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Sweet child of mine: Parental income, child health and inequality

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Parental income, child health and inequality*

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How to allocate limited resources among children is a crucial household decision, especially in developing countries where it might have strong implications for children and family survival. We provide the first systematic study linking variations in parental income in the early life of children to subsequent child health and parental investments across siblings in developing countries, using data from multiple waves of the Demographic and Health Surveys spanning 54 countries. Variations in the world prices of locally produced crops are used as measures of local income. We find that children born in periods of higher income receive better human capital (health and education) investments and durably enjoy better health than their siblings. Children whose siblings were born during favourable income periods receive less investment and exhibit worse health. We also provide evidence that other investments (education, fertility) react to sibling rivalry, and show that these within-households adjustments matter at the aggregate level.

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1 Introduction

How to allocate limited resources among children is a crucial household decision for family well-being. It has been widely shown that much of adult outcomes are determined by age 18, with a crucial role being played by early childhood (e.g., Heckman and Mosso (2014);Almond and Currie (2011); and Cunhaetal2006). However, the literature has so far not presented coherent results about the way parents react to differences in initial endowments across children. The urge for equality among siblings[1] may be overcome by the need to bet on the right child, particularly so in poor countries, where survival can be at stake and resources are limited.

This paper sheds light on parental incentives to invest in children in low-income settings. We study the link between household income variations, child health and parental investments across siblings. Our focus is on income variations during the in utero period, while controlling for income changes in other periods. Our main objective is to assess the extent to which parents direct resources preferentially towards their 'sweet child' – i.e. the one born during a high income period – to the detriment of the other children.

To guide our empirical investigation, we first consider a simple theoretical framework where parents allocate resources across their children. Under plausible assumptions (i.e., that children born in times of higher income have better health; and that better health at birth increases productivity of investments strategies along the entire life of a child – equivalent to assuming dynamic complementarities in investments), the model delivers the following predictions: (i) better income conditions in utero increase the investments received by the child and therefore her future quality (health); (ii) better income conditions during the in utero period of a child decrease the investments received by her future siblings, and therefore their quality – what we refer to as the "sibling rivalry" effect. We also show theoretically that the competition effect exerted by siblings is weaker for children who received higher income in utero – i.e. the sibling and the own effect interact negatively.[2]

The main contribution of the paper is to confront these predictions with large-scale individual data on health investment and outcomes. Our main analysis uses information on around 1,000,000 children (up to five years old) born from 750,000 mothers living in developing countries, from multiple waves of the Demographic and Health Surveys (DHS) spanning the 1986-2016 period. We use variations in the world prices of locally produced crops as measures of local income. Specifically, we combine monthly world prices of agricultural commodities with geo-referenced data on land suitability for agriculture (from FAO-GAEZ) to measure local, exogenous exposure to variations in the prices of produced crops, a major source of income in many developing countries. Such measures, computed by cells of 0.5×0.5^o (around 55×55 km at the equator), have been widely used in recent literature (Berman and Couttenier, 2015; McGuirk and Burke, 2020). We also provide evidence that they positively correlate with in-

[1] As shown by Berry et al. (2020), parents may forego substantial earnings to equalize inputs across children.

[2] We discuss other tests to validate our theoretical framework. We show that the income faced by a child is expected to have a nonlinear impact on her accumulation of human capital, and we derive theoretical predictions on the link between income affecting younger children and human capital of the elders.

come, using proxies from various sources, including nighttime lights and survey data (DHS, Afrobarometer, LSMS), and that they do not affect consumption directly.[3] Child health is proxied by children's body size, as measured by weight-for-age and height-for-age indicators, and survival probability. We measure parental responses using data on health investments, such as vaccinations and provision of health treatments. To investigate further our mechanisms, we also use data on parental time use for a subsample of countries from the Living Standards Measurement Study (LSMS) surveys. We also consider alternative types of parental investment from the DHS: education and fertility.

The DHS data allow us to construct the birth history of mothers in the survey. For each child, we regress health outcomes and parental investments on up to ten years of lags of our local price indexes, and single out the in utero periods of the child and her siblings. This methodology is demanding but it ensures that we are identifying the effect of in utero prices, rather than of other correlated shocks. We also control for cell and year-of-birth fixed effects, as well as for differences in age, birth order and household characteristics. We find that children who benefited from higher prices in utero durably exhibit better health. Our estimates suggest that a standard deviation increase in in utero prices leads to a 19 % of a standard deviation rise in contemporaneous health (or a 0.17 increase in the child health index, as measured by anthropometrics). This effect is significantly higher than that of earlier price variations and comparable to that of prices after birth. Its size is consistent with the findings of the literature on the effects of in utero income variations on later health outcomes. As a comparison, Adhvaryu et al. (2019), using data from Ghana and cocoa prices as income shifter, find that a standard deviation increase in prices generates an improvement of mental health equivalent to 30 % of the standard deviation of their dependent variable. Parental responses can explain how income changes that occurred during pregnancy can affect children's health during childhood. We find that siblings who experience higher local prices in the in utero period are more likely to be breastfed, to receive the expected doses of vaccinations, vitamin A and deworming. We provide evidence that these parental investments correlate strongly with children's health outcomes.

Consistent with the theoretical predictions, income-related variations during the in utero period affect how parents allocate resources across siblings. Crop prices during the in utero period of siblings have a negative effect on the health and parental investments received by the subsequent child. This result is consistent with sibling rivalry: parents divert resources from the low-price to the high-price child. The negative effect of a standard deviation increase in the in utero price received by older siblings is equivalent to around 10 % of the increase in parental investment associated with a higher own in utero price. Finally, and consistent with our model, we find that the negative siblings effect weakens with the own in utero price of the child – parents divert less resources away from a child who was born during good economic

[3] Although we look at prices of *produced* crops, these fluctuations could also affect consumption and hence could have effects opposite to those of income shocks. Our results are difficult to reconcile with this view. In addition, we provide a series of robustness checks suggesting that our results are not driven by consumption. In particular, the effect of crop prices increase with the crop shares in a country's export – which we take as a proxy for actual sales – and remains significant when restricted to cash crops.

times. We also provide support for another implication of our model – the non-linearity of the effect of own and old sibling in utero prices.

We consider several threats to identification. The first is sample selection caused by endogenous mortality and fertility. Our results may partly be interpreted as reflecting selection on mortality: a child who receives a low price in utero is more likely to die and, as a result, subsequent children will receive more investment. Beyond this interpretation issue, the effects on mortality and fertility open the door to the possibility that our estimation sample is selected on the basis of our in utero income variable. Therefore, we provide additional estimations that correct for endogenous selection into fertility and mortality using an "identification-at-infinity" method (Chamberlain, 1986; Mulligan and Rubinstein, 2008; Machado, 2017). We find that siblings effects are amplified when we restrict the estimation to samples where the influence of selective mortality is likely small – i.e. our baseline results are likely attenuated by selection on mortality. Fertility appears to play a more limited role. Other threats to identification are addressed in a wide range of sensitivity exercises. We check that our crop prices do not pick up the effect of local time-varying factors or supply conditions; we discuss measurement error and migration; and we show that our results are stable across countries, robust to using different estimation samples, alternative measures of agricultural specialization, and to accounting for spatial correlation.

The theoretical interpretation of the siblings rivalry effect hinges upon the assumption that child-specific parental investments require the use of limited resources. The health investments that we use in the empirical analysis (vaccinations, deworming and vitamin A treatments) entail monetary (liquidity constraints and lack of access to credit) and non-monetary (time to travel to the clinic and unreliability of the supply) costs (Dupas, 2011; Dupas and Miguel, 2017), which can partly explain why only 62 % of the children in our sample have received the WHO required vaccine doses. We provide suggestive evidence that price variations affect time and caring provided by the household, another limited yet important resource that parents can allocate to children. Using LSMS data, we find that parents' time allocation is affected by the prices faced during in utero periods – hence by the quality of their children. In particular, mothers spend more time in the household and work less outside when they experience 'good' prices during pregnancy periods.

Both health investments and time use are parental responses that are particularly relevant to the early life of children. We deepen our analysis by testing whether our results are confirmed when looking also at long-term outcomes: education and fertility decisions. We find that a child's likelihood to attend school is relatively lower if her older siblings received a higher price while in utero. Observing parental investments strategies that reinforce initial disparities among siblings at different points in the life cycle of the child bolsters our assumption of dynamic complementarities in investments. We also find evidence that mothers adjust their fertility decisions: high past prices decrease birth spacing and increase the probability of future pregnancies, but this effect is reversed when prices were high during past in utero periods.

The results of our micro-level analysis suggest that changes in income widen health disparities across siblings, within households. In the last section of the paper, we show that this intra-household adjustment matters at the aggregate level. We aggregate our data by region, within countries, and provide evidence that variations in crop prices makes within-household child health inequality relatively more prevalent, as compared to inequality between households.

Our findings contribute to the debate about the effectiveness of policies aimed at reducing children's malnutrition, which often rely on households as the targeted units (Brown et al., 2017). The micro results suggest that parents might use the support received (e.g., in the form of cash transfers) to favour the 'strongest' child, thereby exacerbating child health inequalities. The macro evidence implies that income fluctuations increase the prevalence of households where only some children are in need of support. The importance of these mixed households can make it difficult to identify who should receive assistance in the first place.

Contribution and related literature. We provide novel evidence on how variations in the economic environment during early life affects parental investments in the health of their children. Our results suggest that parental health investments enlarge income-related differences in health at birth across siblings. These findings accord well with the existing literature showing that health investments tend to reinforce initial disparities in child endowments – not necessarily across siblings – especially in developing countries.[4] Though, in line with this literature, our results also hold across households, our contribution is to focus mostly on within-household variation. In that sense, we relate to the research which studies dynamic complementarities (Cunha and Heckman, 2007, 2009), and show how the reinforcement mechanism is at play within households. As Francesconi and Heckman (2016) point out, most of the work on the relationship between early-life circumstances, parental investments and human development focuses on single-child models. The small literature on parental investments across siblings has produced mixed findings.[5] Yi et al. (2015) find evidence of "compensating" health investments and "reinforcing" education investments using data from China. A major difference with our paper is that Yi et al. (2015) consider twins. Using Tanzanian data, Adhvaryu and Nyshadham (2016) find evidence of positive spillovers of a iodine-supplementation program (affecting primarily cognitive abilities) on the siblings of treated children. Because we confirm the baseline sibling rivalry effect using only data from Tanzania, the difference in the findings with respect to Adhvaryu and Nyshadham (2016) can be related to the type of treatment. In their study, the iodine supplement intervention can trigger a learning response by the parents about the beneficial effects of medication that can raise health investments also for the siblings. Even though our more general income-related price measure could also trigger learning from parents after they increase investment in some children, our empirical results show that sibling competition driven by differential endowment at birth prevails on learning.

Our paper also relates to the "fetal origin" literature, which hypothesizes that early life con-

[4] See Duque et al. (2018); Almond and Mazumder (2013); Almond et al. (2018) for recent reviews.

[5] A common result in developed countries is that firstborn children receive relatively better parental investments than their siblings (e.g. Black et al., 2005). This pattern is partly reversed in developing countries (De Haan et al., 2014; Baland et al., 2016). We control for the effect of birth order on children's health and parental investments.

ditions have long term effects on health, educational attainment and labor market outcomes (see the surveys by Almond and Currie, 2011, Currie and Vogl, 2013). Our methodology to identify income variations is close to Adhvaryu et al. (2019), who show that, in Ghana, high cocoa prices in early life lead to better adult mental health. Our paper also relates to the literature which estimates the causal impact of *contemporaneous* income shocks – e.g., GDP per capita – on child survival and health – a literature that has produced mixed results for developing countries (e.g., Cogneau and Jedwab, 2012 and Miller and Urdinola, 2010). We estimate the effects of income-related variation at birth on child health while controlling for contemporaneous income level, and further scrutinize the response of parental health investments.

The paper also contributes to the literature studying the link between income and fertility. The relationship between economic growth and fertility has been widely documented both theoretically (e.g. Galor and Weil, 2000) and empirically (e.g. Chatterjee and Vogl, 2018), and varies between malthusian and post-malthusian frameworks. However, the literature on the impact of income shocks on fertility in developing economies has more mixed results (e.g. Gallego and Lafortune, 2021; Alam and Pörtner, 2018). We provide evidence on the link between income and fertility outcomes on both the extensive and the intensive margin, and discuss how they relate to sibling rivalry in families.

Finally, our work relates to the literature studying parental investment in children in developing countries (Dunbar et al., 2013; Jayachandran and Pande, 2017). In particular, the results from our analysis speak to recent work highlighting the importance of intra-household inequalities in poverty status and children malnutrition. The presence of such disparities poses challenges for the targeting and effectiveness of anti-poverty interventions, which normally treat households as homogeneous units (Brown et al., 2017, 2018; de Vreyer and Lambert, 2018).[6] Our findings suggest that differences in income conditions at birth can create inequalities across siblings and hence exacerbate the targeting problem.

The rest of the paper is organised as follows. Section 2 discusses the theory that guide our micro-level empirical analysis. Section 3 describes the data we use. Section 4 presents the empirical strategy and the main results of our paper on children health and parental investments. In section 5, we explore the implications of our micro-level evidence for child health inequality at the regional level. Section 6 concludes.

2 Theoretical Background

Our objective is to study how variations in income during pregnancy affect the allocation of resources across siblings, and ultimately their health. To guide our analysis, we present a simple economic model of parental investment, which analyzes resource allocation across siblings over time in the absence of credit markets, and where the survival rate of children can vary. The

[6] Most of the papers studying child health inequalities focus on inequalities across households or groups with different socio-economic characteristics, but neglect possible intra-household disparities. An exception is Vogl (2018) who examines the evolution of overall (rather than between-group) inequality in child mortality and finds that children's deaths have become more concentrated on a few mothers over time.

formal model is presented in the appendix A. Here we convey the main intuition, which relies on the concepts of endowments and dynamic complementarities introduced in Cunha and Heckman (2007, 2009) and estimated in Cunha et al. (2010).[7]

Consider an economic framework where parents allocate resources across their children. Parents' utility increases with their children's number and 'quality', as proxied by their health. For simplicity, we assume that parents have two children. Each of them lives three periods: in period 1, the child is in utero or is a new born; in period 2, she lives with her parents and accumulates human capital; she becomes an adult and leaves the household in period 3. Assuming also that the household lives three periods, the two siblings overlap in the household only in the second period. The probability of surviving between period 1 and 2 depends on an exogenous component, as well as on reaching a minimum level of nutrition. In each period, parents face a trade-off between consumption and investments in nutrition and in the quality of each child. The optimal choice depends on the inter-temporal returns to investments – i.e., how investments in period 1 of a child affects the returns to her period 2 investments. In the presence of dynamic complementarities, the sign of this effect is positive: the returns to investments in period 2 of the child increase with the level of investments she received in the previous period.

Main Predictions. Competition for resources across siblings and preferences for the child born in 'good times' arise from the combination of dynamic complementarities and the staggered timing of births. Parents face unexpected variations in their income. Without access to lending and borrowing, they adapt their investment choices depending on the sign of the income variation. A higher income attenuates budget constraints and increases investments in all children living in that period. The increase in investment also implies an indirect effect for the child that is in her first period of life when the increase in income occurs: thanks to dynamic complementarities, a positive income variation increases investment also in period 2. Since investing in the child that experienced a positive early shock is more profitable, resources that remain available for the other child go down. We thus have a "sibling rivalry" effect (Godfray, 1995) in the parents' response to early income variations: investments in a child decrease with the income level received by his siblings in early life.

To summarize, children born in a high-income period are expected to receive higher investments and realise better health outcomes than their siblings. Because resources are directed toward the children born in high-income periods, siblings born in later periods receive a lower investment and their health outcomes are worse. These testable predictions can be written in the following two propositions, which proofs appear in the appendix:

Proposition 1 [Income variations and child health]: *Better income conditions occurring during the early life of a child increase the investments received by that child at all periods and, as*

[7] The model can be seen as an extension of the seminal framework of Behrman et al. (1982) to a situation with multiple periods, staggered births, income variations, but only two children. Similar to Behrman et al. (1982), having marginal returns to parental investments increasing in the children's initial endowment is a necessary condition for reinforcing investment strategies.

a result, that child's quality.

Proposition 2 [Income variations and sibling rivalry]: *Better income conditions occurring during the early life of a child decrease the investments received by subsequent children, and as a result, their quality.*

Non-linearities. Income variations have a nonlinear effect. First, the rivalry effect coming from older siblings is attenuated by the own in utero income received by the child. In other words, parents divert less resources away from a child who receives a higher income in early life. This is driven by a higher survival probability combined with dynamic complementarities. Both increase expected investment in the second period and, thus, the overall interest in investing in younger children. Our empirical analysis will further explore this interaction effect between siblings' and own child in utero income variations. Second, because we assume that the human capital production function has decreasing returns, our model predicts that the marginal impact of the income variation realized in utero weakens with the size of the shock.

Younger siblings. Proposition 2 is about the rivalry of elder children with respect to the younger ones. In the appendix we derive complementary predictions on the expected impact of the presence and income of *younger* siblings on investment and health of the elder ones. We show that a shock occurring in their first period of life (i.e., the effect of a shock in period 2 on the investments received by the first child in the same period) affects the investment in the first child non-monotonically, with a positive average effect. If the income shock is not high enough to guarantee survival, the extra income will be shared among the already born children – i.e., the sibling effect would in this case be positive. If, instead the shock is high enough, the rivalry effect coming from younger sibling kicks in and the income effect on elder siblings turns negative once the survival threshold is overcome. Given that we do not have clear prediction on the effect of younger siblings, we separate the in utero prices received by older and younger siblings and concentrate on older siblings, though we also show and discuss the results obtained for younger ones.

Key assumptions. Our theory assumes that investment in children is costly, so that the trade-off when deciding towards which child resources should be diverted is driven by budgetary constraints. Importantly, the costs of parental investments can be both monetary and non-monetary. Existing literature and data on immunization coverage suggest that the vaccination and intervention measures that we use in the paper indeed relate to a costly trade-off that the parents face when allocating resources across children. In their review of the literature, Dupas and Miguel (2017) and Dupas (2011) identify both monetary (liquidity constraints and lack of access to credit)[8] and non-monetary (time to travel to the clinic and unreliability of the supply) costs as

[8] As we discuss in the appendix, under complete financial markets, investments should no longer depend on temporary income variations and our predictions should not hold: in particular, an income shock should have a positive effect on the human capital accumulation of all siblings.

important factors explaining the low take-up of preventive healthcare like child vaccinations in developing countries. In our sample, only 62 % of children between one and five years old have received the WHO required doses (given their age) of Polio, DPT, BCG and measles vaccinations that we use as health investments. The fact that coverage is far from universal or from herd immunity levels indicates that the choice of vaccinating a child implies using parental resources. Similarly, though providing vitamin A supplement is recognized "vital" by the WHO, only slightly more than half of our samples' children have ever received it in our sample.

3 Data

Our predictions relate child health and parental investments to parental income variations. Testing them requires data on (i) health indicators, and health investments at the individual (child) level; and (ii) income variations that are exogenous to health and to parental behavior. The appendix section B provides additional details about the sources and the construction of the data.

3.1 Individual data

Our baseline data on child health, mortality and other individual and household characteristics come from the Demographic and Health Surveys (DHS).[9] We restrict our analysis to country waves containing information on the geo-location of households. The GPS coordinates in the DHS data permit us to link the individual data to the separate data used to construct the local income variable. This restriction leaves us with 54 countries, surveyed between 1986 and 2016; 34 are African countries, 8 are in Latin American, 10 in Asia and 2 in (Eastern) Europe. A map showing the countries covered and the location of the households appears in the appendix, section B.5. Table A.1 contains the number of survey waves, mothers and children for each country in the dataset.

The data include information on the characteristics of household members, primarily the mother and children. Note that the DHS is not a panel: each household – hence child – appears only once in the data. This however is not a problem for our purposes, as we are interested in the effect of income variations within households, across children of the same mother. The repeated cross-section nature of the database implies that we cannot look at the co-evolution of investment and outcome measures for a given child. We remedy this limitation by estimating the impact of in utero income on health outcomes and parental investments at different periods in life (at infancy and during school age), while controlling for the dynamics of the income variable in other periods than the in utero ones.

Child health. We make use of two types of health information: data on anthropometric indicators (height-for-age, weight-for-age) and on child survival at the time of the survey. Anthropometric measures are available only for children under five years old. We therefore restrict

[9] https://dhsprogram.com/Data/

our baseline sample to these children, i.e. a little more than 1,000,000 born from about 760,000 mothers aged between 13 and 49 at the time of the survey. We use as baseline anthropometric indicators weight and height (in logs) divided by their respective age- and gender-specific population means. In robustness exercises, we also use under-weight (under-height), defined as weight (height) being at least three standard deviations below the age- and gender-specific population mean. Population means are sourced from the WHO.[10]

Health and other investments. The DHS data contain detailed information on early-life parental investments in the health of their children. As for the anthropometric indicators, information is available for children under five years old at the time of the survey. We use information on vaccines against Polio, diphtheria-pertussis-tetanus (DPT), tuberculosis (BCG) and measles, as well as medication (vitamin A, deworming) and duration of breastfeeding. In the case of vaccinations, we construct dummy variables which equal 1 if the child has received the number of doses recommended by the WHO, given her age.

Though we also show the results using each of the specific health outcomes and investments, in our baseline estimations we consider indexes which take into account several dimensions of child health or health investments in a "family of outcome" fashion (Kling et al., 2007 – see Lowes and Montero, 2021 for a similar index using DHS data for vaccinations). The first index accounts for both height and weight for age: it is an average of two continuous measures of height and weight, computed relative to the WHO reference values, and standardized. The second index considers jointly six health investments – the vaccination status for DPT, Polio, BCG and measles, breastfeeding, provision of deworming treatment and of vitamin A. Finally, survival is measured by whether the child is alive at the time of the survey. In robustness checks, we consider each health and investment indicator individually and include also measures of underweight and stunting and other mortality indicators.

Other variables. The surveys also contain a rich set of demographic and socio-economic variables, which we use in our empirical analysis. At the child level, we use information on age (in months), gender, birth order, a twin dummy, and school attendance. At the mother or household level, we keep information on age, education, and wealth.

