The More the Merrier? The Effect of Family Size and Birth Order on Children's Education. *The Quarterly Journal of Economics*, *120*(2), 669–700.

Bleakley, H. (2010). Malaria Eradication in the Americas: A Retrospective Analysis of Childhood Exposure. *American Economic Journal: Applied Economics*, *2*(2), 1–45.

Bobonis, G. J. (2009). Is the Allocation of Resources within the Household Efficient? New Evidence from a Randomized Experiment. *Journal of Political Economy*, *117*(3), 453–503.

Boerma, T., Eozenou, P., Evans, D., Evans, T., Kieny, M.-P., and Wagstaff, A. (2014). Monitoring progress towards universal health coverage at country and global levels. *PLoS Medicine*, *11*(9).

Boneva, T., and Rauh, C. (2018). Parental beliefs about returns to educational investments—the later the better? *Journal of the European Economic Association*, *16*(6), 1669–1711.

Boneva, T., and Rauh, C. (2019). *Socio-economic gaps in university enrollment: The role of perceived pecuniary and non-pecuniary returns*. Working Paper.

Bonilla-Chacín, M. E., and Aguilera, N. (2013). *The mexican social protection system in health* (UNICO Studies Series No. 1). World Bank, Washington DC.

Bosch, M., and Campos-Vazquez, R. M. (2014). The Trade-Offs of Welfare Policies in Labor Markets with Informal Jobs: The Case of the "Seguro Popular" Program in Mexico. *American Economic Journal: Economic Policy*, *6*(4), 71–99.

Britton, J. R., Britton, H. L., and Gronwaldt, V. (2006). Breastfeeding, sensitivity, and attachment. *Pediatrics*, *118*(5), e1436–e1443.

Brown, D. W., Kowalski, A. E., and Lurie, I. Z. (2015). *Medicaid as an Investment in Children: What is the Long-Term Impact on Tax Receipts?* (Working Paper No. 20835). NBER.

Buber, I., and Engelhardt, H. (2008). Children's impact on the mental health of their older mothers and fathers: findings from the Survey of Health, Ageing and Retirement in Europe. *European Journal of Ageing*, *5*(1), 31–45.

Caldwell, J. C. (1976). Toward A Restatement of Demographic Transition Theory. *Population and Development Review*, 321–366.

Caldwell, J. C. (1982). *Theory of Fertility Decline*. Academic Press.

Caucutt, E. M., and Lochner, L. (2020). Early and late human capital investments, borrowing constraints, and the family. *Journal of Political Economy*, *128*(3), 1065–1147.

Caucutt, E. M., Lochner, L., and Park, Y. (2017). Correlation, consumption, confusion, or constraints: Why do poor children perform so poorly? *The Scandinavian Journal of Economics*, *119*(1), 102–147.

Chiswick, B. R. (1988). Differences in education and earnings across racial and ethnic groups: Tastes, discrimination, and investments in child quality. *The Quarterly Journal of Economics*, *103*(3), 571–597.

Ciancio, A., Delavande, A., Kohler, H.-P., and Kohler, I. V. (2020). *Mortality Risk Information, Survival Expectations and Sexual Behaviors* (University of Pennsylvania Population Center WorkingPaper (PSC/PARC) No. 2020-39).

Cohen, R. M., Weingartner, H., Smallberg, S. A., Pickar, D., and Murphy, D. L. (1982). Effort and cognition in depression. *Archives of General Psychiatry*, *39*(5), 593–597.

Cohodes, S., Grossman, D., Kleiner, S., and Lovenheim, M. (2016). The Effect of Child Health Insurance Access on Schooling: Evidence from Public Insurance Expansions. *The Journal of Human Resources*, *51*, 727–759.

Colón-González, F. J., Fezzi, C., Lake, I. R., and Hunter, P. R. (2013). The Effects of Weather and Climate Change on Dengue. *PLoS Neglected Tropical Diseases*, *7*(11), e2503.

Conley, T. (1999). GMM estimation with cross sectional dependence. *Journal of Econometrics*, *92*(1), 1–45.