LSMS. We also show results using The Worldbank's Living Standards Measurement Study (LSMS-ISA)[11] data on a subsample of five Sub-Saharan African countries. We restrict to the country-waves that have information on the geolocalization of households, the date of birth of children and anthropometric data. These restrictions leave us with 5 Countries: Ethiopia, Malawi, Nigeria, Tanzania and Uganda. We use these data for two purposes. First, to check that our main results on child health hold using different household data. Second and more importantly, because the LSMS data, though of lower quality when it comes to child health, includes

[10]https://www.who.int/childgrowth/standards/en/

[11]https://www.worldbank.org/en/programs/lsms/initiatives/lsms-ISA

information about parental time use. In particular, most of the country waves record the number of hours household members spend doing activities in the household (i.e. collect water and firewood for the household), taking care of livestocks and doing other household agricultural activities. They also collect detailed data on labour market participation. We use these measures to study how parents – mothers and fathers – allocate their time in reaction to price variations.

3.2 Income variations

Our analysis requires income variations that are exogenous to local conditions and are not expected to impact health directly. The "fetal origin" literature has used exposure to a number of external events (e.g., infectious diseases, extreme weather shocks), usually within a single country and at a specific point in time. Given our focus on poor and often agriculture-oriented countries, we exploit local exposure to changes in world prices of agricultural commodities, as predicted by agro-ecological land characteristics, to identify variations in available income. This type of proxy enhances the validity of the empirical strategy for a wide set of developing countries where agriculture is still a major source of household income.[12] Previous work has indeed successfully applied a similar strategy to test for the effects of income variations on local conflicts (Berman and Couttenier, 2015; McGuirk and Burke, 2020).

To construct a local index of world crop prices, we divide each country of our sample in cells of 0.5×0.5 degrees (roughly 55×55km at the equator). For each of these cells, we compute the suitability of the cell to grow each of the crops for which we have world prices. Land suitability is taken from the FAO's Global Agro-Ecological Zones (GAEZ). These data are obtained from models that use location characteristics such as climate information (for instance, rainfall and temperature) and soil characteristics. This information is combined with crop characteristics to generate a global GIS roster of the suitability of a grid cell for cultivating each crop. The main advantage of this data is that crop suitability is exogenous to changes in local conditions and world demand, as it is not based on actual production. World price data is available from the World Bank for 15 'crops': banana, barley, cocoa, coconut, coffee, cotton, maize, palm oil, rice, sorghum, soybean, sugar, tea, tobacco, wheat. For each cell and year, we compute the following price measure:

$$\mathrm{P}_{kt} = \sum_{p} s_{pk} \times P^{W}_{pt} \tag{1}$$

where s_{pk} is the suitability of cell k to grow crop p and P^{W}_{pt} is the monthly nominal world price of crop p at time (month) t (relative to its level in January 2010). In our baseline regressions we will average these prices across the months of pregnancy (in utero prices) and across other months to obtain average yearly prices that go back up to 10 years before the time of the survey. In a sensitivity check we will also use alternative data from the M3-CROPS database (Monfreda et al., 2008), which measures the share of total harvested area in a cell going to the

[12] An alternative solution would have been to use rainfall or other weather-related shocks as a shifter of local income. These variables, however, might impact health directly through the spread of diseases, or indirectly through channels other than income, e.g. through their impact on infrastructures.

production of crop p around the year 2000. By proxying actual production, this measure is less exogenous to world prices and local conditions (although it does not vary over time) than the GAEZ-based s_{pk}, but it could capture better the patterns of agricultural specialisation. Figure A.2 in the appendix plots the evolution of world prices of each of the crops in our data. There are considerable fluctuations over time – e.g., the two recent spikes related to the 2007-2008 and 2011-2012 world food price crises –, and the prices of different commodities, while being overall positively correlated, do diverge substantially during certain periods.

Interpretation of P_{kt}. Throughout our analysis, we interpret variations in P_{kt} as positively correlated to local agricultural and individual income – the usual interpretation in the literature. McGuirk and Burke (2020) provide direct evidence of the effect of such variations on farmers' income and self-declared poverty using individual data from the Afrobarometer. Berman and Couttenier (2015) show that these variations correlate positively with GDP per capita at the sub-national level. In Section C.1 in the appendix, we provide evidence consistent with Berman and Couttenier (2015) and McGuirk and Burke (2020) using our measure of P_{kt} and a variety of proxies for income from the DHS, the Afrobarometer surveys and the World Bank's Living Standard Measurement Surveys (LSMS). We also show that P_{kt} correlates significantly with nighttime lights at the cell-level, both across time and with country, across-cells. Overall our results suggest that parental income or living conditions are indeed positively correlated with variations in P_{kt}, at the cell and at the household levels.

We are also able to discard two potential alternative interpretations of P_{kt}. First, if production and consumption patterns are correlated in space, increases in P_{kt} could instead be interpreted as *negative* real income variations (increase in consumption prices). Our results are hard to reconcile with this consumption side interpretation. More importantly, we will show that our results hold when we split P_{kt} into two indexes for food crops and for cash crops only – even though cash crops are typically not consumed. We also find similar results using an alternative price index which is not only weighted by a cell's agricultural suitability, but also by the crop share in the country's total exports at the beginning of the period. Because export shares correlate with the production, confirming our results with this additional weighting of the crop prices bolsters our assumption that the price variable indeed captures positive income variations.

Another alternative interpretation is that P_{kt}, by affecting agricultural revenues, also impacts the revenues of local states, in particular through taxation, and in turn affects the provision of public goods, including healthcare or education. This would change the interpretation of our results. Though the countries in our sample typically have weak taxation capacity and centralized revenues, and though we include country $\times$ year fixed effects in our estimations, we cannot rule out this possibility *a priori*. In section C.1 we show that, if anything, our results are actually weakened in countries with better revenue mobilization. Country-specific indicators of tax revenues or government expenditures are also uncorrelated with our price variable.

3.3 Descriptive statistics

Table 1 reports summary statistics for the main variables used in the child-level empirical analysis. The data includes around 5600 cells of 0.5 $\times$ 0.5 degrees of latitute and longitude. In our estimation sample of households with children between 0 and 5 years of age, the average child is a little older than 2 and equally likely to be a boy or a girl. Women in our sample have large parities: the average child has three older siblings. Anthropometric indicators are non-missing for about 655'000 children. Underweight affects 6% of the children, while underheight (a measure of stunting) reaches 16% of the sample. Information on mortality is available for around 1,000,000 children who, if alive, would be between 0 and 5 years of age at the time of the survey.[13]

Table 1: Summary statistics

	Obs.	Mean	S.D.	1st Quartile	Median	3rd Quartile
Child-level						
Age (in months)	1078907	27.51	17.14	13.00	27.00	41.00
Female (dummy)	1078907	0.49	0.50	0.00	0.00	1.00
Birth order	1078907	3.43	2.39	2.00	3.00	5.00
Twin	1078907	0.03	0.17	0.00	0.00	0.00
Index health	661684	0.00	0.93	-0.52	-0.12	0.33
Index investment	923764	-0.09	0.77	-0.52	0.20	0.52
No Underheight	655314	0.84	0.37	1.00	1.00	1.00
No Underweight	655450	0.94	0.24	1.00	1.00	1.00
Heigth (cm)	655314	82.26	14.57	72.00	82.90	93.30
Weight (cm)	655450	11.10	3.73	8.40	11.00	13.60
Death at birth	1078907	0.03	0.16	0.00	0.00	0.00
Death 1st year	1078907	0.05	0.22	0.00	0.00	0.00
BCG (dummy)	687717	0.85	0.35	1.00	1.00	1.00
Polio (dummy)	554503	0.86	0.35	1.00	1.00	1.00
DPT (dummy)	681039	0.72	0.45	0.00	1.00	1.00
Measles (dummy)	682029	0.78	0.42	1.00	1.00	1.00
Breastfeeding>6m	674468	0.79	0.41	1.00	1.00	1.00
Deworming (last 3 months)	546838	0.37	0.48	0.00	0.00	1.00
Vitamin A (ever)	671279	0.55	0.50	0.00	1.00	1.00
Price index	1043536	0.945	0.271	0.660	0.984	1.139

Source: Authors' computations from DHS. GAEZ and World Bank data. See main text for data sources.

Table 1 also displays statistics on the health investments variables that we use in our empirical analysis. Breastfeeding duration is long on average, as 79% of children are breastfed for at least six months. Basic vaccinations such as those against tuberculosis (BCG) and measles are more common than medications such as deworming or Vitamin A supplements, though these are strongly recommended by the WHO. The investment index that we use in our empirical analysis is the average across these health investments measures. The health outcomes and investment variables are available for (slightly) different samples. We confirm our main findings

[13]Information on mortality is also available for children who would be older than 5 at the time of the survey, but we restrict to 0-5 years of age for consistency, as the rest of the health data and parental health investment variables are only available for those ages.

when we perform the estimation on the sample of children for whom we have both health and parental investment measures.

Within household variations. We are mostly interested in within household variation in child health – i.e., comparisons in the effects of the price variables across siblings. In section B.6 of the appendix, we show that a substantial share of the variations in our outcomes of interest are within mother, across children – 20% for the health index, 19% in the case of health investment, and as much as 35% for mortality. Among the investment indicators, vaccination status is found to vary less within-mother, breastfeeding more. In the last section of the paper, we quantify the aggregate implications of adjustments in these within-household variations across countries.

4 Income, child health and early life investment

4.1 Empirical strategy

The theoretical discussion in section 2 provides two main testable predictions. A higher income during the in utero period of a child: (i) increases her endowments, the investment she receives and therefore her health in subsequent periods; (ii) worsens the investment and health of her future siblings through competition effects. The effect of income faced by younger siblings in utero is a priori ambiguous. Our model also predicts that the income faced in utero by a child interacts with that faced by older siblings: positive variations faced by older siblings have a lower effect when a child faces a higher income in utero. Finally, to validate the model, we also test the assumption that income has a non-monotonic effect on health outcomes: the higher income, the lower the marginal increase in health.

In this section we present our empirical strategy to test these predictions. In our main estimations, we focus on health and parental investment during childhood (up to five years of life). Yet, we also investigate the effects of income on education outcomes for children between 5 and 18 years old, on the time that parents spend working outside the household (taken as a negative proxy for parental care and investment in children), and on the future fertility of the mother.

Effect of parental income variations on parental investments and child health. We want to study the effect of in utero income variations, proxied by world agricultural commodity prices, on parental health investments and child health, at birth and in subsequent periods.[14] Our focus on income during pregnancies follows the "fetal origin" literature that has highlighted the

[14] We chose to look at the reduced form relationship between income variations and child health. An alternative approach would have been an IV strategy in which in the first stage we instrument parental investment by income variations, and in the second stage we look at the impact of parental investment on health. However, the self-productivity aspect of health implies that health and investment are co-determined by income variations, thereby invalidating the necessary exclusion restriction.

unique effect of socioeconomic determinants during this period on health outcomes and parental responses later in life.

Denote by c a child, located in cell k and born in year t, month m. Consider the following specification:

$$Y_c = \alpha P^{\text{u}}_{c,k} + \mathbf{D'_c}\delta + \mathbf{FE} + \varepsilon_c \tag{2}$$

where Y_c is a measure of child health or health investment. $P^{\text{u}}_{c,k}$ is the average monthly price faced in utero by child c; D'_c is a vector of child or household characteristics; and **FE** are fixed effects. We are interested in the coefficient α, which estimates the effect of the price during the in utero period on the parental investments and health outcomes received by the child at the time of the survey (or before).

An issue with specification (2) is the persistence in prices over time, which threatens the causal interpretation of α. $P^{\text{u}}_{c,k}$ can correlate with both post-birth prices (up to the year of the survey) and prices before birth, all of which could in principle affect parental investment and child health. Our methodology controls for the full sequence of past prices, up to 10 years before the survey. Denote by $P_{c,k,t-i}$ the average monthly prices observed i years before the survey takes place. This price can be decomposed in three mutually exclusive components:

$$P_{c,k,t-i} = P^{\text{u}}_{c,k,t-i} + P^{\text{pre}}_{c,k,t-i} + P^{\text{post}}_{c,k,t-i} \tag{3}$$

where u denotes the prices of the in utero period of the child, and pre and $post$ are respectively prices before and after birth. $P^{\text{u}}_{c,k,t-i}$ is non zero only for children whose in utero period falls during year $t-i$, $P^{\text{pre}}_{c,k,t-i}$ is non zero outside the in utero period and if $t-i$ is before birth, and $P^{\text{pre}}_{c,k,t-i}$ is non zero if the year $t-i$ occurs after the birth of child c. Applying this decomposition to the specification in eq (2), we obtain:

$$Y_c = \sum_{i=0}^{5} \alpha_i \times P^{\text{u}}_{c,k,t-i} + \sum_{i=1}^{10} \beta_i^{pre} \times P^{\text{pre}}_{c,k,t-i} + \sum_{i=1}^{5} \beta_i^{post} \times P^{\text{post}}_{c,k,t-i} + \mathbf{D'_c}\delta + \mathbf{FE} + \varepsilon_c \tag{4}$$

The α_i coefficients provide the impact of in utero prices – up to 5 years after, given that our health and health investment data is available for children up to 5 years old, which we expect positive on health and health investment. The coefficients β_i^{pre} show the impact of prices pre-birth (where prices corresponding to the months of pregnancy for child c are set to zero before computing the yearly average), and β_i^{post} contains the effect of post-birth prices. For prices pre-birth we include lags for 10 years before birth, whereas for the post-birth period we can include prices up to 5 years before the survey, because the child c is at most 5 years old. Under the assumption that the circumstances during the in utero period play a special role, we expect the α_i coefficient to be larger than β_i^{pre}, which captures the income effect in other 'normal' periods before the birth of the child.

Sibling rivalry effects. Eq (4) only identifies the effect of own in utero prices on health, or health investment; it is silent about sibling rivalry. To investigate further these intra-household adjustments, we modify the specification (4) to isolate sibling effects. This allows us to directly investigate Proposition 2 from the theoretical framework: (subsequent) preferential investment in the 'sweet child' should decrease resources available for the other children.

To do so, we extract from $P^{\text{post}}_{c,k,t-i}$ and $P^{\text{pre}}_{c,k,t-i}$ the prices faced during the in utero periods of the siblings – older siblings in the case of pre-birth prices, younger for post-birth. This leads to our baseline specification:

$$Y_c = \sum_{i=0}^{5} \alpha_i P^{\text{u}}_{c,k,t-i} + \sum_{i=1}^{10} (\beta_i^{pre} P^{\text{pre}}_{c,k,t-i} + \beta_i^{S,pre} P^{\text{S,pre}}_{c,k,t-i}) + \sum_{i=1}^{5} (\beta_i^{post} P^{\text{post}}_{c,k,t-i} + \beta_i^{S,post} P^{\text{S,post}}_{c,k,t-i}) + \mathbf{D'_c}\delta + \mathbf{FE} + \varepsilon_c \tag{5}$$

This specification identifies sibling effects, controlling for post and pre-birth prices in 'normal' periods, i.e. in the absence of sibling in utero periods. When reporting the results, we concentrate on the average values of the α and β coefficients, for readability. We however perform quantification exercises showing how the effect varies with the number of siblings. As in eq (4), we expect the α^s coefficient to be positive and larger than the β^{pre} coefficients. A further comparison of the β_i^{pre} and $\beta_i^{S,pre}$ coefficients allows to assess how older siblings affect the impact of pre-birth prices (similarly for post-birth and younger siblings). The $\beta^{S,pre}$ coefficients should be significantly lower than their respective non-pregnancy counterparts. In the case of younger sibling the prediction is theoretically ambiguous, as discussed in section 2.

The term $\mathbf{D'_c}$ contains both child and household characteristics: child age (in months) dummies, gender, twin and birth order dummies. The gender and birth order dummies control for possible differential treatment of first borns, often in relationship with gender, and in sensitivity checks we account for the possible influences of these factors on the sibling rivalry effect. Though the anthropometric outcome variables are normalized by age- and sex-specific WHO reference values, the age dummies further control for the child height (and weight) age profile (Aiyar and Cummins, 2021). We also control for the number of children in the household, for mother's age (and its square), level of educational attainment (dummies for primary, secondary and tertiary education), for her household's wealth index provided by the DHS (dummies for the quintiles of the estimated wealth distribution), and for a rural-urban dummy.

FE includes cell fixed effects, as well as country$\times$year-of-birth dummies and month-of-birth fixed effects, to control for unobserved factors affecting child health that might be correlated with crop prices. The country$\times$year-of-birth fixed effects account for all country-wide shocks around the in utero period that might affect health, such as global economic conditions or civil wars. The month-of-birth dummies, on the other hand, account for potential seasonality.

Both child quality and parental investments indicators are recorded only for children up to five years old at the time of the survey. To further investigate the long-term consequences of income variations in early life, we use also the sample of children older than five (from 5 to 18 years of age at the time of the survey) and for whom we have information on school attendance.

Econometric and identification issues. We estimate all specifications using least squares; this is the preferred estimator, despite the fact that the dependent variables are sometimes binary or categorical, due to the large dimensions of fixed effects we include. Standard errors are clustered at the cell-level in the baseline. We will also reproduce all the baseline results allowing the error term to be spatially correlated, within various radiuses between 100 and 1000km, as well as serially correlated. There are additional threats to identification in eq (5), which we group into (i) selection; (ii) omitted variable; and (iii) measurement issues.

Selection issues: endogenous mortality and fertility. Our estimates may be affected by endogenous mortality or fertility. Part of such selection does not create a bias, but rather is a channel that affects sibling rivalry. A child who receives a low price in utero (i.e., lower $P^{S,pre}_{c,k,t-i}$ in eq (5)) is more likely to die and, as a result, subsequent children will receive more investment. Our estimates from eq (5) conflate the effect of sibling prices going through sibling mortality and the one going through sibling health, conditional on survival or on being born. Both effects are identified in our regressions because we include the in utero prices of all born siblings, including those who are not alive at the time of the survey. An open question is how much the overall effect that we find comes from sibling mortality – an issue we will investigate in section 4.4.

Beyond this interpretation issue, the effects on mortality and fertility open the door to the possibility that our estimation sample is selected endogenously on the basis of the in utero income variable. A higher in utero income for the elder siblings (or a lower in utero income for the own child) can lower parental investments below survival level for the child, who would not be observed in the sample. Similarly, as we will show in section 4.5, price variations affect subsequent fertility (i.e., the decision to have children). Theoretically, the way in which selective mortality and fertility affect our results is ambiguous. Selection may be driven by households that are more sensitive to income variations. In such case, children would exit more the sample in households that reallocate more resources following a given price change, or where child health responds more to income variations. Both the own price effect and the sibling rivalry effect would be attenuated in the selected sample, which would include children reacting less than average to income variations. On the other hand, if the children who are more affected by selection are less sensitive to income variations, our estimates would be magnified. This would be the case if households in which children are more likely to die (for example because they are closer to the subsistence level of consumption) are those that are less able or willing to reallocate resources after a change in income. Similar reasoning apply to fertility: a higher in utero price, by attracting future resources to the child, can lead the parents towards not having subsequent children. Depending on which households stop fertility – those more or less sensitive to income variations – our coefficients may be biased in either direction.

Empirically, we will gauge the importance of selective mortality and fertility by applying the "identification-at-infinity" method initially proposed by Chamberlain (1986) and Heckman (1990) (see Mulligan and Rubinstein, 2008 or Machado, 2017 for more recent applications). Chamberlain (1986) showed that if some individuals face an arbitrarily large probability of selection and the outcome equation is linear, then one can use these individuals to identify the effects of the covariates on the outcome of interest. In our context, this amounts to estimating our specification on samples selected on observed characteristics such that all children are alive (or born, in the case of fertility). In these samples, selection should not matter. Hence, if selection effects are substantial, we expect our results – in particular the sibling coefficients – to vary across samples. Such methodology allows us to study the actual direction of the bias caused by selection, if any.

Omitted variables and simultaneity. Another threat to identification in (5) is omitted variables that might correlate with world prices and affect child health through channels other than income. In our sensitivity exercises we control for various potential time-varying confounders, such as conflicts and weather shocks. We also check for the assumption that the countries in our sample take the world price of commodities as given.

Measurement error. The last source of potential bias comes from measurement error in our key regressor – the average price during the in utero periods. First, fluctuations in world prices may affect income with with some lag. This would introduce noise in our price variable and hence bias the associated coefficient towards zero. Another issue that can create classical measurement error and attenuate our estimates relates to the misreporting of the child month of birth in the DHS data. It has been shown that health indicators such as z-scores may be affected by such misreporting and systematically vary with the declared month of birth, although controlling flexibly for age through age-in-month dummies appears to mitigate greatly the problem (Agarwal et al., 2017). Our estimations also control for month-of-birth fixed effects, which should pick up potential month-specific variations in height-for-age or weight-for-age. It has also been shown that reporting errors mostly arise when enumerators do not see the health card of the child (Larsen et al., 2019). As an additional robustness, we will run the estimation on the subsample of children whose health card has been seen by the enumerator. Finally, because misreporting could introduce non classical measurement error if it somehow correlates with price seasonality, we will replace month-of-birth with country$\times$month-of-birth dummies to control for such seasonality. Overall, all these tests deliver results which are very close to the baseline, suggesting that our findings do not suffer from attenuation bias.

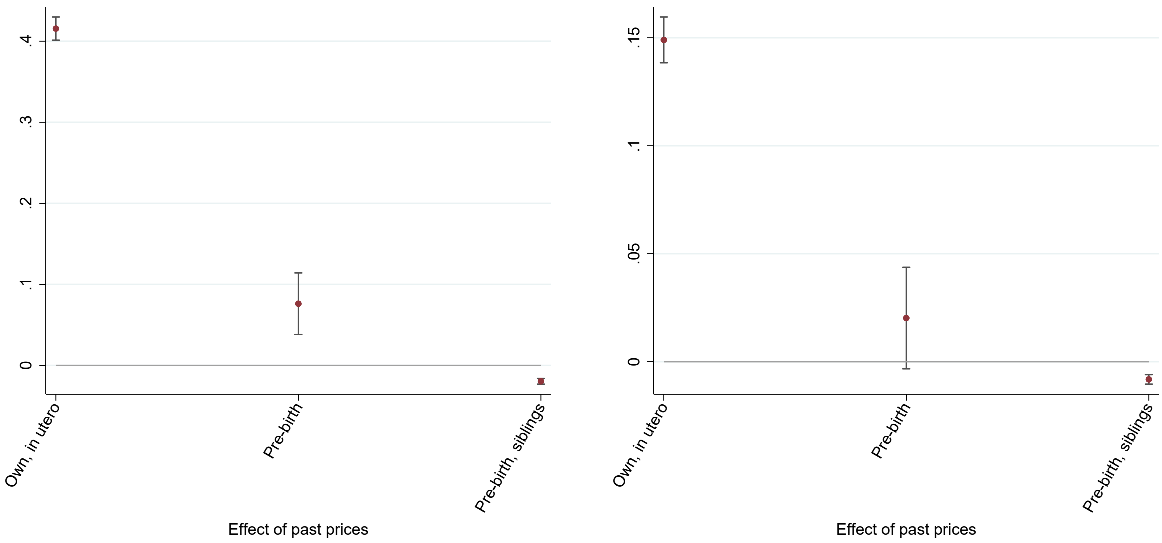
4.2 Results

Baseline results. Our main results are summarized in Figures 1.a and 1.b below, which plot the average coefficients α_i, β_i^{pre} and $\beta_i^{S,pre}$ across periods from eq (5). Table A.9 in the appendix shows the underlying estimates.

The first coefficient is the estimate of the effect of in utero price variation on child health (a) and health investment (b). We see that in utero income has a stronger effect than income during other pre-birth periods (second coefficient in both figures), supporting our first theoretical prediction derived in section 2. This result is also in line with evidence from the vast "fetal origin" literature. The implied magnitudes of the estimated coefficients are sizeable. An increase equal to the average standard deviation in the lagged prices during own in utero periods (i.e., the average standard deviations of P^u in eq (5), 0.42 in the child health estimation sample) leads to a 0.17 increase in health index, or 19 % of its standard deviation (0.93). The same standard deviation rise in the own in utero price is associated with a 0.06 increase in the investments index, i.e. 8 % of its standard deviation. Directly comparing these results with the ones found by the literature is made complicated by substantial differences in the methodologies and income proxies used. Those caveats in mind, the magnitude of our findings appear in line with existing research. For instance, Tiwari et al. (2017), using child-level data on Nepal, find that a 10% increase in rainfall is associated with a 0.13 standard deviation increase in weight for height for children age 0-60 months. Adhvaryu et al. (2019), on the other hand, consider data on Ghana and an income shifter similar to ours – cocoa prices in cocoa producing regions – but they focus on mental health. They find that a standard deviation increase in prices generates an improvement of mental health equivalent to 30 % of the standard deviation of their dependent variable.[15]

Figure 1: Baseline results: effect of price variations on child health and investments

(a) Child health (b) Health investments



Note: OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccine, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in utero prices ("Own, in utero", α in eq (5)), the prices before birth of the child and outside of any in utero period ("Pre-birth", β^{pre} in eq (5)), the in utero prices of older siblings ("Pre-birth,siblings", $\beta^{S,pre}$ in eq (5)). The bars represent 95% confidence intervals. The underlying regression is as in eq (5) and includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

[15] Their baseline coefficient – Table 2, col. 3 – is 0.045. The standard deviation of their "shock" variable is 2.01, and the standard deviation of the dependent variable is 0.31 (see their Table 1).

The third coefficient in both figures presents the estimates on the in utero prices received by older siblings ($\beta^{S,pre}$ in eq (5)). It provides strong evidence for a sibling rivalry effect, which is the main prediction of our theoretical framework. The average coefficient is negative and significantly smaller than the effect of prices during other pre-birth periods. This result suggests that an increase in income affecting a child impacts negatively subsequent investments on future children and their health outcomes. While the point estimates appears small, it has to be multiplied by the number of siblings (2.7 on average) to assess the magnitude of the impact. Doing so implies that a standard deviation increase in the in utero price for older siblings (0.29) reduces the child's health index by 0.015, which amounts roughly to 10 % of the effect of the own in utero price of the child (on average – we explore below the nonlinearity of the effect). The figures are similar in the case of health investment – again the effect of prices faced by older siblings in utero is on average roughly one-tenth of the effect of own in utero prices.

The sign of the impact of the in utero prices received by younger siblings varies across specifications (appendix Table A.9), but it is always significantly lower than the effect of prices during other post-birth periods (itself comparable to the effect of own in utero prices). In other words, we observe a sibling rivalry effect also from younger siblings: a higher income post-birth has a lower positive effect – or even a negative effect in the case of investments – when around the birth of a sibling.

The effects on child survival are summarized in Figure A.3 and Table A.9 in the appendix. Qualitatively, these are similar to the ones on health outcomes and parental investments, though the coefficient on pre-birth prices outside in utero periods is less precisely identified. These findings corroborate the sibling rivalry predictions, which can also go through mortality. Note that we obtain similar findings using alternative mortality indicators – mortality at birth or in the first year (appendix Table A.11). Interestingly, here again the effect of own in utero income is comparable in magnitude to that found by the literature. Bhalotra (2010), using Indian data find that mortality is countercyclical, and that a median drop in state-level GDP per capita decreases first-year mortality probability by 0.2 percentage point. As a comparison, we find that a standard deviation decrease in the in utero prices triggers a 0.018 percentage point drop in first year mortality (using the coefficient from Table A.11, panel A, row 5).[16]

Our results are largely confirmed when we use the specific health and investment outcomes rather than the aggregate indexes. As shown in Table A.11 in the appendix, the in utero price of

[16]This also suggests that our crop price index correlates well with income and GDP per capita. As mentioned earlier, the results reported in section C.1 of the appendix further support this view. We find that the elasticity of nigthttime lights to the crop price index is around 0.87-0.90. Recent literature (Hu and Yao, 2022) finds the elasticity of nighttime lights to GDP to be around 1.3. Though this number is obviously to be taken with caution (and may depend on the country and aggregation level), this would suggest that a 1.5% increase in our crop price index would be equivalent to a 1% increase in local GDP. Applying this conversion to our estimates, we obtain that a 45.3 % increase in income during pregnancy (this is the implied income effect of a average standard deviation increase in the price index) is associated with a 0.19 standard deviation increase in the health index at the time of the survey. This purely suggestive number implies an effect that is slightly larger than in Carneiro et al. (2021), who find that an unconditional cash transfer amounting to a 85 % increase in the mother's monthly income in Northern Nigeria during pregnancy leads to a 0.2 standard deviations increase in the child's height-for-age after two years (our implied effect on height-for-age only has the same size as the one on the health index, which combines height and weight for age).

siblings systematically has a negative impact on health and parental investments. This result is also obtained using two additional health indicators – being underheight (a measure of stunting) and underweight – two alternative mortality indicators – being dead at birth or in the first year of life – and each of the subcomponents of the health investment index – DPT, Polio, BCG and measles vaccines; breastfeeding, vitamin A intake and deworming.

So far, the results presented averaged coefficients of the lagged variables from eq (5). By averaging across coefficients, we aim to capture the central tendency in the effects of interest, whereas each single coefficient can suffer more from multicollinearity. Table A.10 in the appendix shows the estimated coefficients on the lagged prices from eq (5). The coefficients are more volatile, which is expected as prices lags are quite correlated, but in the case of the in utero prices of older siblings, negative and significant coefficients are observed even at long time horizons (9 years of lags on health, 8 years on health investment).[17]

Nonlinearities. Our theory also features two corollary predictions, both related to the nonlinearity of the own and sibling income effect: (i) the higher the income faced by a child, the lower the marginal increase in her health; (ii) the income shocks faced by older siblings have a weaker effect when a child faces a higher positive shock in utero. To test the first prediction, we replace in eq (5) the lagged prices corresponding to the pregnancy periods for older siblings and to the pregnancy period of the child by their respective means across time, and we add squared terms for both means. We still controls for sets of annual pre-birth prices in other periods, the in utero prices of younger siblings, and the post-birth prices outside pregnancy periods. The outputs of this estimation are shown in columns (3) and (4) of Table 2: the effect of both prices decreases as the level of prices increases. This result validates the shape of the production function assumed in the theoretical model.

To test the second prediction, we estimate a third specification in which we interact the two averages mentioned above. The positive and significant coefficient on the interaction term shown in columns (1) and (2) of Table 2 confirms the theoretical prediction. The negative sibling rivalry effect on health outcomes and parental investments becomes weaker with the price received in utero by the child. Figures A.4 and A.5 in section C.2 of the appendix visualize how the negative sibling effect increases with the (average) in utero price received by the child. For both the health specification and the health investment specification, it approaches zero for values above the 90th percentile of the in utero price received by the child.[18]

Gender and Preferences for first-borns. Preference for first borns (Black et al., 2005; Booth

[17] We also observe that the sibling effects tend to be stronger at recent time horizons, and to decrease as one moves back in time. This suggests that our results are not affected by savings or credit, that we assume away in the theory. If income could be saved in the short-run, we would expect the sibling rivalry to be attenuated – the opposite of the results shown in Table A.10.

[18] In our theoretical framework where we shut down intertemporal income effects, these results are consistent with our assumption that the human capital production function has decreasing returns. Clearly, if we relax the impossibility of savings, or if we allow for the possibilities of household public goods, our sibling rivalry effect would be attenuated. However, unless very speci c functional forms of the public good production function are assumed, this effect should hold at any price level and cannot explain non-linear effects.

Table 2: Non-linearities

Dep. var.	(1) Health	(2) Investments	(3) Health	(4) Investments
In utero prices (own)	0.339[a]	0.181[a]	2.380[a]	1.145[a]
	(0.033)	(0.022)	(0.151)	(0.101)
Squared			-0.873[a]	-0.418[a]
			(0.068)	(0.043)
In utero prices (old siblings)	-0.081[a]	-0.038[a]	-0.184[a]	-0.028[a]
	(0.014)	(0.010)	(0.014)	(0.010)
Squared			0.137[a]	0.015[b]
			(0.012)	(0.008)
In utero price, own × siblings	0.054[a]	0.025[a]		
	(0.012)	(0.008)		
Observations	501057	733338	501057	733338
R^2	0.445	0.422	0.445	0.422
Child controls	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes
Fixed effects	Cell, country × year-of-birth, month-of-birth			

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child is the average across lagged prices observed during the pregnancy period. In utero prices of older siblings is the average across lagged prices observed during in utero periods for older siblings. All regressions include post-birth prices and pre-birth prices in non-pregnancy periods, as well as post birth in utero prices. "Child health" is the average of the standardized, age- and gender-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, of polio vaccine, of BCG vaccine, of measles vaccine, a dummy for having received vitamin A supplement, and a dummy for receiving deworming treatment in the last three months. "Survival" is a standardized dummy equal to one if the child is alive at the time of the survey.

and Kee, 2009; Iacovou, 2008) could magnify the rivalry effect of income-related prices received by older siblings. In section C.3 of the appendix, we dispel this concern by computing alternative versions of the older siblings' prices, which exclude the prices faced by first-borns. The results are inconclusive – prices are significant for both first born children and others, and the magnitude is not bigger for first born children. Similarly, preferences for boys (e.g. Bhalotra and Cochrane, 2010; Jayachandran and Kuziemko, 2011; Jayachandran, 2015) could affect our results, possibly through selection. In section C.3, we test whether the price faced by elder brothers have a stronger rivalry effect than prices faced by elder sister. The estimation results show that it is not the case. They are in line with the literature because they show that most of the countries in our sample do not present behaviours consistent with the existence of preferences for boys(Anderson and Ray, 2010; Rossi and Rouanet, 2015; Baland et al., 2022).[19] Digging

[19]Baland et al. (2022) provide a new technique for assessing the presence of the stopping rule that does not relies on natural sex ratio. According to their estimates only seven countries in our sample (Albania, Armenia, Bangladesh, Egypt, Jordan, Pakistan and Tajikistan) have children until the desired gender composition is reached, so that girls end up having more younger siblings than average. This behaviour is considered to be induced by a

deeper in the understanding of gender differences in reaction to the variations in prices, we also look at fertility outcomes: in this case, we find weak evidence of gender-biased preferences as the sibling rivalry effect is slightly less prominent for girls than for boys (section F.3).

4.3 Sensitivity analysis

Our main findings are robust to a large battery of sensitivity checks. The details of each exercise appear in section D of the appendix.

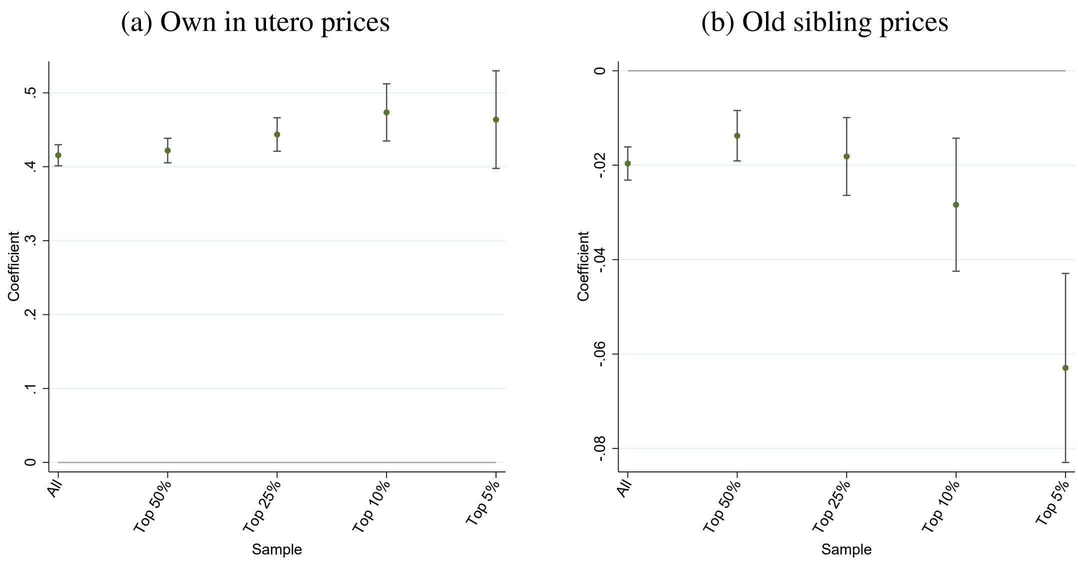
Endogenous mortality and fertility. Our findings so far suggest that in utero prices affect significantly the probability of survival. Furthermore, we show below additional results indicating similar effects on fertility. As mentioned in section 4.1, the effect of sample selection due to endogenous mortality or fertility – i.e. the fact that some children are not observed in the sample – is a priori ambiguous. In section D.1 of the appendix we investigate whether and how our results are affected by endogenous selection. We apply the identification-at-infinity method in the following way. In the case of mortality, we first estimate our baseline specification (eq (5)), using a survival dummy as dependent variable. The predictions are then used to define subsamples with differing survival probabilities, on which we re-estimate our baseline specification. The results obtained in the case of child health are shown in Figure 2. The appendix figure A.6 and Table A.14 contain the full set of results, also for health investments. In each figure we start by reporting the coefficient observed in the full sample (i.e. our baseline coefficient), before progressively restricting the sample to children with higher survival probabilities, i.e. those in the top 50%, 25%, 10% and 5% of the sample in terms of predicted survival probabilities. In the latter, survival rates are high enough to ensure that all children are indeed observed, and that selection on mortality is not affecting the results. We find that the estimates (of both the own and the sibling prices) get bigger, in absolute terms, as we move to samples with increasing survival probability. This is particularly the case for sibling coefficients. This suggests that our baseline results, if anything, tend to underestimate the magnitude of the sibling effects due to endogeneous selection: the selected sample contains children for whom sibling rivalry is not strong enough to trigger exit. Note however that, though slightly stronger in the low mortality samples, the magnitudes of the coefficients remain within the same order of magnitude (-0.02 to -0.06 in the case of child health in Figure 2.b, around -0.01 in the case of health investments in Figure A.6.d).

We perform a similar exercise for fertility. We first estimate the probability that a child is born at the time of the survey, and use the predicted probabilities to construct samples in which selection on fertility is less and less likely.[20] The results, shown in Figure A.7 and Table A.15,

preference for boys. In other seven countries (Cambodia, Cameroon, Colombia, Liberia, Mali, Mozambique and Nigeria) boys have a larger number of younger siblings, suggesting that a preference for girls may be present.

[20] The methodology is presented in details in the appendix section D.1. Using the birth history of each child, we construct a child-level panel which allows estimating the probability of being born for each child of the sample, controlling among others for mother fixed effects. As discussed in the appendix, investigating the effect of selection

Figure 2: Effects of price variation on health, by subsamples of increasing survival probability



Note: OLS estimation. The unit of observation is a child. The dependent variable is the average of the standardized and age-adjusted child weight and height (both in logs). In figure (a) the dots are averages across coefficients for the child in utero prices. In figure (b), the dots are averages across coefficients for the in utero prices of older siblings. Samples are defined according to the child's survival probability as predicted by our baseline specification. The regressions include child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

show little evidence of a clear directional bias induced by endogenous fertility. The sibling effects are similar in the baseline sample and in the sample with the highest fertility probability. The own price effects are slightly lower, though not significantly different across samples.

Omitted variables. We have assumed so far that world prices fluctuations are exogenous to the local conditions observed in the cells present in our sample. However, if countries or regions of our samples are price-makers, their local conditions could affect world prices at the same time as they impact parental investment decisions and child health. We first control directly for a set of time-varying cell-level characteristics – specifically rainfall, temperature and conflict incidence – that may correlate with our price index and affect child health or parental investments. The results, which appear in section D.2, confirm our baseline findings. We also include alternative sets of fixed effects in section D.3. Second, in the appendix D.4, we show that the countries we consider are small from a world perspective, which makes the endogeneity problem unlikely; and that dropping the cells with the highest market power has little effect on our estimates.

Measurement error. A problem with the DHS data is that anthropometric indicators such

on fertility is more complex than in the case of mortality. The problem comes from the fact that we cannot observe the universe of children who are not born: we can estimate the probability of a child being born at the time of the survey (and hence included in our sample), but within the universe of children who will eventually be born, and within mothers who have a positive number of children.

as height or weight-for-age tend to correlate with age (Cummins et al., 2017). The inclusion of age (in month) dummies as controls in our baseline regressions solves the issue as it accounts for any non-linear relationship between age and our health indicators. Another issue comes from measurement error in the reporting of month of birth, which may be country-specific (Agarwal et al., 2017, Larsen et al., 2019). Because reporting errors have been shown to mostly arise when enumerators do not see the health card of the child, in appendix D.5 we confirm the baseline findings on the subsample of children whose health card has been seen by the enumerator.

Spatially correlated errors. The structure of our data and estimations make it likely that the error term exhibits spatial correlation (Conley, 1999). In section D.6 of the appendix, we allow for spatial correlated sequentially within radiuses of 100, 500, or 1000km.[21] Though there is an increase in the standard errors, it is limited and the significance level of our coefficients of interest remains way above conventional thresholds.

Cross-country heterogeneity. In section D.7 we check the stability of our results across the 54 countries of our sample, by estimating our baseline regression (5) country by country. The sign of the average effects is largely confirmed across countries: the effect of the prices during pregnancy periods of older siblings is never positive and significant, and remains negative for most of the countries. The one on the own child in utero price variable becomes negative and significant only in 10% (for health outcomes) and 18% (for parental investment outcomes) of the countries.

Other robustness. Other exercises include: (i) dealing with potential migration by restricting our sample to a subset of the households that did not migrate since the birth of the child (section D.8); (ii) using an alternative measure of agricultural specialization from the M3-CROP database (Monfreda et al., 2008) (section D.9); (iii) checking that our results are unchanged when restricting the estimation to the sample of children for which both the health index and the investment indexes are available (section D.10). The results of all these tests are qualitatively similar to the baseline ones.

4.4 Interpretation and discussion

We have so far interpreted our results as suggesting that variations in the world prices of locally produced crops during in utero periods, through their effect on parental income, affect child health, hence investment in the child as well as investment and health of future siblings. This assumes that our crop price variable is a local income shifter, and that parental investments mediates the health responses. This interpretation also does not consider the role of siblings' mortality. This section discusses these issues.

[21] The estimations in this section are based on the STATA package *acreg* developed by Colella et al. (2019). All estimations also allow for infinite serial correlation.

Sibling mortality and sibling rivalry. Our estimates conflate two effects. First, conditional on survival, prices variations in utero affect health investment and child quality, and subsequently the investment in future siblings. Second, in utero price variations may affect mortality. Low prices may trigger death, which frees up resources and diminishes sibling rivalry.[22] Our model and baseline empirical results are consistent with both channels: our estimates encompass the effect of siblings mortality, as we include in utero prices, regardless of whether the siblings are alive at the time of the survey. In appendix E.1, we try to gauge how much of our baseline estimates come from the sibling selection channel. To do so, we compute child-specific survival probabilities using eq (5), as in the correction for selective mortality (section 4.3). We then restrict the sample to children whose elder siblings have a high survival probability – similarly to what we did in Table A.14, except that the samples are now defined according to the survival probability of elder siblings rather than of the child himself. We find that the sibling effects are indeed slightly smaller in the samples unaffected by sibling mortality. This is consistent with the idea that sibling rivalry partly goes through mortality. However, even in the more restrictive sample where sibling survival probabilities lie in the top 5 percentile, the coefficients are quite similar to our baseline: -0.017 versus -0.020 in the case of health ; -0.007 versus -0.008 in the case of investments. Hence, though sibling rivalry is affected by mortality, the contribution of selection appears moderate.

Correlation between child health and parental health investments. In our theoretical framework, in utero prices have both a direct impact on child quality and an indirect impact on child health through differential parental investments across siblings. Our empirical methodology does not allow to cleanly estimate how much of the impact of prices variations channels through parental investment. We can however perform two suggestive tests, which both appear in the appendix E.2. First, we regress the child health index and its components on the investment index for the same child, and on the same index averaged across siblings. Table A.26 shows a significant correlation between health outcomes and parental investment in the child, and, importantly, a negative association with the parental investments received by the child's siblings, which corroborates the competition mechanism that is at the core of our analysis. Interestingly, the relationship between health investments and health measures is nonlinear, as predicted by our theory (Table A.27). Second, we directly control for the investment index in our baseline health index specification. We find that our main coefficient of interest (own in utero prices, old siblings in utero prices) are 5-15% smaller than in the baseline (Table A.28). Of course, none of these results should be taken as causal – e.g. because child health and investments are jointly determined, yet they suggest that our measures of parental investments correlate with

[22] A discussed in section 4.3, high prices during the in utero period of the elder siblings could also lead to the death of subsequent children. As shown in Table A.9, the negative survival effect of siblings' prices is larger (in absolute value) than the positive effect of the own child in utero prices. This implies that selection through sibling rivalry may be more important than selection through the own price, thus explaining why (i) conditional on survival, the siblings' prices have an effect that is an order of magnitude lower than that of own prices; and (ii) correcting for selection is more important for the effect of old sibling prices than that of the own child prices (see Figure 2).

child health and can channel at least partly the effects of in utero prices.