Conti, G., and Ginja, R. (2017). *Who Benefits From Free Health Insurance: Evidence from Mexico* (Working Papers in Economics No. 18/17). University of Bergen, Department of Economics.

Cox, A., Bradley, R., Caldwell, B., and Walker, S. (2002). *The HOME inventory: A training approach for the UK*. Pavilion.

Cunha, F., Elo, I., and Culhane, J. (2013). *Eliciting maternal expectations about the technology of cognitive skill formation* (Working Paper No. w19144). NBER.

Cunha, F., Elo, I., and Culhane, J. (2019). Eliciting maternal subjective expectations about the technology of cognitive skill formation. *Working paper*.

Cunha, F., Elo, I., and Culhane, J. (2020). Maternal subjective expectations about the technology of skill formation predict investments in children one year later. *Journal of Econometrics*.

Cunha, F., and Heckman, J. J. (2007). The technology of skill formation. *American Economic Review*, *97*(2), 31–47.

Cunha, F., Heckman, J. J., Lochner, L., and Masterov, D. V. (2006). Interpreting the evidence on life cycle skill formation. *Handbook of the Economics of Education*, *1*, 697–812.

Cunha, F., Heckman, J. J., and Navarro, S. (2005). Separating uncertainty from heterogeneity in life cycle earnings. *Oxford Economic Papers*, *57*(2), 191–261.

Currie, J., and Almond, D. (2011). Human capital development before age five. In *Handbook of Labor Economics* (Vol. 4, pp. 1315–1486). Elsevier.

Currie, J., Decker, S., and Lin, W. (2008). Has Public Health Insurance for Older Children Reduced Disparities in Access to Care and Health Outcomes? *Journal of Health Economics*, *27*(6), 1567–1581.

Das Gupta, M. (2005). Explaining Asia's "Missing Women": A New Look at the Data. *Population and Development Review*, *31*(3), 529–535.

DaVanzo, J., and Pebley, A. (1993). *Maternal Depletion and Child Survival in Guatemala and Malaysia* (Papers No. 93-18). RAND - Labor and Population Program.

De Neve, J.-W., and Fink, G. (2018). Children's education and parental old age survival–Quasi-experimental evidence on the intergenerational effects of human capital investment. *Journal of Health Economics*, *58*, 76–89.

De Neve, J.-W., and Harling, G. (2017). Offspring schooling associated with increased parental survival in rural KwaZulu-Natal, South Africa. *Social Science & Medicine*, *176*, 149–157.

De Quidt, J., and Haushofer, J. (2016). *Depression for economists* (Working Paper No. w22973). NBER.

Dearden, L., Ferri, J., and Meghir, C. (2002). The Effect of School Quality on Educational Attainment and Wages. *Review of Economics and Statistics*, *84*(1), 1–20.

Delavande, A. (2008). Pill, patch, or shot? Subjective expectations and birth control choice. *International Economic Review*, *49*(3), 999–1042.

Delavande, A. (2014). Probabilistic expectations in developing countries. *Annual Review of Economics*, *6*(1), 1–20.

Delavande, A., and Kohler, H.-P. (2009). Subjective expectations in the context of HIV/AIDS in Malawi. *Demographic Research*, *20*, 817.

Delavande, A., and Kohler, H.-P. (2016). HIV/AIDS-related expectations and risky sexual behaviour in Malawi. *The Review of Economic Studies*, *83*(1), 118–164.

Delavande, A., Lee, J., and Menon, S. (2017). Eliciting survival expectations of the elderly in low-income countries: Evidence from India. *Demography*, *54*(2), 673–699.

Delavande, A., and Rohwedder, S. (2011). Individuals' uncertainty about future social security benefits and portfolio choice. *Journal of Applied Econometrics*, *26*(3), 498–519.

Delavande, A., and Zafar, B. (2019). University choice: The role of expected earnings, nonpecuniary outcomes, and financial constraints. *Journal of Political Economy*, *127*(5), 2343–2393.

Deming, D. J., Hastings, J. S., Kane, T. J., and Staiger, D. O. (2014). School Choice, School Quality, and Postsecondary Attainment. *American Economic Review*, *104*(3), 991–1013.