Income versus consumption shock. Our empirical strategy and results are consistent with the interpretation of the variation in the crop price index as a shifter of local income. The alternative approach would be to think of our price variable as affecting households as consumers. This would however imply that child health deteriorates with exposure to higher prices of the supposedly 'consumed' crops, which counters our baseline findings. Our estimates could still provide a 'net' effect that masks the counteracting influence of the price of some consumed crops. To check for this possibility, we perform three distinct empirical exercises.

First, we assess whether our findings are indeed weaker for households whose income should depend less on the price of agricultural commodities. In particular, we identify "urban" households as those that are classified as urban in the DHS and that report not owning agricultural land or performing other activities than agriculture as their main source of income.[23] The estimates from our baseline specification on our urban subsample are shown in the appendix, section E.3. While the results go overall in the same direction as the ones obtained in the full sample[24], we find substantially smaller and statistically insignificant effect of old sibling in utero prices.

Another exercise consists in splitting our price index (eq (1)) into two components: the price of "cash" crops (as defined by McGuirk and Burke (2020) — in our sample: cocoa, coffee, cotton, tea and tobacco), which should be mainly for production, and the other crops, which could be also consumed. In the appendix section E.4 we report the results from a specification where we include the lagged variables separately for the two types of crops. Using our baseline measure of agricultural specialization from GAEZ, we find that both cash crops and food crops prices do have a significant effect on child health and parental investment. The impact tends to be stronger for cash crops in the case of child health, and smaller in the case of parental health investment. Though intuitively, cash crops should be more likely to affect income through international prices fluctuations, there are limitations. First, though cash crops are more likely to be exchanged, those that we define as food crops – e.g. maize, rice, etc. – may also be. Second and more importantly, the GAEZ data that we use to compute crop suitability considers "potential yields". It can thus underestimate the weight of cash crops in production: because cash crops are more profitable, they may be produced even when agricultural suitability is relatively low. Indeed, when we perform the same exercise using actual production data from M3 crop data instead of GAEZ, the results are much clearer: the own child and sibling effects are significantly stronger for cash crop than food crop prices.

Finally, we compute an alternative price index that reflects the country specialization. More precisely, we use the country-level crop share of agricultural exports computed from FAOSTAT

[23] We depart from the urban classification of the DHS, which varies over time and across countries and is not entirely relevant to our purpose. For instance, among the household considered urban in the DHS for which occupation data or land ownership data are available, 27 % say that they work in agriculture or own agricultural land.

[24] We do not expect to find null results on the urban sample as increases in agricultural income is likely affecting individuals outside the rural areas, i.e. intermediaries, sellers, traders, etc.

at the beginning of our sample (before 2000) as an additional weight in the local price index – where world prices are also weighted by the crop share of local land suitable for cultivation as in eq (1). Export-oriented crops are less likely to be mainly consumed domestically and hence variation in their prices can be considered mainly an income shock. Section E.5 in the appendix reports the results of a specification where we include the sets of lagged prices as in eq (5) and the same sets of the lagged export-weighted prices. Both the positive own and the negative sibling price effects are stronger when we consider the export-weighted prices, which give more weight to crops whose export sales (and hence the income channel) are more important.

4.5 Other parental investments

Our conceptual framework discusses the drivers of parental investment in children's health within the family. Similar mechanisms should nonetheless apply to other types of parental investments affecting children quality and hence the parents' objective function.

Allocation of parental time. Besides health investments, time spent with children is another costly parental input in early life that can have durable effects on the development of children. Because the DHS does not include proxies of time use that could serve our analysis, we turn to the World Bank's LSMS. The LSMS contains data on the allocation of parental time for 5 countries of our sample.[25] In the absence of information on the time spent by parents with children, we resort to labour market proxies: how much time the parent spends working within the household, or outside. Working outside the household can be considered an activity that takes time away from children, whereas spending time in household activities is interpreted as having more opportunities to be with children. The data allows to construct two proxies: (i) the number of hours worked in the household over the last week; and (ii) whether the individual worked outside the household over the last week. Section B.2 in the appendix provides more details on the construction of the dataset. We then estimate the following model:

$$Y_{h,k,t} = \sum_{i=0}^{10} (\beta_i^u P^{\mathrm{u}}_{h,k,t-i} + \beta_i^{nu} P^{\mathrm{nu}}_{h,k,t-i}) + \mathbf{D'_h}\delta + \mathbf{FE} + \varepsilon_h \tag{6}$$

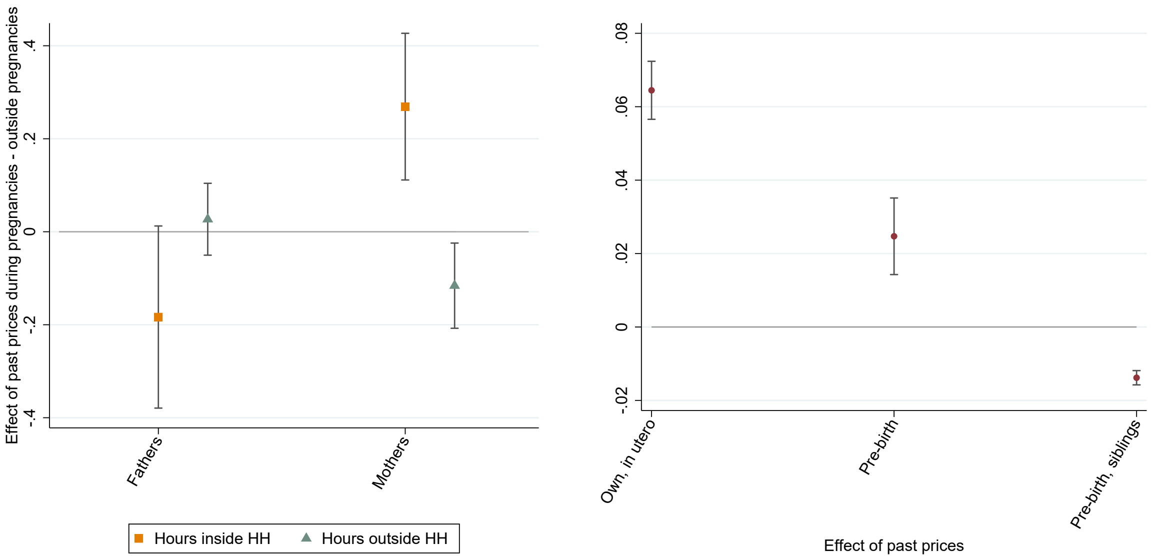
The unit of observation, h, is the household member, which can be a mother or a father. Y identifies hours worked inside the household, or the probability of working outside. The outcome variable is standardized and regressed on two sets of 10 lags of the cell-level (k) price index: P^{u}, which equals the average yearly local price index in periods where the mother was pregnant, and zero otherwise; and P^{nu}, which corresponds to the average yearly local price index in periods outside pregnancy, and zero otherwise. $\mathbf{D'_h}$ includes a set of parent-level control variables (age of the mother, of the father, and dummies for the number of childre). We also include cell fixed effects and dummies for the month and country-year of the survey.

[25] For these countries, data on child health that resembles the DHS is available, and we can check that our main results also hold. The results appear in appendix F.1. Though the sample is different and much smaller, we find results which are very similar to our baseline.

We are interested in the difference between β^u and β^{nu}: do past variation in prices affect the household members' time use differently when they occurred during in utero periods – i.e., when they affected child quality? This difference is plotted in Figure 3.a, separately for mothers and fathers (the detailed results and robustness analysis appear in the appendix F.2). Exposure to positive crop prices during in utero period induces intra-household specialisation, which is mostly driven by mother's adjustment. The estimates show that fathers tend to work more outside the household after the birth of the higher quality child, but the effect is not statistically significant. Mothers, on the other hand, spend significantly more time at home and less working outside the household when they experience "good" prices during pregnancy periods. Insofar as we interpret these proxies as correlated with time spent with children, our results suggest that time is another input that parents – particularly mothers – allocate strategically towards the higher quality children.Note that, because the working time information is not child-specific, we cannot estimate directly sibling rivalry effects in the way we do for parental investments in children health through the specification in eq (5).

Figure 3: Results: effect of price variations parental time use and child schooling

(a) Parental time use (b) Child schooling



Note: OLS estimations, standard errors clustered at the cell level. Figure (a): The unit of observation is the individual. Coefficients computed from the estimation of eq (6). The outcome variable is the standardized: (a) hours spent on activities within the household (denoted by squares), (b) the probability of working outside the household (denoted by triangles). The points denote the average difference between the β^u (effect of prices during in utero periods) and β^{nu} (effect of prices outside in utero periods). The underlying regression controls for the age of the mother and the age of the father and dummies for for the number of children of the mother. All regressions have cell, country-(survey)year and month fixed effects. Standard errors are clustered at the cell level. See Table A.34 in the appendix for detailed estimation results. Figure (b) The unit of observation is a child who is at most 15 at the time of the survey. The outcome variable is an indicator for school attendance. The dots are averages across coefficients for the child in utero prices ("Own, in utero", α in eq (5)), the prices before birth of the child and outside of any in utero period ("Pre-birth", β^{pre} in eq (5)), the in utero prices of older siblings ("Pre-birth,siblings", $\beta^{S,pre}$ in eq (5)). The underlying regression is as in eq (5) but ran on the sample of children aged 5-18, with up to 15 years of lags of prices, and includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural, and cell and country-(survey)year fixed effects.

Education. While health investments and parental time are inputs that may be particularly important in the very early life of children, education is a crucial investment later on in their life. Most of the research in economics on parental investments has indeed focused on education (see e.g. Almond et al., 2018, Francesconi and Heckman, 2016). In Figure 3.b (Table A.35 in the appendix shows the coefficients), we test whether our baseline results on health hold also for children's education. In particular, we use an indicator for school attendance for children in school age as outcome variable in our baseline regression model. Because the children observed in the sample are older (aged 5-18 at the time of survey) than the ones in the health regressions (at most 5 at the time of the survey), we include up to 15 lags of the price variable. The results show that children who received a higher income-related price at birth are significantly more likely to attend school, the effect being larger than that of lagged prices outside pregnancy periods. The reinforcing investment strategies found for health are thus confirmed for children's education. These results also speak directly to the assumption of dynamic complementarities in investments. While we do not observe parental investments at different ages for the same child, the fact that education investments react in the same way as earlier health ones to early-life income is suggestive of synergies between parental investments at different points in time during childhood. The results also confirm the siblings' rivalry effect coming from older siblings. Parents' investments in the 'strong' older siblings have a negative effect on school attendance of the child.[26]

Table 3: Effect of price variations on subsequent fertility investments

	(1)	(2)	(3)
Indicators		Fertility	
Dep. var.	Last child dummy	# future children	Future birth spacing
Past prices (exc. in utero)	-0.053^a	0.024^a	-0.343
	(0.002)	(0.001)	(0.242)
Past prices (in utero)	0.042^a	-0.037^a	2.672^a
	(0.001)	(0.001)	(0.211)
Obs.	3196848	3196848	2276968
Child controls	Yes	Yes	Yes
Mother controls	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child (aged 6 to 17 in columns 1 to 3). Standard errors clustered at the cell level in parentheses. All estimations include country $\times$ year-of-birth and month-of-birth dummies. Child controls include: gender, birth order, twin dummy, and dummies for age in years. Mother controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. Last child dummy is a dummy taking the value 1 if no other children is ever born from that particular mother in the subsequent years. # future children is the number of children born from that mother in the subsequent years. Future birth spacing is the average birth spacing observed in subsequent periods. ln crop price index is the log of the world price of the crops produced in the cell, weighted by the share of each crop in the area. Past prices (exc. in utero) is the average coefficient on the lags of past prices (up to 10 years), outside in utero periods. Past prices (in utero) is the average coefficient on the lags of past prices (up to 10 years) restricted to in utero prices.

Fertility. Price variations and child quality may also affect fertility decisions. Conditional on

[26] The negative and significant average coefficient on lagged prices during the in utero periods of older siblings is confirmed in 14 out of the 15 coefficients on the lagged prices during the in utero periods of older siblings – see Table A.36 in the appendix.

having a 'strong' child, mothers might delay having other children – i.e., increase birth spacing. In Table 3, we study how income conditions of previously born children affect women's fertility decisions. We consider the average income conditions observed in the early life of existing children, and three different outcomes: a dummy which equals 1 if no further pregnancy is observed in the future (up to the year of the survey – column 1); the number of children born in the subsequent years (column 2); and the average future birth spacing in months (column 3).[27] The results clearly show that the effect of past prices variations depend on whether they occurred during past children's in utero periods or not. In general, positive price variations tend to favor fertility – the probability of having children in the future (col 1) and the number of future children (col 2) increase. When faced during in utero periods, however, the effect is reversed: mothers are more likely to stop having children, to have fewer children, and to delay subsequent pregnancies. These findings reconcile within a unitary household framework the results found in the literature on the relationship between income and fertility for malthusian and post-malthusian economies (see Chatterjee and Vogl, 2018 for differences between short term and long term time horizons): the income effect dominates when shocks are unable to affect the quality of a child, while the substitution effect dominates when shocks affect the initial endowment and subsequent human capital accumulation of children.

Overall, higher income during in utero periods are thus associated with increased parental effort in current children at the expenses of further reproductive effort, and such higher income lead to higher quality (i.e., higher investments in the child born during good economic times) and lower quantity (i.e., lower likelihood of having children and longer birth spacing).

5 Aggregated Child health inequality

The results of our empirical analysis suggest that changes in income – triggered by crop prices variability – widen health disparities across siblings. How much does this within-household adjustment matter at the aggregate level? What is the importance of the intra-household dimension compared to inequalities across households? In this last section, we try to provide a partial answer to these questions, which are important when it comes to the targeting of poverty reduction policies: these often take (under)nutrition at the household level as a key poverty indicator under the implicit assumption that economic and nutritional outcomes are uniform within the household.

We start by computing a measure of within-household child health inequality using underweight and underheight indicators (the subcomponents of our health index). We categorize each child as "undernourished" if she is either underheight or underweight at the time of the survey, and classify households in three categories: (i) those where all children are undernourished; (ii) those where part of the children are undernourished; and (iii) those where none of the children

[27] We include the birth spacing after the last observed child, computed as the number of months between the last birth and the month of the survey.

is undernourished. We then compute the share of households falling in each category at the level of the administrative region (*Admin2*), within country. An increase in within-household inequality in child health (relative to between-household inequality) should lead to a higher share of households where children have different nutritional status. We restrict our sample to countries featuring at least two DHS surveys, as we want to understand changes in aggregate inequality over time. The data contains 3505 administrative regions located in 30 countries. The appendix G reports some descriptive statistics. Within household child health inequality is substantial: on average, in 26% of the households, some, but not all children are undernourished - and this share varies between 8 and 39% depending on the region.

Our objective is to study how variations in prices faced during in utero periods translate into higher level of aggregate inequality, especially within household. To do so, we compute the average price faced in utero by the cohort of children born in region r in the five years preceding the survey date, $\overline{P}^{u}_{r,t}$. We limit the horizon to five years because we only observe child health up to five years of age.

We then estimate the following specification:

$$\Delta \text{Share}_{rt} = \alpha |\Delta \overline{\text{P}^{u}}_{r,t}| + \beta \Delta \mathbf{D'_{rt}} + \mu_t + \gamma_n + \varepsilon_{rt} \tag{7}$$

Where Share_{rt} denotes one of our measures of child health inequality: the region-specific share of households with all, no, or some children undernourished. Δ denotes the first-difference operator. The coefficient of interest is α which identifies the association between changes in child health inequality and changes in the average in utero price across cohorts. We take first differences and use the absolute value of the price change because our theory and previous child-level results imply that changes in prices during in utero periods magnify health inequality within-household regardless of the direction of the change: parents invest more (less) in the child born under better (worse) income conditions; differences in child health widens when income fluctuates more. Hence, $|\Delta \overline{\text{P}}^{u}_{r,t}|$ is interpreted here as a measure of in utero price volatility. The first-difference specification wipes out time-invariant factors that are specific to region r. We also control for the changes in a set region-specific characteristics $\mathbf{D'_{rt}}$, which include the regional child sex ratio, share of twins, and average number of children per household. In our robustness we also control for the absolute change in the average price observed in five years before the survey, to ensure we identify the effect of price variations in utero.[28] Finally, our estimations include country fixed effects γ_n and (average) year of birth dummies μ_t to control for aggregate trends.

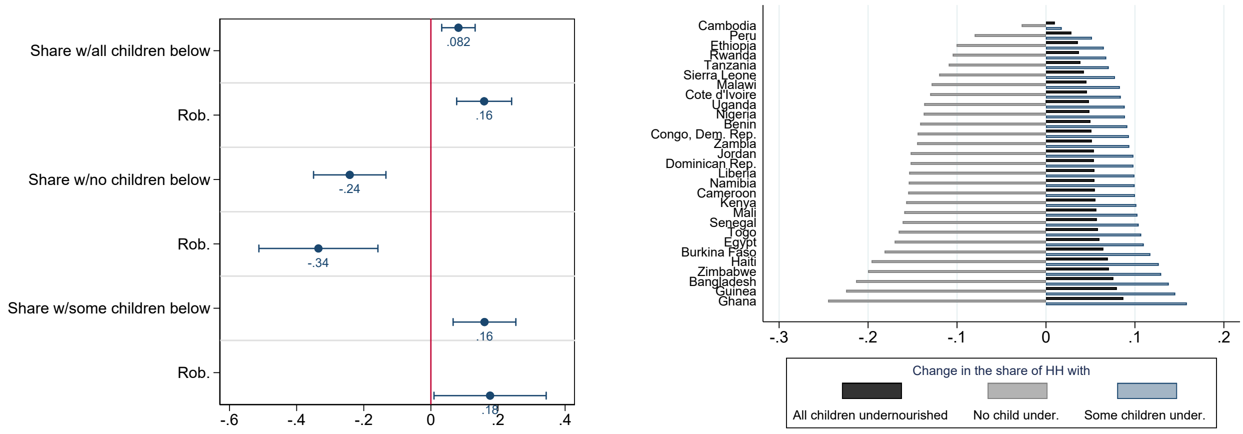
The results of estimation (7) are provided in Figure 4.a – the full estimates are reported in Table A.39 of the appendix. The figure depicts the estimated coefficient (α) on $|\Delta \overline{\text{P}^{u}}_{r,t}|$ in our baseline specification, and in a robustness check where we control for the change in the average price observed over the previous five years, including non in utero periods. Because the household categories are mutually exclusive, the sum of the coefficients across category

[28] Alternatively, we have controlled for individual prices faced by children during their fist, second, third and fourth year; the results are similar.

shares must equal zero. The results show that price volatility makes intra-household health inequality relatively more prevalent: the share of households where only some children suffer from malnutrition increases with variations in average prices that children faced in utero.

Figure 4: Exposure to world crop prices and child health inequality at the macro level

(a) Estimation results (b) Counterfactual exercise



Note: Figure (a) reports the coefficient on the crop price variable – the absolute value of the (changes in) average prices faced by the cohort of children born in region r in the five years preceding the survey date, during the in utero period – i.e. α^D in the baseline regression (7). The "Rob." specifications replace country dummies with country-year-of-survey fixed effects. All regressions include: changes (in absolute value) in average prices faced by children in their second, third, and fourth year of life; changes in average age in months, proportion of female children, of twins, and average number of children per household; and year-of-birth dummies. Bars represent 90% confidence intervals. Figure (b) reports the result of the following counterfactual exercise. (1) estimate eq 7; (2) predict ΔShare_{rt} using actual data; (2) predict ΔShare_{rt} assuming that $|\Delta\overline{\text{P}^u}_{r,t}| = 0$; (3) average the predictions by country under each scenario (4) plot the average difference between the two scenario's predictions.

To illustrate the importance of income variations for within-household inequality, we use the previous estimates to perform a counterfactual exercise. We compute the predicted changes in each shares under two scenarios: using the actual price changes; and under a counterfactual situation where there was no change in average crop prices in utero – i.e. $|\Delta\overline{\text{P}^u}_{r,t}| = 0$ in eq (7). This is equivalent to an hypothetical situation where two consecutive cohorts of children faced the same in utero prices within a region. Under each scenario, the region-level predictions are then averaged across regions within countries to convey country-level predicted household category shares.[29]

The results of the counterfactual analysis are shown in Figure 4.b. The figure shows the contribution of in utero price volatility to the child health inequality. Price variations increase the share of 'mixed' households, where healthy and malnourished siblings co-exist, and reduce the share of 'no-undernourished' households. The average region in our sample has 10 percentage-point higher 'mixed-household' share when we include the effect of price volatility,

[29]While indicative of the size of the effects, this exercise rests on some approximations. In particular, we are using estimates that exploit within-country variation to obtain predictions at the country level. This would create bias in our predictions if crop suitability in one region affects exposure in neighbouring regions – e.g., if higher suitability of one region to produce high-price crops makes also producers in neighbouring regions with lower suitability more exposed to world prices. For this reason, we treat the results of the exercise as suggestive of the magnitudes involved.

relative to a situation without any changes in crop prices in utero. Variation across countries arise from differences in crop specialisation and time periods. This is substantial, given that the average of share of mixed-household is 0.26 (appendix table G). The spatial variation for Africa is plotted in Figure A.23 in the appendix. We estimate substantial differences across countries. The smallest increase in within-household inequality is found in Cambodia and Peru, and the strongest increase is observed in West African countries such as Ghana and Guinea.

6 Concluding remarks

In this paper, we provide novel evidence on how fluctuations in local economic conditions can shape the way parents allocate resources across siblings. Geo-localised survey health data for 54 developing countries are matched with measures of local exposure to world prices of crops, whose variation affects agricultural income, a major source of total income in the developing world. Our empirical analysis relies on variation in crop prices during pregnancy across siblings.

The results point to strong positive effects of early exposure to high prices on children's health and parental investments. The improvements in health and investments received following a positive income variation are partly at the expense of the other siblings. This siblings rivalry effect is stronger and more robust from older than from younger siblings. The negative effect from the in utero prices of older siblings weakens with the in utero price received by the child. Education and fertility react in a similar way – in particular, mothers slow down or stop their fertility after the birth or 'high quality' children. These findings imply that parental income variations affect child health inequality acting through a widening of disparities within the household. Results from aggregate regressions at the regional level confirm this – income fluctuations during pregnancy increase the fraction of households where healthy and undernourished children live together.