Den Hartog, H., Derix, M., Van Bemmel, A., Kremer, B., and Jolles, J. (2003). Cognitive functioning in young and middle-aged unmedicated out-patients with major depression: Testing the effort and cognitive speed hypotheses. *Psychological Medicine*, *33*(8), 1443–1451.

Dinkelman, T. (2013). *Mitigating Long-run Health Effects of Drought: Evidence from South Africa* (Working Paper No. 19756). NBER.

Dizon-Ross, R. (2019). Parents' beliefs about their children's academic ability: Implications for educational investments. *American Economic Review*, *109*(8), 2728–65.

Doepke, M. (2005). Child mortality and fertility decline: Does the Barro-Becker model fit the facts? *Journal of Population Economics*, *18*(2), 337–366.

Dominitz, J., and Manski, C. F. (2011). Measuring and interpreting expectations of equity returns. *Journal of Applied Econometrics*, *26*(3), 352–370.

Duflo, E. (2003). Grandmothers and Granddaughters: Old-Age Pensions and Intrahousehold Allocation in South Africa. *The World Bank Economic Review*, *17*(1), 1–25.

Duque, V., Rosales-Rueda, M., and Sanchez Torres, F. (2019). *How Do Early-Life Shocks Interact with Subsequent Human Capital Investments? Evidence from Administrative Data* (Working Papers No. 2019-17). University of Sydney, School of Economics.

Ebenstein, A. (2010). The "Missing Girls" of China and the Unintended Consequences of the One Child Policy. *Journal of Human Resources*, *45*(1), 87–115.

Eisenhauer, P., Heckman, J. J., and Mosso, S. (2015). Estimation of dynamic discrete choice models by maximum likelihood and the simulated method of moments. *International Economic Review*, *56*(2), 331–357.

Ermisch, J., Jantti, M., and Smeeding, T. M. (2012). *From parents to children: The intergenerational transmission of advantage*. Russell Sage Foundation.

Everding, J. (2019). *Heterogeneous spillover effects of children's education on parental mental health*. HCHE Research Paper.

Fang, H., Eggleston, K. N., Rizzo, J. A., Rozelle, S., and Zeckhauser, R. J. (2012). *The Returns to Education in China: Evidence from the 1986 Compulsory Education Law* (Working Paper No. 18189). NBER.

Field, C. B., Barros, V., Stocker, T. F., and Dahe, Q. (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation: Special report of the intergovernmental panel on climate change*. Cambridge University Press.

Finkelstein, A., Taubman, S., Wright, B., Bernstein, M., Gruber, J., Newhouse, J. P., ... Group, O. H. S. (2012). The Oregon Health Insurance Experiment: Evidence from the First Year. *The Quarterly Journal of Economics*, *127*(3), 1057–1106.

Fitzsimons, E., and Vera-Hernández, M. (2013). *Food for thought? Breastfeeding and child development* (IFS Working Papers No. W13/31).

Fleisher, B. M., Sabirianova, K., and Wang, X. (2005). Returns to skills and the speed of reforms: Evidence from Central and Eastern Europe, China, and Russia. *Journal of Comparative Economics*, *33*(2), 351–370.

Fleisher, B. M., and Wang, X. (2004). Skill differentials, return to schooling, and market segmentation in a transition economy: the case of Mainland China. *Journal of Development Economics*, *73*(1), 315–328.

Frankenberg, E., and Thomas, D. (2017). Human Capital and Shocks: Evidence on Education, Health, and Nutrition. In *The Economics of Poverty Traps*. University of Chicago Press.

Frenk, J., Gomez-Dantes, O., and Knaul, F. (2009). The democratization of health in Mexico: financial innovations for universal coverage. *Bulletin of the World Health Organisation*, *87*, 542–548.

Friedman, E. M., and Mare, R. D. (2014). The schooling of offspring and the survival of parents. *Demography*, *51*(4), 1271–1293.

Gabrysch, S., Waid, J. L., Wendt, A. S., Müller, A. A., Kader, A., and Gosh, U. (2018). Nutritional effects of flooding due to unseasonably early monsoon rainfall in Bangladesh: a cross-sectional study in an ongoing cluster-randomised trial. *The Lancet Planetary Health*, *2*, S3.