The empirical evidence provided in this paper gives rise to two important considerations about the effectiveness of anti-poverty policies that seek to reduce children's malnutrition. First, the child-level results suggest that parents might use the support received (e.g., in the form of cash transfers) to favour the 'strongest' child, who might not be the one in need. The policy would thus aggravate child health inequalities, whose reduction is one the United Nations Sustainable Development Goals.[30] Second, the evidence at the regional level indicates that income fluctuations can make policy targeting more problematic as they are associated with a higher prevalence of households where only some children are in need of support. If targeted, these households would allocate relatively more resources towards children who are not in need. These reasons call for greater scrutiny in the delivery and monitoring of anti-poverty policies in rural households that are exposed to substantial income fluctuations.

[30] http://www.undp.org/content/dam/undp/library/corporate/brochure/SDGs_Booklet_Web_En.pdf

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Sweet child of mine:
Parental income, child health and inequality
Online Appendix

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Contents

A Theoretical Appendix

We present here a simple theoretical framework that highlights the conditions under which variations in household income occurring in the early life of a child have lasting consequences on the health investments she receives. This framework also allows us to study investment externalities across siblings and their impact on child quality.

A.1 Environment

Consider a representative household consisting of a married couple (the parents) with children. Parents allocate resources across children and over time. To characterise the parents' problem, we build on seminal models of children human capital accumulation, parents' optimal investment decisions, and sibling externalities (Behrman et al., 1982; Cunha and Heckman, 2007, 2009; Almond and Currie, 2011; Yi et al., 2015; Almond et al., 2018). As our objective is to study the effect of income fluctuations on investment at different stages of children's life, we extend these frameworks to incorporate a time dimension in investment decisions.

Assume for simplicity that the parents have two children, and have no access to credit or saving facilities. We distinguish three stages in the life of a child. Stage 1 represents the early life period (i.e., in utero and birth): parents need to decide how much income to devote to the child's nutrition and health, given income and competing expenditures. In stage 2 the child still lives with her parents who have to decide how much to invest in her human capital (health and education). Investments in period 1 and 2 determine the quality of the child that is realized in period 3, when she becomes and adult and does not depend on parents' resources anymore.

Children come in a specified birth order. The first child is alone with the parents during stage 1 of life; in stage 2, she overlaps with the second child, who is in his stage 1. So, overall, the household lives 4 periods – the last one being when the quality of the second child is realized.

Children Survival. To reflect the situation of many rural areas in poor countries, we allow for child mortality. In particular, each child is assumed to be alive in her first period of life. Survival to the second period is assumed to depend on endogenous and exogenous factors. Endogenous factors are linked to parental investment: parents need to give a minimum level of nutrition to the child so that she stays alive in the next period. We define this as being the minimum level of investment (nutrition) N^0 that the child needs so that $\psi(N^0)$ (the probability of not dying from starvation) is equal to 1, with $\psi(N) = \{0, 1\}$. Survival can be determined also bye exogenous factors: children survive between period 1 and period 2 with probability π, assumed to be the same for the two children.

Human capital production function. As in Almond et al. (2018), and following Cunha and Heckman (2007), the quality of children production technology is given by a two-period Constant Elasticity of Substitution (CES) function:

$$h_c = A\left[\gamma(I_c^{p1})^{\frac{(s-1)}{s}} + (1-\gamma)(I_c^{p2})^{\frac{(s-1)}{s}}\right]^{\frac{s}{(s-1)}}$$

where $I_c^{p_1}$ and $I_c^{p_2}$ are the investments parents make into child $c = (c1, c2)$ in period 1 and 2 of their life. Specifically, these are investments on top of the minimum level N_c^t that parents have to provide in period $t = (p1, p2)$ to ensure the survival of child $c = (c1, c2)$. Since we are interested in the long-term effect of early life shocks, the parameter s, the elasticity of substitution between $I_c^{p_1}$ and $I_c^{p_2}$, is key. We derive results for $s = 0$, implying that the two investments are complements.

If $s = 0$, the production function takes on a Cobb-Douglas form:

$$h_c = A(I_c^{p1})^{\gamma}(I_c^{p2})^{1-\gamma}$$

The specific functional form we use embeds some assumptions: first, since $\frac{\partial^2 h_c}{\partial I_c^{p_2} \partial I_c^{p_1}} > 0$, we are assuming dynamic complementarities in investment, meaning that the returns of the second-period investment increase with first-period investment. Also, as the "fetal origin" literature has shown, health investments during early life are particularly important for further development (see Almond and Currie

(2011) for a review of this literature) – we assume that $\gamma > \frac{1}{2}$.

Parents' preferences and budget constraint. Parents value investments as long as they guarantee child survival and increase quality. Investment is traded-off against parental consumption. In particular, the expected inter-temporal utility function of the parents has the following form[4]:

$$u = \alpha(\log(C_1) + \log(C_2) + \log(C_3)) + \beta E(\log(n+1)) + \pi\psi(N_{c1}^{p_1})\psi(N_{c1}^{p_2})h_{c1} + \pi\psi(N_{c2}^{p_1})\psi(N_{c2}^{p_2})h_{c2}$$

where $\beta E(\log(n+1))$ is the expected gross benefit of having a certain family size (Jayachandran and Kuziemko, 2011) in the last period of life of the parents (when they are old), n is the number of alive children, h_c is the benefit of having a child of a certain quality, and $\alpha \log(C)$ is the utility parents get form consumption (related to the opportunity cost of investing in children). $\frac{\alpha}{\beta}$ measure the weight of consumption relatively to family size in the parents' utility. Time is denoted with subscripts for consumption, and with superscripts ($p1$ and $p2$) for the minimum level of nutrition that child 1 (N_{c1}) or child 2 (N_{c2}) needs for survival. The number of children n can be between 0 and 2, depending on the survival of the two children (the elder child is alive in period 3 if she is alive in 2, even though no investment has to be made in her at that point).

Since we are interested in how competition about resources affects investment across children, we assume that parents have no inequality aversion in children quality.[5]

Parents face the following budget constraints:

$$C_1 + p(N_{c1}^{p_1} + I_{c1}^{p_1}) \leq Y_1$$
$$C_2 + p\left(N_{c1}^{p_2} + N_{c2}^{p_1} + I_{c1}^{p_2} + I_{c2}^{p_1}\right) \leq Y_2$$
$$C_3 + p(N_{c2}^{p_2} + I_{c2}^{p_2}) \leq Y_3$$

where p is the aggregate cost of human capital investment in children.

We first assume that income is fixed over time, i.e. that $y_1 = y_2 = y_3 = \overline{y}$, and then see what impact an increase in income in the first period has on the quality of both children. We also assume that parents lack access to lending and borrowing, implying that they adapt their investment and consumption choices to the sign of the income shock. A positive income shock attenuates budget constraints and increases investments in all children living in that period. To solve the model we use backward induction from period 3 to period 1.

A.2 Parental optimal investment and realised quality

This simplified model allows us to derive some standard predictions about the relationship between birth rank, parental investments, and competition for resources across siblings.[6] As we will see below, since investment in the first period of life of a child has higher returns and that the first child is alone in his period of life, her realised quality is higher. This is due to the fact that the lower investment in the first child in period two is less important than the lower investment in the second child in period one. This prediction refers to the "siblings' rivalry" effect: a child born at a later birth order has (by definition) more older siblings and, thus, has to compete more for resources.[7]

We then consider the effects of a positive income realization $y_t > \overline{y}$ occurring in period 1 on investment in period 1 and 2 for one child, keeping the income of the other period fixed and equal to $\overline{y}$.[8]

[4]Since we are ruling out savings and credit, we assume the discount factor equals 1.

[5]Our theoretical predictions still hold for a moderate level of inequality aversion.

[6]In the literature, there is a well-established negative relationship between birth-order and education in developed countries (Black et al., 2005), while there is some evidence on the relationship working in the opposite direction in developing countries (De Haan et al., 2014; Baland et al., 2016).

[7]The "siblings' rivalry" effect has been shown the be particularly detrimental for high birth rank girls (Garg and Morduch, 1998; Pande, 2003).

[8]All the results hold in a symmetric way for a negative shock.

Without access to lending and borrowing, parents adapt their investment choices depending on the sign of the income shock. A positive income shock attenuates budget constraints and increases investments in all children living in that period. The increase in investment also implies an indirect effect for the child that is in her first period of life when the increase in income occurs: thanks to dynamic complementarities, a positive income shock increases the productivity of investment also in period 2, and more resources are devoted to that child at the expenses of the second child. Since investing in the child that experienced a positive early shock is more profitable, resources that remain available for the other child go down. We thus have what is defined as a "sibling rivalry" effect in the investment response to early income shocks: the child born in 'worse times' receives less investments and hence is of worse quality than her sibling.

A.3 Lemmas, Propositions and Proofs

A.3.1 Parental optimal investment and realised quality without income fluctuations

Lemma 1. *Whatever the income of the parents, they always invest in the first child if they invest in the second child.*

Proof.

We solve the model by backward induction.

Period 3. If the second child receives nutrition in period 2 and survives to period 3, to decide the optimal second period investment $I_{c2}^{*p_2}$ in child two, the parents face the following first order condition:

$$\begin{array}{rcll} -\frac{1}{\overline{y}-I_{c2}^{p_2}-N_{c2}^{p_2}}+(1-\gamma)A(I_{c2}^{p_1})^{\gamma}(I_{c2}^{p_2})^{-\gamma} & = & 0 & \text{if} \quad N_{c2}^{*p_2}=N^0 \\ -\frac{1}{\overline{y}-I_{c2}^{p_2}} & = & 0 & \text{otherwise} \end{array} \tag{8}$$

The investment decision depends on whether the child is alive, which is in turn determined by the 'nutritional' investment N – this is what gives the endogenous survival probability $\psi(N)$. To decide whether to ensure subsistence, parents compare their indirect utility with or without the nutritional investment. In period 3, we have to distinguish two cases: the cases in which the first child survived to the last period, and the case in which he did not.

If he did not survive, parents compare $\alpha\log\left(\overline{y}-N^0-I_{c2}^{*p_2}\right)+\beta\log(2)+h_{c2}^*$ to $\alpha\log(\overline{y})+\beta\log(1)$. Instead, if the first child survived, the parents compare $\alpha\log\left(\overline{y}-N^0-I_{c2}^{*p_2}\right)+\beta\log(3)+h_{c2}^*$ to $\alpha\log(\overline{y})+\beta\log(2)$. In both cases, the optimal nutritional investment is $N_{c2}^{*p_2}=N^0$ unless $\overline{y}$ is particularly low. Furthermore, in period 2, parents were facing a very similar optimization problem but with a tighter budget constraint and some risk with respect to the realisation of the investment. So if $N_{c2}^{*p_1}=N^0$ in period 2 (as it is necessarily the case if the child is alive in period 3), it follows that $N_{c2}^{*p_1}=N^0$ is optimal.

Period 2. Knowing that if the child is alive in period 3, parents will invest in her, we now analyze optimal investment in the two children in period 2. Again, we can distinguish two cases: whether child 1 is alive or not.

For nutritional investment, when the first child is not alive, the parents compare

$\alpha\log\left(\overline{y}-N^0-I_{c2}^{*p_1}\right)+\pi\beta\log(2)+\pi h_{c2}^*$ to $\alpha\log(\overline{y})$. For levels of incomes sufficiently high the optimal nutritional investment is $N_{c2}^{*p_1}=N^0$.

When the first child is alive, the parents need to decide which one to feed or both, so the comparison is modified as follow:

$$
\begin{array}{llll}
(1) & 2\alpha\log(\overline{y}) & \text{if} & N_{c1}^{*p_2}=0, \quad N_{c2}^{*p_1}=0 \\
(2) & \begin{array}{l}\alpha\log(\overline{y}-N^0-I_{c2}^{*p_1})+\pi\beta\log(2)+\pi h_{c2}^*+ \\ +\pi\alpha\log(\overline{y}-N^0-I_{c2}^{*p_2})+(1-\pi)\alpha\log(\overline{y})\end{array} & \text{if} & N_{c1}^{*p_2}=0, \quad N_{c2}^{*p_1}=N^0 \\
(3) & \alpha\log(\overline{y}-N^0-I_{c1}^{*p_2})+\beta\log(2)+h_{c1}^*(1)+\alpha\log(\overline{y}) & \text{if} & N_{c1}^{*p_2}=N^0, \quad N_{c2}^{*p_1}=0 \\
(4) & \begin{array}{l}\alpha\log(\overline{y}-2N^0-I_{c_1}^{*p_2}-I_{c2}^{*p_1})+\pi\beta\log\left(\frac{3}{2}\right)+\beta\log(2)+ \\ +h_{c1}^*(2)+\pi h_{c2}^*+\pi\alpha\log(\overline{y}-N^0-I_{c2}^{*p_2})+(1-\pi)\alpha\log(\overline{y})\end{array} & \text{if} & N_{c1}^{*p_2}=N^0, \quad N_{c2}^{*p_2}=N^0
\end{array}
$$

where $h_{c1}^*(1)$ and $h_{c1}^*(2)$ are the optimal human capital of child 1 when one or two children are alive respectively. Eqs (1) and (2) are clearly dominated by (3) as long as $\overline{y} > N^0$. To see whether the parents invest in both children or just in child 1 the relevant comparison is between (3) and (4). This can be rewritten as:

$$
\pi\beta\log\left(\frac{3}{2}\right)+h_{c1}^*(2)+\pi h_{c2}^*-\pi\alpha\log\left(\frac{\overline{y}}{\overline{y}-N^0-I_{c2}^{*p_2}}\right) \lesseqgtr \alpha\log\left(\frac{\overline{y}-N^0-I_{c1}^{*p_2}}{\overline{y}-2N^0-I_{c1}^{*p_2}-I_{c2}^{*p_1}}\right)+h_{c1}^*(1)
$$

When households are relatively rich (implying that N^0 is very small with respect to $\overline{y}$) the left hand side always dominate for level of π high enough: in this case, the parents invest in both children, as investing in two children dominates investing in one (from the first order condition of investment below). For lower levels of $\overline{y}$, the trade-off between investing in children and consuming becomes more salient, the more so the lower π. See Lemma 2 for a more detailed proof.

Conditional on providing the nutritional investment N^0, optimal investment in child 2 depends on whether the first child is alive. When he is not alive, optimal investment in period 2 I_{c2}^{p2} is determined by the following FOC:

$$
-\frac{\alpha}{\overline{y}-N^0-I_{c2}^{p_1}}+\pi\gamma A(I_{c2}^{p_1})^{\gamma-1}(I_{c2}^{*p_2}(I_{c2}^{p_1}))^{1-\gamma}+\pi(1-\gamma)A(I_{c2}^{p_1})^{\gamma}(I_{c2}^{*p_2}(I_{c2}^{p_1}))^{-\gamma}\frac{\partial I_{c2}^{*p_2}(I_{c2}^{p_1})}{\partial I_{c2}^{p_1}} = 0 \quad (9)
$$

that gives an interior solution for investment as long as $\overline{y} > N^0$.

When child 1 is alive, the FOC is modified as follows:

$$
\begin{array}{ll}
\left.-\frac{\alpha}{\overline{y}-N^0-I_{c1}^{p_2}}+(1-\gamma)A(I_{c1}^{p_1})^{\gamma}(I_{c1}^{p_2})^{-\gamma} = 0\right\} & \text{if} \quad N_{c2}^{*p_2}=0 \\
\left.\begin{array}{l} -\frac{\alpha}{\overline{y}-2N^0-I_{c1}^{p_2}-I_{c2}^{p_1}}+(1-\gamma)A(I_{c1}^{p_1})^{\gamma}(I_{c1}^{p_2})^{-\gamma} = 0 \\ -\frac{\alpha}{\overline{y}-2N^0-I_{c1}^{p_2}-I_{c2}^{p_1}}+\pi\gamma A(I_{c2}^{p_1})^{\gamma-1}(I_{c2}^{*p_2}(I_{c2}^{p_1}))^{1-\gamma}+ \\ +\pi(1-\gamma)A(I_{c2}^{p_1})^{\gamma}(I_{c2}^{*p_2}(I_{c2}^{p_1}))^{-\gamma}\frac{\partial I_{c2}^{*p_2}(I_{c2}^{p_1})}{\partial I_{c2}^{p_1}} = 0 \end{array}\right\} & \text{if} \quad N_{c2}^{*p_2}=N^0
\end{array} \quad (10)
$$

It follows immediately that, given the functional forms, the investment in the first child will always be positive and the investment in the second child is positive as long as $N_{c2}^{*p_2} = N^0$.

Period 1. Finally, in period 1, the parents determine the optimal investment in child 1 maximising their expected lifetime utility.

If the parents decide to provide the subsistence level of investment N^0, the optimal (additional) investment is given by the following FOC:

$$-\frac{\alpha}{\overline{y}-N^0-I_{c1}^{p_1}}+\pi\gamma A(I_{c1}^{p_1})^{\gamma-1}(I_{c1}^{*p_2})^{1-\gamma}+\pi(1-\gamma)A(I_{c2}^{p_1})^{\gamma}(I_{c1}^{*p_2}(I_{c1}^{p_1}))^{-\gamma}\frac{\partial I_{c1}^{*p_2}(I_{c1}^{p_1})}{\partial I_{c1}^{p_1}} \quad = \quad 0 \qquad (11)$$

that always gives interior solutions.

To decide whether to invest N^0 and assure the child's survival, they compare:

$$\alpha\log\left(\overline{y}-N^0-I_{c_1}^{*p_1}\right)+\pi\alpha\log\left(\overline{y}-2N^0-I_{c_1}^{*p_2}-I_{c2}^{*p_1}\right)+(1-\pi)\alpha\log\left(\overline{y}-N^0-I_{c2}^{*p_1}\right)+$$
$$\pi\alpha\log\left(\overline{y}-N^0-I_{c2}^{*p_2}\right)+(1-\pi)\alpha\log\left(\overline{y}\right)+\pi^2\beta\log\left(3\right)+2\pi(1-\pi)\beta\log\left(2\right)+\pi h_{c1}^*(2)+\pi h_{c2}^*$$

to

$$\alpha\log\left(\overline{y}\right)+\alpha\log\left(\overline{y}-N^0-I_{c2}^{*p_1}\right)+\pi\alpha\log\left(\overline{y}-N^0-I_{c2}^{*p_2}\right)+$$
$$+(1-\pi)\alpha\log\left(\overline{y}\right)+\pi\beta\log\left(2\right)+\pi h_{c2}^*$$

which reduces to:

$$\pi^2\beta\log\left(\tfrac{3}{2}\right)+\pi\beta\log\left(2\right)+\pi h_{c1}^*(2) \quad \lesseqgtr \quad \alpha\log\left(\frac{\overline{y}}{\overline{y}-N^0-I_{c_1}^{*p_1}}\right)+\pi\alpha\log\left(\frac{\overline{y}-N^0-I_{c2}^{*p_1}}{\overline{y}-2N^0-I_{c_1}^{*p_2}-I_{c2}^{*p_1}}\right)$$

Given that we have an interior solution for investment, this implies that $\pi h_{c1}^*(2)-\alpha\log\left(\frac{\overline{y}}{\overline{y}-N^0-I_{c_1}^{*p_1}}\right)>0$. Also, from the functional forms we know that since $I_{c2}^{*p_1}<I_{c_1}^{*p_2}$ it cannot be $2(\overline{y}-2N^0-I_{c_1}^{*p_2}-I_{c2}^{*p_1})<\overline{y}-N^0-I_{c2}^{*p_1}$ so that $\pi\beta\log\left(2\right)>\pi\alpha\log\left(\frac{\overline{y}-N^0-I_{c2}^{*p_1}}{\overline{y}-2N^0-I_{c_1}^{*p_2}-I_{c2}^{*p_1}}\right)$. This means it is it optimal for the parents to provide the first child with the subsistence level of nutrition. ■

We want to understand how investment varies with income and risk.

Lemma 2. *When income is low parents stop investing in children. When income decreases investment stops first for the second child and then for the first one.*

Proof.

For very low levels of income parents never invest in children. This happens when:

$$\pi\beta\log\left(2\right)+\pi h_{c2}^*(2) \quad < \quad \alpha\log\left(\frac{\overline{y}}{\overline{y}-N^0-I_{cj}^{p_1}(2)}\right) \qquad (12)$$

Let's now consider the case in which $\overline{y}>N^0$ but, in period 2, parents invest in the second child only if the first child does not survive. This occurs if

$$\pi\beta\log\left(\tfrac{3}{2}\right)+\pi h_{c2}^*(3) \quad < \quad \alpha\log\left(\frac{\overline{y}-N^0-I_{c_1}^{*p_2}(2)}{\overline{y}-2N^0-I_{c_1}^{*p_2}(3)-I_{c_2}^{*p_1}(3)}\right)+h_{c1}^*(2)-h_{c1}^*(3) \qquad (13)$$

and

$$\pi\beta\log\left(2\right)+\pi h_{c2}^*(2) \quad > \quad \alpha\log\left(\frac{\overline{y}}{\overline{y}-N^0-I^{*p_2}-I_{c_2}^{*p_1}(2)}\right) \qquad (14)$$

For this to happen there must exist a level of income $y(\pi)$ such that, for $y(\pi)>\overline{y}>N^0$, parents in period 2 invest only in child 1 and, for $\overline{y}>y(\pi)$, parents invest in both children. We show here that this level of income depend on π and decreases with π.

Let's first consider the case in which $\pi=1$. When income is low ($\overline{y}\leq 2N^0$) we showed above that investing in the first child always dominates investing in the second. When $\overline{y}=2N^0+\epsilon$, with $\epsilon\to 0$, $\overline{y}-2N^0$ is very close to 0 as well and investing in the second child is never optimal for any level of π.

On the other hand, when $\overline{y} \rightarrow \infty$, $\alpha \log \left(\frac{\overline{y} - N^0 - I_{c_1}^{*p_2}(2)}{\overline{y} - 2N^0 - I_{c_1}^{*p_2}(3) - I_{c_2}^{*p_1}(3)} \right) \rightarrow 0$. So, in this case of high income, when $\pi = 1$, the LHS is bigger then the RHS as $h_{c1}^*(2) - h_{c1}^*(3)$ also tends to zero. Finally, as both sides monotonically increase with income, there must be a unique level of income in which the LHS equals the RHS. Let's define this level of income $y(\pi = 1)$.

Let's now consider what happens when $\pi < 1$, for a given level of income $\overline{y} > y(\pi = 1)$. By definition, for this level of income, when $\pi = 1$ parents invest in both children. Instead, when $\pi = 0$, the LHS is always smaller than the LHS. Furthermore, from the envelope theorem, we know that $\frac{\partial u_p^*(3)}{\partial \pi} = h_{c2}^*(3) > 0$ while $\frac{\partial u_p^*(2)}{\partial \pi} = 0$, so there must exist a level of $\hat{\pi}$ such that for $\pi < \hat{\pi}$ investing in the nutrition of the second child is sub-optimal.

Finally, we show now that $\frac{\partial \hat{\pi}}{\partial \overline{y}} < 0$. This is because the cross-derivative of the parents' value function in period 2 with respect to income and π is positive when they invest in two children, while is equal to 0 when they invest only in child 1. So the point in which the RHS and LHS equate is reached faster when income is higher. ■

We now study how income variability affects optimal investment.

A.3.2 Parental optimal investment and realised quality with income fluctuations

Proposition 1. *A positive shock occurring in the first period of life of a child increases both first and second period investment on that child. Thus, adult quality increases following a positive income shock.*

Proof. We discuss here the case in which income is high enough so that investment in at least one child occurs. We start with a shock to the first child: the income realization in the first period is $y_1 > \overline{y}$ while, in the following periods, income realisations are equal to $\overline{y}$.

The effect of a positive income shock on investment in the first and second period for child 1 comes from the Equation 11 and Equation 10 . First, let's prove that, when the child is alive in period 2, $\frac{\partial I_{c2}^{*p_2}(I_{c1}^{p_1})}{\partial I_{c1}^{p_1}} > 0$: differentiating the $I_{c1}^{p_2}$ FOC in Equation 10 with respect to $I_{c1}^{p_1}$ we get that

$$\frac{\partial I_{c1}^{p_2}}{\partial I_{c1}^{p_1}} = -\frac{\frac{\partial^2 u_P}{\partial I_{c1}^{p_2} \partial I_{c1}^{p_1}}}{\frac{\partial^2 u_P}{\partial^2 I_{c1}^{p_2}}} = -\frac{(1-\gamma)\gamma A (I_{c1}^{p_1})^{\gamma-1} (I_{c1}^{p_2})^{-\gamma}}{\frac{\partial^2 u_P}{\partial^2 I_{c1}^{p_2}}} > 0$$

since the denominator is negative due to second order conditions for maximization, and all the terms of the nominator are positive.

Then, we look at how the first period investment varies with variation in income:

$$\frac{\partial I_{c1}^{p_1}}{\partial Y_1} = -\frac{\frac{\partial^2 u_P}{\partial I_{c1}^{p_1} \partial Y_1}}{\frac{\partial^2 u_P}{\partial^2 I_{c1}^{p_1}}} = -\frac{\partial^2 I_{c1}^{p_1}}{(Y_1^j - I_{c1}^{p_1})^2 \partial^2 u_P} > 0 \tag{15}$$

Turning to the second child, an income shock occurring in his first period of life correspond to a shock to y_2: let's consider an income realization in the second period $y_2 > \overline{y}$ while, in periods 1 and 3, income realizations are going to be equal to $\overline{y}$.

The effect of a positive income shock on investment in the first and second period for child 2 is symmetric to the case of child 1, so the prove above applies. ■

We can further study the 'sibling effect' – the marginal effect of an income shock in the first period on parents' investments in the second and third period on the second child. The "sibling rivalry" mechanism occurring in period 2 is the main channel of transmission of the shock: since investment in child 1 is more profitable, thanks to dynamic complementarities, incentives to devote resources to the second child decrease. Formally:

Proposition 2. *A positive shock occurring in the first period of life of the first child reduces both first and second period investments on the second child. Thus, adult quality of the second child decreases following a positive income shock occurring in the first period of life of the first child.*

Proof. For levels of income such that $y(\pi) \geq y_2$, an increase in income in period one has no effect on the quality of child 2.

For levels of income such that $y(\pi) < y_2$ but close to $y(\pi)$ an increase in the first period income may have two effects on the second child. The first one is on the investment in nutrition N^0_{c2}. As it is clear form Equation 13, an increase in income in the fist period increase the cost of reducing investment in the first child so it increases the level of income in period 2 at which investment in the first child occurs.

The direct effect of investment for all level of income $y(\pi) > y_2$ is the following:

$$
\begin{aligned}
\frac{\partial I^{p_1,j}_{c2}}{\partial Y_1} &= -\frac{\frac{\partial^2 u_P}{\partial I^{p_1}_{c2} \partial I^{p_2}_{c1}} \frac{\partial I^{p_1}_{c1}}{\partial Y_1}}{\frac{\partial^2 u_P}{\partial^2 I^{p_1}_{c2}}} = \frac{\partial^2 u_P}{\partial^2 I^{p_1}_{c2}} \frac{1}{(Y^k_2 - I^{p_2,k}_{c1} - I^{p_1,k}_{c2})^2 \frac{\partial I^{p_2}_{c1}}{\partial Y_1}} < 0 \\
\frac{\partial I^{p_2,j}_{c2}}{\partial Y_1} &= \frac{\partial I^{p_2}_{c2}}{\partial I^{p_1}_{c2}} \frac{\partial I^{p_1}_{c2}}{\partial Y_1} = \frac{(1-\gamma)\gamma A (I^{p_1}_{c2})^{\gamma-1} (I^{p_2}_{c2})^{-\gamma}}{\frac{\partial^2 u_P}{\partial^2 I^{p_2}_{c2}}} \frac{\partial I^{p_1}_{c2}}{\partial Y_1} < 0
\end{aligned}
\tag{16}
$$

■

Finally, we want to understand how the shocks of the two children interact. As a first step, we study the impact of a shock occurring in the first period of life of the second child on investment in the first child. Since the first period of life of the second child coincides with the second period of life of the first child, these two shocks cannot be disentangled. However, we can look at how the presence of the younger children affects investment in the first one and how this varies with the magnitude of the available resources. We have the following result:

Corollary 1. *The presence of the second child reduces investment in the first child when household income and the probability of surviving (π) are high enough. A shock occurring in the first period of life of the second child (second period of the first child) affects the investment in the first child non-monotonically.*

Proof. The two children overlap in period 2. If the income realization in the second period is too low, parents neglect the second child so his presence does not affect investment in the first child. If household income is high enough to guarantee child 2 survival ($y(\pi) \geq \overline{y}$), the presence of the second child reduces investment in the first child. However, for ($y(\pi) < \overline{y}$), investment in the first child is positively affected by a positive income shock in the first period of life of the second child. Also, above the survival threshold, investment in the first child is positively affected by a positive income shock in the first period of life of the second child. Formally, below the survival threshold we have:

$$
\frac{\partial I^{p_2,j}_{c1}}{\partial Y_2} = -\frac{\frac{\partial^2 u_P}{\partial^2 I^{p_2}_{c1}}}{\frac{\partial^2 u_P}{\partial^2 Y_2}} = -\frac{-\frac{\alpha}{D^2} - \gamma(1-\gamma) A (I^{p_1}_{c1})^{\gamma} (I^{p_2}_{c1})^{-\gamma-1}}{\frac{\alpha}{D^2}} > 0 \tag{17}
$$

■

The proof above the threshold is equivalent.

Second, we want to understand how of a shock occurring in the first period of life of the first child interact with a shock occurring in the first period of life of the second child . We have the following result:

Corollary 2. *The stronger the shock occurring in the first period of life of the second child the smaller the reduction in the first and second period investment of the second child following a positive shock occurring in the first period of life of the first child.*

Proof. For $y(\pi) < \overline{y}$, the the shock occurring in the first period of life of the first child has no effect on investment in the second child. For $y(\pi) \geq \overline{y}$, the effect of an increase in investment in the first child on the second child investment, a shown in Proposition 2, are given by:

$$\begin{aligned} \frac{\partial I_{c2}^{p_1,j}}{\partial Y_1} &= -\frac{\frac{\partial^2 u_P}{\partial I_{c2}^{p_1} \partial I_{c1}^{p_2}} \frac{\partial I_{c1}^{p_1}}{\partial Y_1}}{\frac{\partial^2 u_P}{\partial^2 I_{c2}^{p_1}}} = \frac{\partial^2 u_P}{\partial^2 I_{c2}^{p_1}} \frac{1}{(Y_2^k - I_{c1}^{p_2,k} - I_{c2}^{p_1,k})^2 \frac{\partial I_{c1}^{p_2}}{\partial Y_1}} < 0 \\ \frac{\partial I_{c2}^{p_2,j}}{\partial Y_1} &= \frac{\partial I_{c2}^{p_2}}{\partial I_{c2}^{p_1}} \frac{\partial I_{c2}^{p_1}}{\partial Y_1} = -\frac{(1-\gamma)\gamma A (I_{c2}^{p_1})^{\gamma-1} (I_{c2}^{p_2})^{-\gamma}}{\frac{\partial^2 u_P}{\partial^2 I_{c2}^{p_2}}} \frac{\partial I_{c2}^{p_1}}{\partial Y_1} < 0 \end{aligned} \tag{18}$$

From there we can compute:

$$\begin{aligned} \frac{\partial I_{c2}^{p_1,j}}{\partial Y_1 \partial Y_2} &= \frac{\partial^3 u_P}{\partial^3 I_{c2}^{p_1}} \frac{1}{B^2 \frac{\partial I_{c1}^{p_2}}{\partial Y_1}} \frac{\partial I_{c2}^{p_1,j}}{\partial Y_2} - \frac{\partial^2 u_P}{\partial^2 I_{c2}^{p_1}} \left[2B \frac{\partial I_{c1}^{p_2}}{\partial Y_1} + B^2 \frac{\partial^2 I_{c1}^{p_2}}{\partial Y_1 \partial Y_2} \right] > 0 \\ \frac{\partial I_{c2}^{p_2,j}}{\partial Y_1 \partial Y_2} &= (1-\gamma)\gamma A \left[-\frac{C}{\frac{\partial^2 u_P}{\partial^2 I_{c2}^{p_2}}} \frac{\partial I_{c2}^{p_1}}{\partial Y_1} - \frac{(I_{c2}^{p_1})^{\gamma-1} (I_{c2}^{p_2})^{-\gamma}}{\frac{\partial^2 u_P}{\partial^2 I_{c2}^{p_2}}} \frac{\partial^2 I_{c2}^{p_1}}{\partial^2 Y_1} + \frac{(I_{c2}^{p_1})^{\gamma-1} (I_{c2}^{p_2})^{-\gamma}}{(\frac{\partial^2 u_P}{\partial^2 I_{c2}^{p_2}})^2} \frac{\partial^2 u_P}{\partial^2 I_{c2}^{p_2}} \frac{\partial^3 u_P}{\partial^3 I_{c2}^{p_2}} \right] > 0 \end{aligned} \tag{19}$$

where $B = (Y_2^k - I_{c1}^{p_2,k} - I_{c2}^{p_1,k}) > 0$ and $C = (\gamma - 1)(I_{c2}^{p_1})^{\gamma-2}(I_{c2}^{p_2})^{-\gamma} - \gamma(I_{c2}^{p_1})^{\gamma-1}(I_{c2}^{p_2})^{-\gamma-1} < 0$ ■

B Additional data description

B.1 DHS data

Our baseline data on child mortality, health and other individual and household characteristics come from the Demographic and Health Surveys (DHS).[9] We downloaded all country waves containing information on the geo-location of households as of July, 2017. These data cover 54 countries, surveyed between 1986 and 2016. A map showing the countries covered and the location of the households appears in section B.5. Table A.1 shows the number of survey waves, mothers and children for each country contained in the dataset.

Table A.2 lists all the years and surveys used per country. Most of the data comes from the standard DHS Model Questionnaires.[10]. For 14 country waves the data come from the Malaria Indicator Survey (MIS) Questionnaires[11] and for 2 country waves they come from the Aids Indicator Survey (AIS) Questionnaires.[12] Most of the variables relevant for us are present in most of the phases/questionnaires. However, there have been some variation in questionnaires composition over time and across types. This explain most of the variation in the number of observations across the different estimations in the analysis.

The variables we use are collected in the woman, biomarker and household questionnaires, and recorded in the children, birth, women and household recodes. To construct the final database, we merge variables related to alive children (from the children recode) with those on dead children and women (from the women recode). We then combine these individual variables with household level variables coming from the household recode.

We compute three categories of indicators that we will use as dependent variables, either in an index form or individually. The first are health indicators based on anthropometric data. We use the height (in cm) and weight (in kg) and compute height-for-age (respectively weight-for-age) as the ratio of height (resp. weight) over gender- and age- specific population mean from the WHO[13]. Our *health index* is equal to the average of the standardized height-for-age and weight-for-age. We also compute measures of underheight and underweight, defined as a dummy which equals 1 if height (or weight) is below three standard deviations of the age-specific population mean.

The second type of measures are health investments, which are respectively: a dummy for being breastfed in the first six months of life; a dummy for having received the expected doses, given age, of the DPT vaccine (3 doses for children older than one), polio vaccine (2 doses for children between one and two years old, 3 doses for children between two and three years old, foud doses for children older than 3), BCG vaccine (1 doses for children older than one), measles vaccines (1 dose for children older than one); a dummy for having received vitamin A supplement, and a dummy for receiving deworming treatment in the last three months. The vaccination recommendation come from the WHO[14]. Our *investment index* is equal to the average of the seven standardized investment dummies.

Finally, we use three variables directly available from the DHS to measure survival: dummies denoting death in the first year and death at birth, and a dummy equal to one if the child is alive at the time of the survey.

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[9] https://dhsprogram.com/Data/

[10] https://dhsprogram.com/What-We-Do/Survey-Types/DHS-Questionnaires.cfm The year reported in Table A.2 is the year of interview reported in the database, that may differ from the label reported on the DHS website when downloading the data.

[11] https://dhsprogram.com/What-We-Do/Survey-Types/MIS-Model-Questionnaires.cfm

[12] https://dhsprogram.com/What-We-Do/Survey-Types/AIS-Questionnaires.cfm

[13] https://www.who.int/childgrowth/standards/en/

[14] https://cdn.who.int/media/docs/default-source/immunization/immunization_schedules/immunization-routine-table2.pdf?sfvrsn=3e27ab48_9&download=true.

B.2 LSMS data

Our baseline data on parental time use and households' shocks come from the Living Standard Measurement Survey - Integrated Surveys on Agriculture (LSMS - ISA).[15] We decided to use the LSMS-ISA because it contains data on the geo-localization of households. We downloaded all countries in which information on the geo-location of households, the birth-date of children and anthropometric data were available as of April, 2022. These data leave us with 5 countries, surveyed between 2009 and 2018. The exact Country-Waves are the following: Ethiopia (2011, 2013, 2015, 2018), Malawi (2010, 2013), Nigeria (2010, 2012, 2015, 2018), Tanzania (2010, 2012), Uganda (2009, 2010, 2011).

All the variable used come from the household survey. The data include information on several characteristics of household members: anthropometric measures for children younger than 5 years; education, time use and labour force participation for all members older than 5. While the LSMS-ISA are panel databases, they have been designed to monitor agriculture, socioeconomic outcomes, and non-farm income activities at the household level. The tracking of individual family members over time is instead less straightforward and introduces noise in the data. This is why we have chosen to consider the data as repeated cross-section when it comes to the construction of the individual level variables.

We make use of three types of information: data on the date of birth of children to construct our main explanatory variable, crop prices during pregnancies. We use data on anthropometric indicators (height-for-age, weight-for-age), available for children under 5, to replicate our main estimations on the LSMS data.

For the time use and labour market participation variables, we constructed two variables: the "hours spent on activities within the household" is a continuous variable that measure how many minutes the household member spent on household activities that include firewood and water collection, taking care of livestock and of the household plot over the last week; the "probability of working variable" is a dummy variable that takes value one if, over the last week, the household member worked for a wage, or for self-employment or agriculture outside the household, or for an internship. Since we are interested in understanding time use of the parents, we only kept these two variables for the father and the mother of the children in the household.

Table A.3 shows descriptive statistics for each country contained in the dataset and table A.4 for the main variables used in the analysis.

B.3 Agricultural specialization and producer prices

Agricultural specialization. We compute our baseline measure of agricultural specialization from the FAO's Global Agro-Ecological Zones (GAEZ).[16] It contains the suitability of each location for 45 different cultivating crops. This dataset is constructed from models that use location characteristics such as climate information (rainfall and temperature for instance) and soil characteristics. The climate information is based on the average information over the period 1961-1990. This information is combined with crops' characteristics (in terms of growing requirements) to generate a global GIS raster of the suitability of a grid cell for each crop. Suitability is then defined as the percentage of the maximum yield that can be attained in each grid cell. As several suitabilities are computed based on different scenarii, we consider the one where crop production has been considered with intermediate input level conditions. As an alternative measure of agricultural specialization, we use the M3-CROPS dataset from Monfreda et al. (2008), which contains information on the harvested area in hectares for 137 different crops for grid-cells of 5 arc minutes$\times$5 arc minutes resolution for the year 2000.

International crop prices. Data on the monthly international market prices of each crop come from the World Bank Commodities Dataset.[17] Figure A.2 displays the time variations of the most produced

[15] https://www.worldbank.org/en/programs/lsms/initiatives/lsms-ISA
[16] http://gaez.fao.org/Main.html
[17] http://databank.worldbank.org/data/databases/commodity-price-data

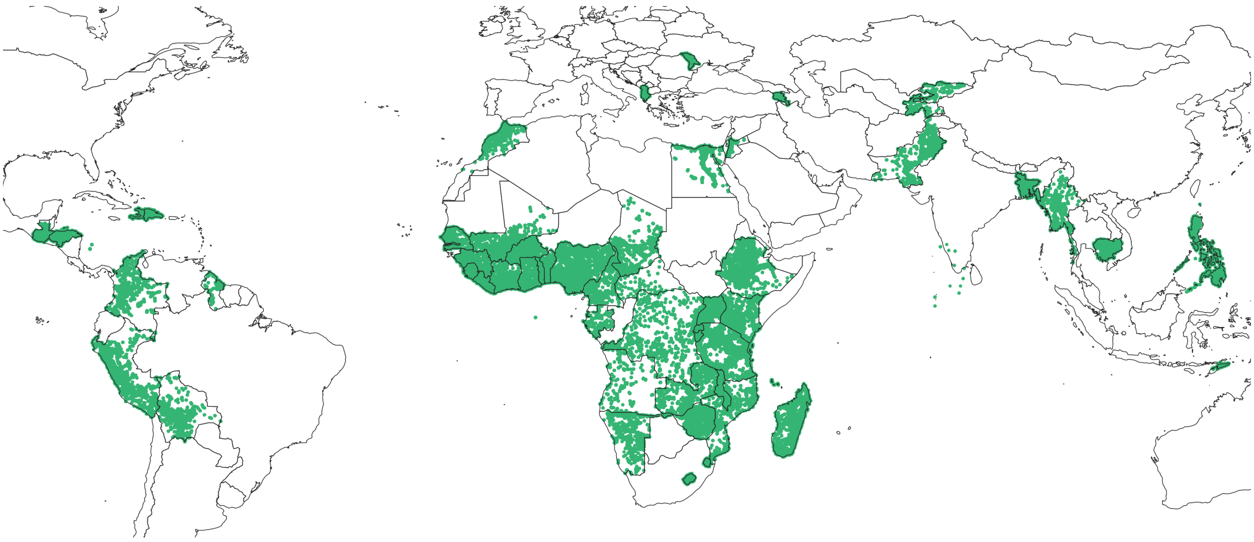
crops.

B.4 Other data

Time-varying cell-specific information. We compute a number of cell-specific controls. First, we compute the number of conflict events in the cell at the monthly frequency using data from the UCDP-Georeferenced Event dataset (UCDP-GED) dataset (we use this dataset rather than ACLED, as it starts in 1989 while ACLED starts in 1997). This dataset records events pertaining to conflicts reaching at least 25 battle-related deaths per year. Finally, we compute monthly precipitation and temperature using data from the university of East Anglia[18].

B.5 Statistics

Figure A.1: Location of DHS households



[18] https://crudata.uea.ac.uk/cru/data/hrg/

Table A.1: Country-level statistics

Country	Waves	# mothers	# children (6-18 years)	# children (0-5 years)	Country	Waves	# mothers	# children (6-18 years)	# children (0-5 years)
Albania	1	4817	8212	1617	Kenya	3	37670	74545	36318
Angola	1	7603	11818	9028	Kyrgystan	1	5555	8296	4314
Armenia	2	7862	8684	3183	Lesotho	3	14230	21673	10585
Bangladesh	4	58800	98066	35222	Liberia	4	25755	47532	27356
Benin	3	18648	43169	20007	Madagascar	4	31737	42519	34456
Bolivia	1	11694	23754	8581	Malawi	4	49463	103174	51615
Burkina Faso	4	31535	79365	36436	Mali	3	32119	66959	37259
Burundi	1	7348	13517	8954	Moldova	1	4934	5316	1549
Cambodia	2	30592	67961	23795	Morocco	1	8660	18066	6181
Cameroon	3	19078	40596	20571	Mozambique	1	10624	20903	11103
Central African Republic	1	3978	9162	2696	Myanmar	1	7796	13511	4817
Chad	1	14156	41413	18628	Namibia	3	17748	29463	14108
Colombia	1	34295	50247	17390	Nigeria	4	69037	162783	82902
Comoros	1	2789	6364	2992	Pakistan	1	3976	57	6103
Congo Democratic Republic	2	20046	45868	25981	Peru	3	48821	67873	36488
Cote d'Ivoire	2	14653	32613	13483	Philippines	2	17315	34446	13662
Dominican Republic	2	26182	42786	14832	Rwanda	3	20088	46452	22999
Egypt	4	72787	152345	61317	Senegal	3	34520	81836	40746
Ethiopia	3	29648	72325	31132	Sierra Leone	3	23072	41009	23710
Gabon	1	6328	12065	6021	Swaziland	1	3431	6014	2762
Ghana	6	22937	43786	21274	Tajikistan	1	6172	10884	5013
Guatemala	1	17066	30954	12354	Tanzania	4	32445	60204	36808
Guinea	3	18520	45490	19118	Timor-Leste	1	7956	21411	9788
Guyana	1	3359	5958	2086	Togo	3	15570	36926	14679
Haiti	3	21348	45856	19650	Uganda	3	22897	51684	29754
Honduras	1	15562	27469	10697	Zambia	2	17790	39838	19817
Jordan	3	25636	64404	26769	Zimbabwe	4	24062	39950	20201

Source: Authors' computations from DHS data.