Galor, O. (2012). The Demographic Transition: Causes and Consequences. *Cliometrica*, *6*(1), 1–28.

Galor, O., and Weil, D. N. (2000). Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond. *American Economic Review*, *90*(4), 806–828.

Garg, T., Jagnani, M., and Taraz, V. P. (2017). *Human Capital Costs of Climate Change: Evidence from Test Scores in India* (2017 Annual Meeting, July 30-August 1, Chicago, Illinois No. 258018). Agricultural and Applied Economics Association.

Gelaye, B., Rondon, M. B., Araya, R., and Williams, M. A. (2016). Epidemiology of maternal depression, risk factors, and child outcomes in low-income and middle-income countries. *The Lancet Psychiatry*, *3*(10), 973–982.

Giustinelli, P. (2016). Group decision making with uncertain outcomes: Unpacking child–parent choice of the high school track. *International Economic Review*, *57*(2), 573–602.

Grantham-McGregor, S., Cheung, Y. B., Cueto, S., Glewwe, P., Richter, L., Strupp, B., Group, I. C. D. S., et al. (2007). Developmental potential in the first 5 years for children in developing countries. *The Lancet*, *369*(9555), 60–70.

Gross, T., and Notowidigdo, M. J. (2011). Health Insurance and the Consumer Bankruptcy Decision: Evidence from Expansions of Medicaid. *Journal of Public Economics*, *95*(7-8), 767–778.

Gruber, J., and Yelowitz, A. (1999). Public health insurance and private savings. *Journal of Political Economy*, *107*(6), 1249–1274.

Gunnsteinsson, S., Adhvaryu, A., Christian, P., Labrique, A., Sugimoto, J., Shamim, A. A., and West Jr, K. P. (2019). *Protecting Infants from Natural Disasters: The Case of Vitamin A Supplementation and a Tornado in Bangladesh* (Working Paper No. 25969). NBER.

Guo, C., Wang, X., and Meng, C. (2017). *The Effect of Age at School Entry on Educational Attainment and Labor Market Outcomes: Evidence from China*. Unpublished manuscript.

Guodong, C., and Xiaoyan, L. (2009). "Fertility effect" or "supporting effect?"-Quantity of children and parental health. *Frontiers of Economics in China*, *4*(4), 601–616.

Hamadani, J. D., Tofail, F., Huda, S. N., Alam, D. S., Ridout, D. A., Attanasio, O., and Grantham-McGregor, S. M. (2014). Cognitive deficit and poverty in the first 5 years of childhood in Bangladesh. *Pediatrics*, *134*(4), e1001–e1008.

Hank, K. (2010). Childbearing history, later-life health, and mortality in Germany. *Population Studies*, *64*(3), 275–291.

Hanushek, E. A. (1992). The Trade-off Between Child Quantity and Quality. *Journal of Political Economy*, *100*(1), 84–117.

Hanushek, E. A. (2013). Economic Growth in Developing Countries: The Role of Human Capital. *Economics of Education Review*, *37*, 204–212.

Hardee-Cleaveland, K., and Banister, J. (1988). Fertility Policy and Implementation in China, 1986-88. *Population and Development Review*, 245–286.

Hazan, M., and Berdugo, B. (2002). Child Labour, Fertility, and Economic Growth. *The Economic Journal*, *112*(482), 810–828.

Heckman, J. J., and Kautz, T. (2014). Fostering and measuring skills interventions that improve character and cognition. In J. J. Heckman, J. E. Humphries, and T. Kautz (Eds.), *The GED Myth: Education, Achievement Tests, and the Role of Character in American Life* (Chap. 9). Chicago, IL: University of Chicago Press.

Heckman, J. J., and Mosso, S. (2014). The economics of human development and social mobility. *Annual Review of Economics*, *6*(1), 689–733.

Hsiang, S. M., Burke, M., and Miguel, E. (2013). Quantifying the Influence of Climate on Human Conflict. *Science*, *341*(6151), 1235367.