Table A.2: DHS sample composition

Country	Waves	Years	Phase	Surveys	Country	Waves	Years	Phase	Surveys
Albania	1	2006/2007	DHS-V	Standard	Lesotho	3	2004/2005	DHS-IV	Standard
Angola	1	2006/2007-2010/2011	DHS-V	MIS			2009/2010	DHS-V	Standard
Armenia	2	2010	DHS-VI	Standard			2014	DHS-VI	Standard
		2015/2016	DHS-VII	Standard	Liberia	4	1986	DSH-I	Standard
Bangladesh	4	1999/2000	DHS-III	Standard			2006/2007-2008/2009	DHS-V	Standard, MIS
		2004	DHS-IV	Standard			2011/2013	DHS-VI	Standard, MIS
		2007	DHS-V	Standard			2016	DHS-VII	Standard
		2011/2014	DSH-VI	Standard	Madagascar	4	1997	DHS-III	Standard
Benin	3	1996	DHS-III	Standard			2008/2009	DHS-V	Standard, MIS
		2001	DHS-IV	Standard			2011/2013	DHS-VI	Standard, MIS
		2011/2012	DHS-VI	Standard			2016	DHS-VII	MIS
Bolivia	1	2008	DHS-V	Standard	Malawi	4	2000	DHS-IV	Standard
Burkina Faso	4	1993	DHS-II	Standard			2010	DHS-V	Standard
		1998/1999	DHS-III	Standard			2012-2014	DHS-VI	MIS(s)
		2003	DHS-IV	Standard			2015/2016	DHS-VII	Standard
		2010	DHS-VI	Standard	Mali	3	1995/1996	DHS-III	Standard
Burundi	1	2010/2011-2012	DHS-VI	Standard, MIS			2006	DHS-V	Standard
Cambodia	2	2000	DHS-IV	Standard			2012/2013-2015	DHS-VI	Standard, MIS
		2005/2006-2010/2011	DHS-V	Standard(s)	Moldova	1	2005	DHS-IV	Standard
Cameroon	3	1991	DHS-II	Standard	Morocco	1	2003/2004	DHS-IV	Standard
		2004	DHS-IV	Standard	Mozambique	1	2011	DHS-VI	Standard
		2011	DSH-VI	Standard	Myanmar	1	2015/2016	DHS-VII	Standard
Chad	1	2014/2015	DSH-VI	Standard	Namibia	3	2000	DHS-IV	Standard
Colombia	1	2010	DSH-V	Standard			2006/2007	DHS-V	Standard
Comoros	1	2012	DSH-VI	Standard			2013	DHS-VI	Standard
Congo Democratic Republic	2	2007	DSH-V	Standard	Nigeria	4	1990	DHS-II	Standard
		2013/2014	DSH-VI	Standard			2003	DHS-IV	Standard
Cote d'Ivoire	2	1994-1998/1999	DSH-III	Standard(s)			2008	DHS-V	Standard
		2011-2012	DHS-VI	Standard			2010-2013-2015	DHS-VI	Standard, MIS(s)
Dominican Republic	2	2007	DSH-V	Standard	Pakistan	1	2006/2007	DHS-V	Standard
		2013	DHS-VI	Standard	Peru	3	2000	DHS-IV	Standard
Egypt	4	1992/1993	DSH-II	Standard			2003/2006-2007/2008	DHS-V	Continous
		1995/1996	DHS-III	Standard			2009	DHS-V	Continous
		2000-2005	DHS-VI	Standard(s), Interim	Philippines	2	2003	DHS-IV	Standard
		2014	DHS-VI	Standard			2008	DHS-V	Standard
Ethiopia	3	1992-1997	DSH-IV	Standard	Rwanda	3	2005	DHS-IV	Standard
		2003	DHS-VI	Standard			2007/2008	DHS-V	Interim
		2008	DHS-VII	Standard			2010/2011	DHS-VI	Standard
Gabon	1	2012	DHS-VI	Standard	Senegal	3	1992/1993-1997	DHS-II	Standard(s)
Ghana	6	1993-1994	DHS-II	Standard			2005	DHS-IV	Standard
		1998-1999	DHS-III	Standard			2010/2011-2012/2013	DHS-VI	Standard, Continous
		2003	DHS-IV	Standard	Sierra Leone	3	2008	DHS-V	Standard
		2008	DHS-V	Standard			2013	DHS-VI	Standard
		2014	DHS-VI	Standard			2016	DHS-VII	MIS
		2016	DHS-VI	MIS	Swaziland	1	2006/2007	DHS-V	Standard
Guatemala	1	2014-2015	DHS-VI	Standard	Tajikistan	1	2012	DHS-VI	Standard
Guinea	3	1999	DHS-III	Standard	Tanzania	4	1999	DHS-III	Standard
		2005	DHS-IV	Standard			2007/2008-2009/2010	DHS-V	Standard, AIS
		2012	DHS-VI	Standard			2011/2012	DHS-VI	AIS
Guyana	1	2009	DSH-V	Standard			2015/2016	DHS-VII	Standard
Haiti	3	2000	DHS-IV	Standard	Timor-Leste	1	2009/2010	DHS-V	Standard
		2005/2006	DHS-V	Standard	Togo	3	1988	DHS-I	Standard
		2012	DHS-VI	Standard			1998	DHS-III	Standard
Honduras	1	2011/2012	DHS-VI	Standard			2013/2014	DHS-VI	Standard
Jordan	3	2002	DHS-IV	Standard	Uganda	3	2000/2001	DHS-IV	Standard
		2007	DHS-V	Standard			2006-2009/2010	DHS-V	Standard, MIS
		2012	DHS-VI	Standard			2011-2014/2015	DHS-VI	Standard, MIS
Kenya	3	2003	DHS-IV	Standard	Zambia	2	2007	DHS-V	Standard
		2008/2009	DHS-V	Standard			2013/2014	DHS-VI	Standard
		2014/2015	DHS-VI	Standard, MIS	Zimbabwe	4	1999	DHS-IV	Standard
Kyrgystan	1	2012	DHS-VI	Standard			2005/2006	DHS-V	Standard
							2010/2011	DHS-VI	Standard
							2015	DHS-VII	Standard

Source: Authors' computations from DHS data.

Table A.3: Country-level statistics - LSMS Data

Country	Waves	— # mothers —	— # children — (6-18 years)	(0-5 years)
Ethiopia	4	232	5288	921
Malawi	2	545	10990	2001
Nigeria	4	2904	22803	7141
Tanzania	2	446	4447	1658
Uganda	4	645	11743	3304

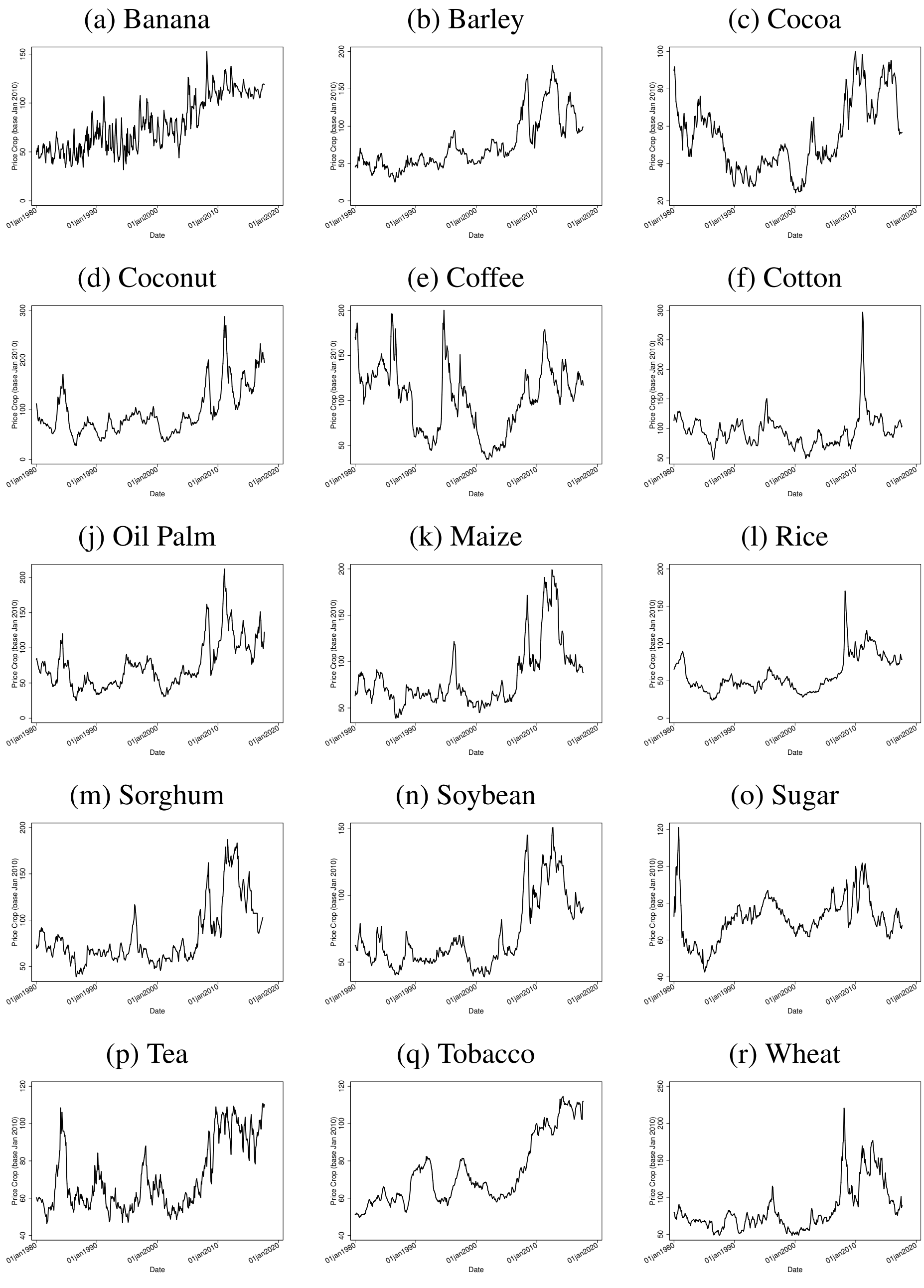
Source: Authors' computations from LSMS data.

Table A.4: Summary statistics - LSMS Data

	Obs.	Mean	S.D.	1st Quartile	Median	3rd Quartile
Child-level						
Age (in months)	15025	29.25	16.11	15	29	42
Female (dummy)	15025	0.46	0.50	0	0	1.00
Birth order	15025	3.25	2.05	1.00	3.00	5.00
Index health	15025	-0.02	0.90	-0.41	-0.10	0.28
No Underheight	13950	0.82	0.38	1.00	1.00	1.00
No Underweight	14964	0.94	0.24	1.00	1.00	1.00
Heigth (cm)	13950	85.29	16.86	76.2	87	96
Weight (cm)	14964	12.04	3.84	9.05	11.90	14.30
Price index	15006	1.08	0.17	0.95	1.08	1.21
Parent-level						
Age (mother)	26200	35.81	10.85	28	34	42
Age (father)	31347	43.78	12.36	35	42	51
# of children	37612	3.29	2.21	2	3	4.5
Hours in the hh (week, mother)	17949	17.77	21	1	10.5	28
Hours in the hh (week, father)	21772	10.67	17.41	0	1	16
Working (dummy, week, mother)	26088	0.76	0.43	1	1	1
Working (dummy, week, mother)	31284	0.89	0.32	1	1	1

Source: Authors' computations from LSMS, GAEZ and World Bank data. See main text for data sources.

Figure A.2: Crop prices



Source: World Bank.

B.6 Within-household variation

Table A.5 below shows the share of the total variance of our variables of interest that is within mother. Health is found to be more dispersed within households; mortality

Table A.5: Within-household variance

Var.	Within HH share	Var.	Within HH share	Var.	Within HH share
Health index	0.209	Underweight	0.213	Polio vac.	0.0783
Investment Index	0.189	Underheight	0.222	DPT vac.	0.0687
		Height	0.213	BCG Vac.	0.0659
		Weight	0.198	Measles vac.	0.0849
		Death birth	0.354	Breastfeed.	0.188
		Death 1st year	0.356	Vitamin A	0.101
		Alive in t	0.350	Deworm	0.123

Note: Share of the variance of each variable within mother, compared to total variance.

C Additional results

C.1 Interpretation of the agricultural price measure

World commodity prices and parental income. Our identification assumption is that crop prices are positively correlated with local agricultural income, and hence with parental income. In the absence of direct measures of household income in the DHS data, we cannot directly perform two stage estimations where income would be instrumented by variations in the world prices of locally produced crops. However, we can estimate the effect of world prices of produced crops on income proxies, using DHS data and external sources for a subset of countries.

At the cell-level, we use data on nighttime lights, as available in Prio-Grid. In Table A.6 we regress yearly cell-level nightlights on our crop price index, controlling for cell and time fixed effects, as well as for weather variables – temperature, rainfall. The results show a significant positive impact of crop prices on nightlights in all estimations.

Table A.6: Exposure to world crop prices and nighttime lights

	(1)	(2)	(3)	(4)
Dep. var.	Nighttime lights			
Crop price index	1.308[a]	1.340[a]		
	(0.178)	(0.183)		
ln Crop price index			0.879[a]	0.901[a]
			(0.128)	(0.130)
Observations	122342	120510	122342	120510
Fixed effects	Cell, year			
Weather controls	No	Yes	No	Yes

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a cell-year. Standard errors clustered at the cell-level in parentheses. Weather controls include average yearly temperature and rainfall, both from Prio-Grid.

We use three different sources of data at the individual level. The first is the DHS. The closest proxy of income in the DHS is the wealth index, which measures where the wealth of the household locates in the overall country-specific distribution. It is a categorical variables which ranges from 1 to 5 for each quintile of the distribution. The second source is the Afrobarometer surveys, as constructed in Berman et al. (2022). The data include 4 waves of the Afrobarometer surveys (round 3 to 6) which contain geolocalized information at the individual level for 28 African countries over the period 2005-2015. For each survey, the Afrobarometer gives access to the exact centroid coordinate of respondents' town, village or neighborhood of residence, which allows us to match the individuals with grid cells and with our time varying measure of crop prices. The Afrobarometer also contains detailed individual characteristics such as age, gender, education level, or employment status, as well as indirect measures of income – whether the individual has been lacking essential items like food or income, and the individual's perception of his/her living conditions. The last source of data is the World Bank Living Standard Measurement Surveys (LSMS). We use two version of the LSMS: one available from Berman et al. (2021), which contains information on land value. Another that we constructed, which contains information about various shocks faced by households. The data cover six African countries (Ethiopia, Malawi, Niger, Nigeria, Tanzania and Uganda), for which (i) the GPS coordinates of the household are available, and (ii) at least two years of data are available. Despite covering a limited number of countries, the significant advantage of the LSMS data is that it is a panel, which allows us to identify changes in (proxies for) household income over time. Interestingly it also contains plot-level information. In the case of DHS and Afrobarometer, which are repeated cross-sections, we aggregate the data at the cell $\times$ time level and estimate the impact of the within-cell variations in the world prices of locally produced crops on changes in average income. In the case of the LSMS, we retain the household dimension and estimate the effect of price variations within household, over time.

Table A.7 presents the results. In column (1) we use the wealth index from the DHS data as a proxy for income. The measure is individual (mother) specific, and aggregated at the cell-time level. We find that cell-specific variations in crop prices are associated with a higher wealth index (p-value is 0.058). In column (2), we turn to the Afrobarometer data, which contain more income proxies. We follow Berman et al. (2022) and use three different proxies. In column (2), we proxy the material wealth of the household computing a "family of outcomes" index as the mean of the standardized variables using questions on whether the respondent personally owns a radio, a TV, and a vehicle. [19] In column (3), we again use a deprivation index based on five different Afrobarometer questions in which individuals report whether their household has lacked over the past year essential welfare-related items: food, cash income, clean water, medicine or fuel to cook.[20] Finally, column (4) uses information on individuals perceptions of changes in their living conditions. Individuals are asked about how their living conditions today compare to their living conditions 12 months before.[21] The results echoes those found by McGuirk and Burke (2020): we find a positive and significant effect of world prices of locally produced crops on wealth and perceptions of absolute living conditions (columns 2 and 4), and a negative effect on deprivation (column 3).

We then turn to the LSMS. Here the data cover fewer countries but has a panel dimension which enables to study the effect of price variations within households, over time. In column (5), we use a plot-level measure of land value, directly taken from Berman et al. (2021). In four countries – Malawi, Niger, Nigeria and Uganda –, households who are land-owners are asked the following question: "If you were to sell this parcel of land today, how much could you sell it for?". Using information on the area of each plot, Berman et al. (2021) construct a land value per square meter in USD, as a proxy for rents. We find a positive effect of our crop price index on land value (p-value is 0.062).

Alternative interpretations. Throughout the paper, we assume that our world price measure impacts parental income. Is it possible, however, that, through their effect on agricultural revenues, changes in crop prices also impact the revenues of local states, in particular through tax revenues, and in turn affect the provision of public goods. This would change the interpretation of our results. There are several reasons why we believe that this interpretation is unlikely to be relevant in our context. First, it is inconsistent with the sibling rivalry that we find: if higher state revenues translate in better public goods, e.g. healthcare and education system, future children should also be positively affected. Second, our sample is composed of developing countries in which taxation capacity is usually low and revenues quite centralized. For instance, according to data from the Global Financial Statistics[22], local state revenues represent only 4% of total government revenues in the median country in our sample. Second, the evidence from Table A.7 suggests that individual income is indeed significantly affected by crop price variations. Third, we have tried to correlate changes in various measures of country-level tax revenues, total national expenditures or health expenditures with the country specific average of our agricultural price measure. None of the coefficients were statistically significant at conventional levels.[23] Fourth,

[19]The precise Afrobarometer question is the following: "Which of these things do you personally own: [Radio] / [TV] / [Vehicle]? ". Variables are standardized by subtracting their mean and dividing by their standard deviation. See Berman et al. (2022) for more details.

[20]The precise question is the following: "Over the past year, how often, if ever, have you or anyone in your family gone without:[Food] / [Cash income] / [Enough clean water for home use] / [Medicines or medical treatment] / [Enough fuel to cook your food?] ". Answers are the following: 0=Never, 1=Just once or twice, 2=Several times, 3=Many times, 4=Always.]

[21]The original question is the following: "Looking back, how do you rate the following compared to twelve months ago: Your living conditions?". Answers are the following: 1=Much worse, 2=Worse, 3=Same, 4=Better, 5=Much better.

[22]https://data.imf.org/?sk=1C28EBFB-62B3-4B0C-AED3-048EEEBB684F

[23]We have considered the following measures: tax revenues, in constant USD or as a share of GDP; total

Table A.7: Exposure to crop prices and parental income

	(1)	(2)	(3)	(4)	(5)
Data	DHS	—— Afrobarometer	——	——	LSMS
Dep. var.	Wealth index	Wealth index	Deprivation index	Living conditions	ln land value
Crop Price index	0.001[b]	0.003[b]	-0.003[a]	0.003[c]	0.008[c]
	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)
ln rainfall					1.954[a]
					(0.581)
Observations	17747	5626	5626	3548	31211
R^2	0.732	0.631	0.769	0.534	0.699
Fixed effect	——	—— Cell	——	——	HH-plot
Time dummies			Yes		
Additional controls			Yes		

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. The unit of observation is cell-year-month in columns (1) to (4), a household-plot-year in column (5). Standard errors clustered at the cell level in parentheses. Only rural households considered in all columns. The dependent variables are the following: in column (1), the average wealth index observed in the cell, from the DHS, ranging from 1 to 5; in column (2), a wealth index computed as the average of dummy variables denoting ownership of radio, TV, and vehicle, averaged at the cell-level; in column (3) a deprivation index, computed as the average of dummy variables denoting whether the respondent has gone without of food, income, water, medicine and fuel over the last 12 months, and averaged at the cell-level; in column (4), the cell-specific average of respondents' perceptions of their living conditions, compared to 12 months before. Estimation (1) include cell and time fixed effects, and control for cell-year average mothers' age, age squared, and education level. Columns (2)-(4) include cell and time fixed effects and controls for cell-year average respondent gender, age and age squared, and education level. Columns (6)-(8) include household-plot and year fixed effects and controls for household size, gender of the head of household and cell-level rainfall.

if our main results were driven by the effect of price variations on state revenues and public goods, we would expect our coefficients to be magnified in countries with higher levels of revenue mobilization, or in countries characterized by more decentralized taxation and expenditures systems. In Table A.8, we have augmented our baseline estimations with interaction terms between our price measure and an indicator measuring the country-specific efficiency of revenue mobilization. The indicator is the CPIA efficiency of revenue mobilization rating (1=low to 6=high) from the World Development Indicators, taken as the average over the period. The data is available for 43 countries of our sample. The sign of the interaction is mostly insignificant, or of the opposite of the coefficient on the non-interacted price. If anything, our results are weaker in countries with more efficient revenue mobilization – the opposite of what we would expect if our results were driven by increases in tax revenues or changes in public goods provision.[24] These results are consistent with Berman and Couttenier (2015), who show that variations in the demand for agricultural commodity do not affect (Sub-Saharan African) countries through changes in state capacity, but rather through their effect on individual income. Likewise, the findings of Table A.8 suggest that variations in agricultural prices affect child health and parental investment through their effect on parental income rather than through state revenues or public goods provision. On the other, hand, they also (weakly) support the idea that state policies might be able to play a role in limiting the increase in intra-household inequality driven by parental income variability.

gross national expenditure, per capita, of as a fraction of GDP; health expenditures per capita. All variables were extracted from the World Bank Development Indicators. Estimations were ran over the 1960-2017 period on our sample of countries and controlled for country and year fixed effects. The results are available upon request.

[24] We have also tried to interact our variable with measures of decentralization of tax revenues. The coefficients were similar to those of Table A.8, but the indicators (from the Global Financial Statistics) were available only for 10 countries in our sample.