Huggett, M., Ventura, G., and Yaron, A. (2011). Sources of lifetime inequality. *American Economic Review*, *101*(7), 2923–54.

Islam, A., and Smyth, R. (2015). Do Fertility Control Policies Affect Health in Old Age? Evidence from China's One-Child Experiment. *Health Economics*, *24*(5), 601–616.

Jensen, R. T. (2005). *Equal Treatment, Unequal Outcomes? Generating Sex Inequality through Fertility Behavior*. Unpublished manuscript.

Keane, M. P., and Wolpin, K. I. (1997). The career decisions of young men. *Journal of Political Economy*, *105*(3), 473–522.

Knaul, F. M., Arreola-Ornelas, H., Méndez-Carniado, O., Bryson-Cahn, C., Barofsky, J., Maguire, R., … Sesma, S. (2006). Evidence is good for your health system:

policy reform to remedy catastrophic and impoverishing health spending in Mexico. *The Lancet*, *368*(9549), 1828–1841.

Knaul, F. M., González-Pier, E., Gomez-Dantes, O., García-Junco, D., Arreola-Ornelas, H., Barraza-Lloréns, M., ... Frenk, J. (2012). The Quest for Universal Health Coverage: Achieving Social Protection for All in Mexico. *The Lancet*, *380*, 1259–79.

Kolenikov, S., and Angeles, G. (2004). The use of discrete data in PCA: theory, simulations, and applications to socioeconomic indices. *Chapel Hill: Carolina Population Center, University of North Carolina*, *20*, 1–59.

Kruk, K. E., and Reinhold, S. (2014). The Effect of Children on Depression in Old Age. *Social Science & Medicine*, *100*, 1–11.

Kugler, A. D., and Kumar, S. (2017). Preference for Boys, Family Size, and Educational Attainment in India. *Demography*, *54*(3), 835–859.

Kurowski, C., Vilar-Compte, M., Araujo, E. C., and Stanciole, A. (2012). *Mexico social protection system in health and the formal sector*. The World Bank.

Lee, J.-W., and Lee, H. (2016). Human capital in the long run. *Journal of Development Economics*, *122*, 147–169.

Lee, J. (2008). Sibling size and investment in children's education: An Asian instrument. *Journal of Population Economics*, *21*(4), 855–875.

Levine, P. B., and Schanzenbach, D. (2009). The impact of children's public health insurance expansions on educational outcomes. In *Forum for Health Economics & Policy* (Vol. 12, *1*). De Gruyter.

Li, H., Zhang, J., and Zhu, Y. (2008). The quantity-quality trade-off of children in a developing country: Identification using chinese twins. *Demography*, *45*(1), 223–243.

Liu, K. (2016). Insuring against health shocks: Health insurance and household choices. *Journal of Health Economics*, *46*, 16–32.

Livneh, B., Bohn, T. J., Pierce, D. W., Munoz-Arriola, F., Nijssen, B., Vose, R., ... Brekke, L. (2015). A spatially comprehensive, hydrometeorological data set for Mexico, the U.S., and Southern Canada 1950–2013. *Scientific Data*, *2*, 150042.

Lundborg, P., and Majlesi, K. (2018). Intergenerational Transmission of Human Capital: Is It a One-Way Street? *Journal of Health Economics*, *57*, 206–220.

Ma, M. (2019). Does Children's Education Matter for Parents' Health and Cognition? Evidence from China. *Journal of Health Economics*.

Maccini, S., and Yang, D. (2009). Under the Weather: Health, Schooling, and Economic Consequences of Early-Life Rainfall. *American Economic Review*, *99*(3), 1006–26.

Magana, V., Vázquez, J., Párez, J., and Pérez, J. (2003). Impact of El Niño on precipitation in Mexico. *Geofisica Internacional*, *42*, 313–330.

Mani, A., Mullainathan, S., Shafir, E., and Zhao, J. (2013). Poverty impedes cognitive function. *Science*, *341*(6149), 976–980.

Manski, C. F. (2004). Measuring expectations. *Econometrica*, *72*(5), 1329–1376.

Marten, R., McIntyre, D., Travassos, C., Shishkin, S., Longde, W., Reddy, S., and Vega, J. (2014). An assessment of progress towards universal health coverage in Brazil, Russia, India, China, and South Africa (BRICS). *The Lancet*, *384*(9960), 2164–2171.

Maynard, A., and Qiu, J. (2009). Public insurance and private savings: Who is affected and by how much? *Journal of Applied Econometrics*, *24*(2), 282–308.

McCrary, J., and Royer, H. (2011). The effect of female education on fertility and infant health: Evidence from school entry policies using exact date of birth. *American Economic Review*, *101*(1), 158–95.

McEwan, P. J. (2015). Improving learning in primary schools of developing countries: A meta-analysis of randomized experiments. *Review of Educational Research*, *85*(3), 353–394.

Miguel, E., Satyanath, S., and Sergenti, E. (2004). Economic Shocks and Civil Conflict: An Instrumental Variables Approach. *Journal of Political Economy*, *112*(4), 725–753.

Miller, S., and Wherry, L. R. (2019). The Long-Term Effects of Early Life Medicaid Coverage. *Journal of Human Resources*, *54*(3), 785–824.

Ming, C. K. (1986). China's Recent Education Reform: The Beginning of an Overhaul. *Comparative Education*, *22*(3), 255–269.

Moav, O. (2004). Cheap Children and the Persistence of Poverty. *The Economic Journal*, *115*(500), 88–110.

Mocan, N. H., and Yu, H. (2017). *Can superstition create a self-fulfilling prophecy? School outcomes of Dragon children of China* (Working Paper No. 23709). NBER.

Mullainathan, S., and Shafir, E. (2013). *Scarcity: Why having too little means so much*. Macmillan.

Nakasone, E., and Torero, M. (2016). *Agricultural Extension through Information Technologies in Schools: Do the Cobbler's Parents go Barefoot?* (2016 Annual

Meeting, July 31-August 2, Boston, Massachusetts No. 236114). Agricultural and Applied Economics Association.

Navarro, S., and Zhou, J. (2016). *Quantifying credit constraints, preferences, and uncertainty in a lifecycle model of schooling choice*. Working paper, Dept. Econ., Univ. Western Ontario.

OBrien, L. V., Berry, H., Coleman, C., and Hanigan, I. (2014). Drought as a mental health exposure. *Environmental Research*, *131*, 181–187.

Oreopoulos, P., and Salvanes, K. G. (2011). Priceless: The nonpecuniary benefits of schooling. *Journal of Economic Perspectives*, *25*(1), 159–84.

Park, R. J., Goodman, J., Hurwitz, M., and Smith, J. (2020). Heat and Learning. *American Economic Journal: Economic Policy*, *12*(2), 306–39.

Pepper, S. (1990). China's Education Reform in the 1980s. *China Research Monograph*, (36).

Putnam, R. D. (2016). *Our kids: The American dream in crisis.* New York: Simon and Schuster.

Qian, Z. (1997). Progression to Second Birth in China: A Study of Four Rural Counties. *Population Studies*, *51*(2), 221–228.

Raj, A., Saggurti, N., Balaiah, D., and Silverman, J. G. (2009). Prevalence of child marriage and its effect on fertility and fertility-control outcomes of young women in India: a cross-sectional, observational study. *The Lancet*, *373*(9678), 1883–1889.

Rataj, E., Kunzweiler, K., and Garthus-Niegel, S. (2016). Extreme weather events in developing countries and related injuries and mental health disorders – a systematic review. *BMC Public Health*, *16*(1), 1020.

Read, S., Grundy, E., and Wolf, D. A. (2011). Fertility history, health, and health changes in later life: a panel study of British women and men born 1923–49. *Population Studies*, *65*(2), 201–215.

Reich, M. R., Harris, J., Ikegami, N., Maeda, A., Cashin, C., Araujo, E. C., ... Evans, T. G. (2016). Moving towards universal health coverage: Lessons from 11 country studies. *The Lancet*, *387*(10020), 811–816.

Rocha, R., and Soares, R. R. (2015). Water Scarcity and Birth Outcomes in the Brazilian Semiarid. *Journal of Development Economics*, *112*, 72–91.

Ronda, V. (2016). *The Effect of Maternal Psychological Distress on Children's Cognitive Development*. Working Paper.

Rosales, M. (2014). *Impact of Early Life Shocks on Human Capital Formation: El Niño Floods in Ecuador*. IDB Working Paper No. IDB-WP-503.

Rosenzweig, M. R., and Evenson, R. (1977). Fertility, Schooling, and the Economic Contribution of Children of Rural India: An Econometric Analysis. *Econometrica*, 1065–1079.

Rosenzweig, M. R., and Schultz, T. P. (1982). Market Opportunities, Genetic Endowments, and Intrafamily Resource Distribution: Child Survival in Rural India. *The American Economic Review*, *72*(4), 803–815.

Rosenzweig, M. R., and Wolpin, K. I. (1980). Testing the Quantity-Quality Fertility Model: The Use of Twins as a Natural Experiment. *Econometrica*, 227–240.

Rosenzweig, M. R., and Zhang, J. (2009). Do Population Control Policies Induce More Human Capital Investment? Twins, Birth Weight and China's "One-Child" Policy. *The Review of Economic Studies*, *76*(3), 1149–1174.

Rubalcava, L., and Teruel, G. (2006). *Mexican Family Life Survey, Second Round.* Working Paper, www.ennvih-mxfls.org. Retrieved from www.ennvih-mxfls.org

Rubalcava, L., and Teruel, G. (2013). *Mexican Family Life Survey, Third Round.* Working Paper. Retrieved from www.ennvih-mxfls.org

Rubalcava, L., Teruel, G., and Thomas, D. (2009). Investments, Time Preferences, and Public Transfers Paid to Women. *Economic Development and Cultural Change*, *57*(3), 507–538.

Sanderson, E., and Windmeijer, F. (2016). A weak instrument F-test in linear IV models with multiple endogenous variables. *Journal of Econometrics*, *190*(2), 212–221.

Savage, L. J. (1954). *The foundations of statistics*. New York: Wiley.

Scharping, T. (2013). *Birth Control in China 1949-2000: Population Policy and Demographic Development.* Routledge.

Schilbach, F., Schofield, H., and Mullainathan, S. (2016). The psychological lives of the poor. *American Economic Review*, *106*(5), 435–40.

Schultz, T. P. (1997). Demand for children in low income countries. *Handbook of Population and Family Economics*, *1*, 349–430.

Schultz, T. P. (2007). Population Policies, Fertility, Women's Human Capital, and Child Quality. *Handbook of Development Economics*, *4*, 3249–3303.

Shah, M., and Steinberg, B. M. (2017). Drought of Opportunities: Contemporaneous and Long-Term Impacts of Rainfall Shocks on Human Capital. *Journal of Political Economy*, *125*(2), 527–561.

Sikander, S., Ahmad, I., Atif, N., Zaidi, A., Vanobberghen, F., Weiss, H. A., ... Bibi, A., et al. (2019). Delivering the Thinking Healthy Programme for perinatal depression through volunteer peers: a cluster randomised controlled trial in Pakistan. *The Lancet Psychiatry*, *6*(2), 128–139.

Sikander, S., Lazarus, A., Bangash, O., Fuhr, D. C., Weobong, B., Krishna, R. N., ... Rahman, A., et al. (2015). The effectiveness and cost-effectiveness of the peer-delivered Thinking Healthy Programme for perinatal depression in Pakistan and India: the SHARE study protocol for randomised controlled trials. *Trials*, *16*(1), 534.

Skoufias, E., and Vinha, K. (2013). The Impacts of Climate Variability on Welfare in Rural Mexico. *Population and Environment*, *34*(3), 370–399.

Spence, N. J. (2008). The Long-Term Consequences of Childbearing: Physical and Psychological Well-Being of Mothers in Later Life. *Research on Aging*, *30*(6), 722–751.

Stinebrickner, R., and Stinebrickner, T. (2012). Learning about academic ability and the college dropout decision. *Journal of Labor Economics*, *30*(4), 707–748.

Stinebrickner, R., and Stinebrickner, T. (2014a). A major in science? Initial beliefs and final outcomes for college major and dropout. *Review of Economic Studies*, *81*(1), 426–472.

Stinebrickner, R., and Stinebrickner, T. (2014b). Academic performance and college dropout: Using longitudinal expectations data to estimate a learning model. *Journal of Labor Economics*, *32*(3), 601–644.

Teruel, G., Rubalcava, L., and Santana, A. (2005). *Escalas de Equivalencia para México* (Documentos de Investigación No. 23). Secretaría de Desarrollo Social Mexico.

Thomas, D. (1990). Intra-household resource allocation: An inferential approach. *Journal of Human Resources*, 635–664.

Torssander, J. (2013). From Child to Parent? The Significance of Children's Education for Their Parents' Longevity. *Demography*, *50*(2), 637–659.

Turner, E. L., Sikander, S., Bangash, O., Zaidi, A., Bates, L., Gallis, J., . . . Maselko, J. (2016). The effectiveness of the peer-delivered Thinking Healthy Plus (THPP+) Programme for maternal depression and child socio-emotional development in Pakistan: Study protocol for a three-year cluster randomized controlled trial. *Trials*, *17*(1), 442.

UIS. (2017). *More than one-half of children and adolescents are not learning worldwide* (Fact Sheet No. 46, UIS/FS/2017/ED/46). UNESCO Institute for Statistics.

UIS. (2018). *One in Five Children, Adolescents and Youth is Out of School* (Factsheet No. 48, UIS/FS/2018/ED/48). UNESCO Institute for Statistics.

UNESCO. (2014). Teaching and learning: Achieving quality for all. *(Education for All Global Monitoring Report 2013/4).*

Wang, S. Y. (2019). *The Labor Supply Consequences of Having a Boy in China* (Working Paper No. 26185). NBER.

Wherry, L. R., Kenney, G. M., and Sommers, B. D. (2016). The Role of Public Health Insurance in Reducing Child Poverty. *Academic Pediatrics*, *16*(3), S98–S104.

WHO. (2000). *The world health report 2000 - health systems: Improving performance*. World Health Organization.

WHO. (2019). *World health statistics overview 2019: monitoring health for the SDGs, sustainable development goals*. World Health Organization.

WHO and World Bank. (2017). *Tracking universal health coverage: 2017 global monitoring report*. World Health Organization.

WHO and World Bank. (2020). *Global monitoring report on financial protection in health 2019*. World Health Organization.

Wiswall, M., and Zafar, B. (2015). Determinants of college major choice: Identification using an information experiment. *The Review of Economic Studies*, *82*(2), 791–824.

Wiswall, M., and Zafar, B. (2018). Preference for the workplace, investment in human capital, and gender. *The Quarterly Journal of Economics*, *133*(1), 457–507.

World Bank. (2015). *Mind, Society and Behavior: World Development Report 2015*. The World Bank.

Wu, X., Lu, Y., Zhou, S., Chen, L., and Xu, B. (2015). Impact of climate change on human infectious diseases: Empirical evidence and human adaptation. *Environment International*, *86*, 14–23.

Xie, Y., and Hu, J. (2014). An Introduction to the China Family Panel Studies (CFPS). *Chinese Sociological Review*, *47*(1), 3–29.

Xiu, L., and Gunderson, M. (2013). Gender Earnings Differences in China: Base Pay, Performance Pay, and Total Pay. *Contemporary Economic Policy*, *31*(1), 235–254.

Zhang, J., Zhao, Y., Park, A., and Song, X. (2005). Economic returns to schooling in urban China, 1988 to 2001. *Journal of Comparative Economics*, *33*(4), 730–752.

Zhao, Y., Hu, Y., Smith, J. P., Strauss, J., and Yang, G. (2014). Cohort profile: the China Health and Retirement Longitudinal Study (CHARLS). *International Journal of Epidemiology*, *43*(1), 61–68.

Zimmer, Z., Martin, L. G., Ofstedal, M. B., and Chuang, Y.-L. (2007). Education of adult children and mortality of their elderly parents in Taiwan. *Demography*, *44*(2), 289–305.