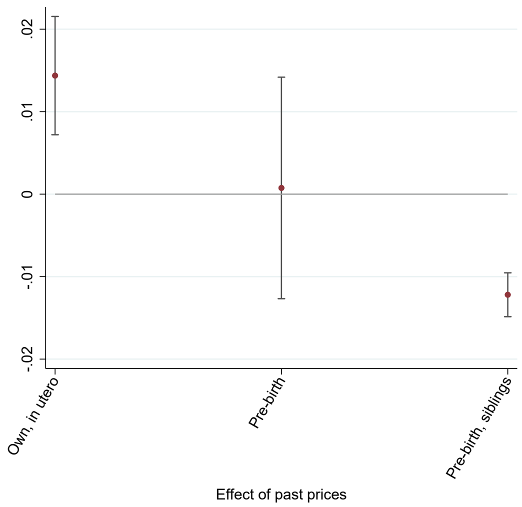
Table A.8: Revenue mobilization

	(1)	(2)
Dep. var.	Health	Investments
In utero prices (own)	0.796[a]	0.450[a]
	(0.036)	(0.030)
× Revenue Mob.	-1.089[a]	-0.609[a]
	(0.054)	(0.047)
In utero prices (old siblings)	-0.000	-0.009
	(0.009)	(0.006)
× Revenue Mob.	-0.012	0.009
	(0.008)	(0.005)
In utero prices (young siblings)	0.062[a]	-0.019[a]
	(0.006)	(0.005)
× Revenue Mob.	-0.075[a]	-0.023[a]
	(0.007)	(0.006)
Observations	402551	598951
R^2	0.429	0.418
Child controls	Yes	Yes
Mother Controls	Yes	Yes
Fixed effects		
Cell, country × year-of-birth, month-of-birth		

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child is the average across lagged prices observed during the pregnancy period. In utero prices of older siblings is the average across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings is the average across lagged prices observed during in-utero periods for younger siblings. All regressions include post-birth prices and pre-birth prices in non-pregnancy periods, and their interaction with revenue mobilization. The indicator is the CPIA efficiency of revenue mobilization rating (1=low to 6=high) from the World Development Indicators, taken as the average over the period. "Child health" is the average of the standardized, age- and gender-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement, and a dummy for receiving deworming treatment in the last three months.

C.2 Baseline results: additional figures and tables

Figure A.3: Baseline results: effect of price variations on survival probability



Note: OLS estimation. The unit of observation is a child. The dependent variable is a dummy equal to one if the child is alive at the time of the survey. The dots are averages across coefficients for the child in-utero prices ("Own, in utero", α in eq (5)), the prices before birth of the child and outside of any in-utero period ("Pre-birth", β^{pre} in eq (5)), the in-utero prices of older siblings ("Pre-birth,siblings", $\beta^{S,pre}$ in eq (5)). The bars represent 95% confidence intervals. The underlying regression is as in eq (5) and includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

Table A.9: Baseline results

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.416^a	0.076^a	-0.020^a	0.452^a	0.042^a	501011	0.525
		(0.007)	(0.017)	(0.002)	(0.019)	(0.003)		
(2)	Health Investments	0.149^a	0.020^b	-0.008^a	0.233^a	-0.028^a	733247	0.463
		(0.005)	(0.009)	(0.001)	(0.012)	(0.003)		
(3)	Survival	0.014^a	0.001	-0.012^a	0.010	-0.096^a	865801	0.062
		(0.004)	(0.006)	(0.001)	(0.007)	(0.004)		

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-utero periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, dummies for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A in the last six months, a dummy for receiving deworming treatment in the last six months. "Survival" is a dummy equal to one if the child is alive at the time of the survey.

Table A.10: Baseline results: detailed coefficients

	(1)		(2)		(3)	
Dep. var.	Child Health		Health Inv.		Survival	
	Coef.	SE	Coef.	SE	Coef.	SE
Own prices, in utero prices						
t	-0.232[a]	(0.044)	-0.101[a]	(0.030)	0.058[a]	(0.018)
t-1	1.548[a]	(0.013)	0.984[a]	(0.011)	-0.021[a]	(0.004)
t-2	0.390[a]	(0.007)	0.064[a]	(0.006)	-0.006	(0.005)
t-3	0.318[a]	(0.008)	0.029[a]	(0.005)	0.017[a]	(0.005)
t-4	0.245[a]	(0.009)	-0.032[a]	(0.007)	0.020[a]	(0.006)
t-5	0.224[a]	(0.010)	-0.050[a]	(0.010)	0.019[b]	(0.008)
Pre-birth prices						
t-1	0.739[a]	(0.050)	0.128[a]	(0.031)	-0.089[a]	(0.018)
t-2	-0.084[b]	(0.042)	-0.225[a]	(0.024)	-0.008	(0.017)
t-3	0.256[a]	(0.030)	0.187[a]	(0.023)	0.026	(0.017)
t-4	0.187[a]	(0.032)	0.195[a]	(0.026)	0.001	(0.019)
t-5	-0.053	(0.038)	0.030	(0.024)	0.027	(0.020)
t-6	-0.031	(0.035)	-0.002	(0.024)	0.013	(0.019)
t-7	-0.115[b]	(0.056)	0.034	(0.035)	-0.022	(0.022)
t-8	-0.069	(0.057)	-0.179[a]	(0.038)	0.065[b]	(0.027)
t-9	-0.195[a]	(0.076)	-0.048	(0.045)	0.028	(0.036)
t-10	0.126	(0.079)	0.084[c]	(0.046)	-0.036	(0.031)
Pre-birth prices, siblings in utero						
t-1	-0.059[a]	(0.012)	-0.060[a]	(0.007)	-0.047[a]	(0.009)
t-2	-0.033[a]	(0.006)	-0.026[a]	(0.004)	-0.032[a]	(0.004)
t-3	-0.005	(0.004)	0.009[a]	(0.003)	-0.016[a]	(0.003)
t-4	-0.017[a]	(0.004)	-0.002	(0.003)	-0.026[a]	(0.003)
t-5	-0.017[a]	(0.004)	0.001	(0.003)	-0.022[a]	(0.003)
t-6	-0.024[a]	(0.004)	-0.007[a]	(0.003)	-0.018[a]	(0.003)
t-7	-0.016[a]	(0.004)	0.002	(0.003)	0.009[a]	(0.003)
t-8	-0.011[a]	(0.004)	-0.006[c]	(0.003)	0.010[a]	(0.004)
t-9	-0.012[a]	(0.005)	0.010[a]	(0.003)	0.012[a]	(0.004)
t-10	-0.001	(0.004)	-0.003	(0.003)	0.008[c]	(0.004)
Post-birth prices						
t	0.464[a]	(0.037)	0.256[a]	(0.025)	-0.015	(0.015)
t-1	0.174[a]	(0.036)	0.048[b]	(0.022)	0.000	(0.016)
t-2	0.873[a]	(0.037)	0.425[a]	(0.022)	-0.036[b]	(0.017)
t-3	0.383[a]	(0.027)	0.215[a]	(0.024)	0.043[b]	(0.018)
t-4	0.367[a]	(0.030)	0.222[a]	(0.038)	0.055[a]	(0.021)
Post-birth prices, siblings in utero						
t	-0.028[a]	(0.004)	-0.027[a]	(0.003)	0.009[b]	(0.004)
t-1	0.019[a]	(0.003)	-0.016[a]	(0.003)	-0.056[a]	(0.004)
t-2	0.047[a]	(0.004)	-0.009[b]	(0.004)	-0.064[a]	(0.005)
t-3	0.049[a]	(0.006)	-0.039[a]	(0.005)	-0.160[a]	(0.007)
t-4	0.124[a]	(0.013)	-0.049[a]	(0.011)	-0.209[a]	(0.016)
Observations	501011		733247		865801	
R^2	0.525		0.463		0.062	

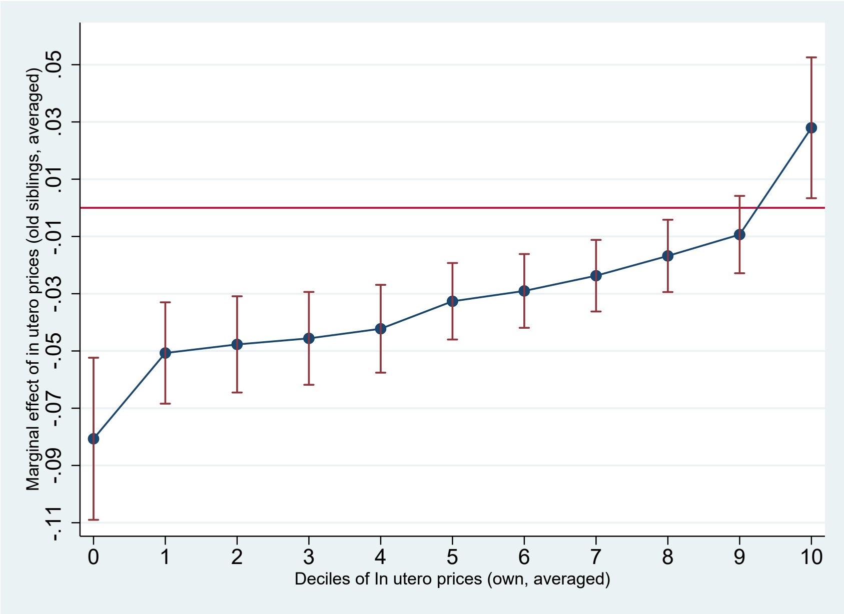
[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. "Survival" is a dummy equal to one if the child is alive at the time of the survey.

Table A.11: Child health, parental investments and crop prices: results for detailed outcome variables

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
				A. Child health				
(1)	No underheight	0.090^a	-0.003	-0.008^a	0.105^a	0.010^a	496689	0.175
		(0.003)	(0.005)	(0.001)	(0.006)	(0.002)		
(2)	No underweight	0.038^a	-0.006^c	-0.005^a	0.041^a	0.008^a	495617	0.129
		(0.002)	(0.003)	(0.001)	(0.004)	(0.001)		
(3)	ln height	0.048^a	0.010^a	-0.002^a	0.054^a	0.005^a	496689	0.421
		(0.001)	(0.002)	(0.000)	(0.002)	(0.000)		
(4)	ln weight	0.092^a	0.014^a	-0.006^a	0.100^a	0.012^a	495617	0.450
		(0.006)	(0.016)	(0.002)	(0.019)	(0.004)		
(5)	No death 1^{st} year	0.004^a	0.004^a	-0.002^a	0.006^a	-0.015^a	868303	0.037
		(0.001)	(0.001)	(0.000)	(0.001)	(0.001)		
(6)	No death at birth	0.006^a	0.002	-0.004^a	0.005^a	-0.025^a	868303	0.050
		(0.001)	(0.002)	(0.000)	(0.002)	(0.001)		
(7)	Survival	0.005^a	0.000	-0.004^a	0.003	-0.032^a	868303	0.062
		(0.001)	(0.002)	(0.000)	(0.002)	(0.001)		
				B. Health investments				
(1)	Polio Vac.	0.001	0.010^c	-0.006^a	0.029^a	-0.010^a	465477	0.204
		(0.002)	(0.005)	(0.001)	(0.006)	(0.002)		
(2)	DPT Vac.	0.005^b	0.022^a	-0.008^a	0.020^a	-0.007^a	545153	0.334
		(0.002)	(0.006)	(0.001)	(0.006)	(0.002)		
(3)	BCG Vac.	0.003	0.001	-0.006^a	0.011^b	-0.008^a	550488	0.329
		(0.002)	(0.005)	(0.001)	(0.005)	(0.001)		
(4)	Measles Vac.	0.007^a	-0.017^a	-0.011^a	0.011^c	-0.008^a	546180	0.262
		(0.003)	(0.006)	(0.001)	(0.006)	(0.002)		
(5)	Breastfeeding	0.080^a	0.033^a	-0.004^a	0.245^a	-0.036^a	500400	0.641
		(0.003)	(0.006)	(0.001)	(0.007)	(0.003)		
(6)	Vitamin A	0.038^a	-0.000	-0.002^b	0.039^a	-0.010^a	593773	0.272
		(0.004)	(0.007)	(0.001)	(0.008)	(0.002)		
(7)	Deworm	0.038^a	0.020^b	0.004^a	0.066^a	-0.005^b	528517	0.311
		(0.003)	(0.008)	(0.001)	(0.008)	(0.002)		

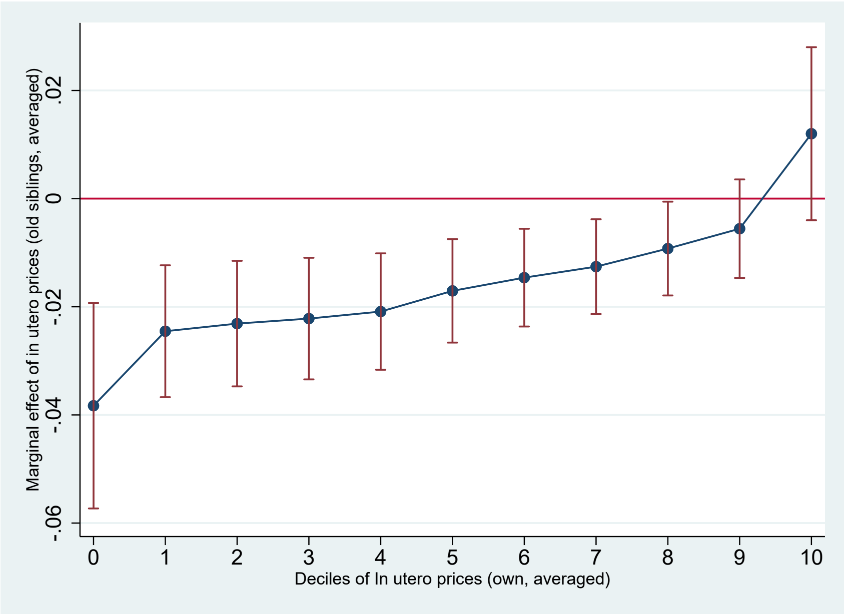
[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. In panel A, the child health dependent variables are: dummies equal to 1 if the child does not suffer from underweight (underheight) – i.e., weight (height) below three standard deviations of the age-specific population mean); age-adjusted child weight and height (in logs); dummies denoting survival in the first year and at birth; dummy equal to one if the child is alive at the time of the survey. In panel B, the health investments dependent variables are: dummies for having received the expected doses of polio vaccination, DPT vaccine, BCG vaccine, measles vaccination; a dummy for being breastfed in the first six months of life; a dummy for receiving deworming treatment in the last six months, and a dummy for having received vitamin A supplement in the last six months.

Figure A.4: Marginal effect of older siblings in-utero prices on the health index



Note: These figures plot the marginal effect of (averaged) in-utero prices for older siblings on the health index against deciles of the (averaged) in utero prices of the own child, using the estimates of the interaction model in column (1) of Table 2.

Figure A.5: Marginal effect of older siblings in-utero prices on the parental investment index



Note: These figures plot the marginal effect of (averaged) in-utero prices for older siblings on the parental investment index index against deciles of the (averaged) in utero prices of the own child, using the estimates of the interaction model in column (2) of Table 2.

C.3 Preference for first-borns and gender-specific results

Preference for first born children. Our main results show that children whose older-sibling have been exposed to higher parental income levels exhibit weaker health condition and receive smaller health investments. These results may partly come from a preference for first-borns. To determine whether it is the case, we perform the following exercise: we recompute the prices faced by older siblings in utero, separately for the first born child and subsequent siblings. We decompose in a similar way own in utero prices. We then run our baseline estimation again. The results are shown in Table A.12 below. Overall, we find little evidence that our results are driven by a preference for first born.

Table A.12: Baseline results - first born children

Est.	Prices coef.	In utero		Pre-birth	Pre-birth siblings		Post-birth	Post-birth siblings	Obs.
		(1st born)	(excl. 1st born)		(1st born)	(excl. 1st born)			
(1)	Child Health	0.424^{a}	0.414^{a}	0.074^{a}	-0.018^{a}	-0.024^{a}	0.448^{a}	0.043^{a}	501056
		(0.008)	(0.007)	(0.016)	(0.003)	(0.002)	(0.019)	(0.003)	
(2)	Health Investments	0.135^{a}	0.154^{a}	0.019^{b}	-0.015^{a}	-0.010^{a}	0.229^{a}	-0.027^{a}	733337
		(0.006)	(0.005)	(0.009)	(0.002)	(0.001)	(0.012)	(0.003)	

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period, for the first born and for all the other children in the parity. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings, for the first born and for all other children in the parity. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. Estimations include children for whom both the health index and the investment index are available.

Gender specific results. In Table A.13 we present the result of an additional specification that is meant to test for gender differences in reactions to variations in prices. In this specification, we interact the own in utero price and the gender of the child. Wee also compute separately the price faced by older brothers and older sisters. We see that the effects of both the own price and the siblings' one do not differ along any dimension related to gender.

Table A.13: Baseline results - gender

Est.	Prices coef.	In utero		Pre-birth	Pre-birth siblings		Post-birth	Post-birth siblings	Obs.
		Males	Females		Males	Females			
(1)	Child Health	0.414[a]	0.417[a]	0.074[a]	-0.020[a]	-0.019[a]	0.449[a]	0.043[a]	501056
		(0.007)	(0.007)	(0.017)	(0.002)	(0.002)	(0.019)	(0.003)	
(2)	Health Investments	0.147[a]	0.152[a]	0.019[b]	-0.008[a]	-0.010[a]	0.230[a]	-0.028[a]	733337
		(0.005)	(0.006)	(0.009)	(0.001)	(0.001)	(0.012)	(0.003)	

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period, for males and females. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings, for males and females. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. Estimations include children for whom both the health index and the investment index are available.

D Sensitivity analysis

D.1 Selection on mortality and fertility

This section explores whether our results are affected by endogenous selection on mortality and fertility. As discussed in the main text, in theory endogenous sample selection – the fact that a child is included or not in the sample – affects our results in an ambiguous way. Selection may be driven by households that are more sensitive to income variations – in which case the own price effect and the sibling rivalry effect would be attenuated in the selected sample. Instead, if the children who are more affected by selection are less sensitive to income variations, our estimates would be biased upward. We explore sequentially the role of endogenous mortality and fertility in this section.

Given the structure of our baseline estimated equation (5), dealing with endogenous selection is non-trivial. We cannot use a standard Heckman model to correct for selection because we are using estimations containing large sets of fixed effects and do not have access to an exclusion variable affecting mortality but not future health. Bounding exercises a la Manski (1990) or Lee (2009) are typically designed for RCT-type of contexts with a single binary treatment. We pursue an alternative methodology, the identification-at-infinity method, initially proposed by Chamberlain (1986) and Heckman (1990) (see Mulligan and Rubinstein (2008); or Machado (2017) for more recent applications). Chamberlain (1986) showed that if some individuals face an arbitrarily large probability of selection and the outcome equation is linear, then one can use these individuals to identify the effects of the covariates on the outcome of interest. In our context, this amounts to estimating our specification on samples selected on observed characteristics such that all children are alive (or born, in the case of fertility). In these samples, selection should not matter: if selection effects were substantial in explaining our results, we would expect the sibling effects to vary across samples.[25]

Endogenous sample selection on mortality. Survival probabilities are estimated through equation (5), using a survival dummy as a dependent variable. These predictions are then used to define samples of survival probabilities, on which we re-estimate our baseline specification. The results obtained for the own in-utero prices and old siblings' in utero prices are shown graphically in Figure A.6. Table A.14 contains the estimates. In each figure we start by reporting the coefficient observed in the full sample (i.e. our baseline coefficient), before progressively restricting the sample to children with higher survival probabilities, i.e. those in the top 50%, 25%, 10% and 5% of the sample in terms of predicted survival probabilities. In the latter, survival rates are high enough to ensure that all children are indeed observed, and that selection on mortality is not affecting the results. We find that the estimates (of both the own and the sibling prices) get bigger, in absolute terms, as we move to samples with increasing survival probability. This is particularly the case for sibling coefficients. This suggests that our baseline results, if anything, underestimate the magnitude of the sibling effects due to potential endogeneous selection: the selected sample children contains children for whom sibling rivalry is not strong enough to trigger exit. Note however that, though slightly stronger in the low mortality samples, the magnitudes of the coefficients remain within the same order of magnitude (-0.02 to -0.06 in the case of child health in Figure A.6.c, around -0.01 in the case of health investments in Figure A.6.d).

Endogenous sample selection on fertility. Though in theory selection on fertility (the fact that we

[25] We also tried to control for selection directly in our baseline sample. Our methodology here follows Cosslett (1991), who proposes a semi-parametric estimator in which the selection correction is approximated through indicator variables computed from the predictions obtained from survival regression. The idea is akin to an Heckman two-step estimators, except that 100 bins of survival probabilities are included instead of a standard inverse mills ratio (which we cannot estimate as probit does not allow including our various dimensions of fixed effects). These bins, which correspond to each centile of the predicted survival probabilities, are estimated using our baseline equation (5). Controlling for both own and sibling mortality has a moderate impact on our estimates: the sibling effect increases to -0.022 in the case of health (instead of -0.020) and -0.010 (instead of -0.008) in the case of investments.

only observe children who are born, which could correlate with past prices) works in a similar way as selection on mortality, in practice dealing with it is more complex. The problem comes from the fact that we cannot observe the universe of children who are not born: we can estimate the probability of a child being born at the time of the survey (and hence included in our sample), but within the universe of children who will eventually be born, and within mothers who have a positive number of kids.

To estimate the probability of being included in the sample, we estimate the following specification:

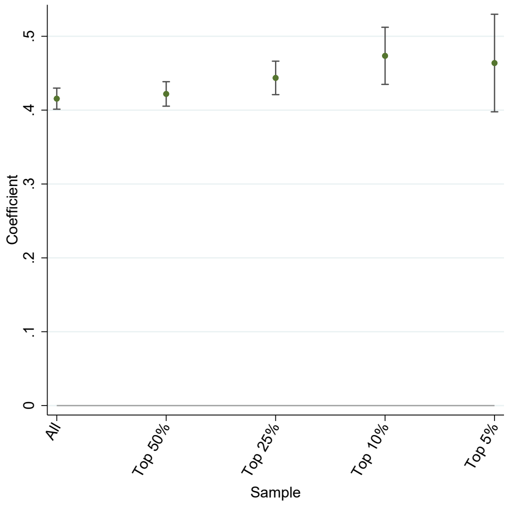
$$\text{Born}_{ct} = \sum_{i=0}^{10} \beta_i P_{c,k,t-i} + \mathbf{H}'_{\mathbf{c}}\delta + \mathbf{FE} + \varepsilon_c \tag{20}$$

Where Born_{ct} is a dummy that takes the value 1 if child c is born at time t. $P_{c,k,t-i}$ are the cell-level prices observed in year $t-i$ (up to 10 years), H'_c is a vector of time-varying characteristics that include number of children in the family and dummies for the age of the mother. **FE** include mother fixed effects as well as year and month dummies. The predictions from equation (20) are an estimate of the probability of being born at time t for child c. We use these predictions to perform the identification-at-infinity method and restrict the sample to children with a high enough probability of being born.

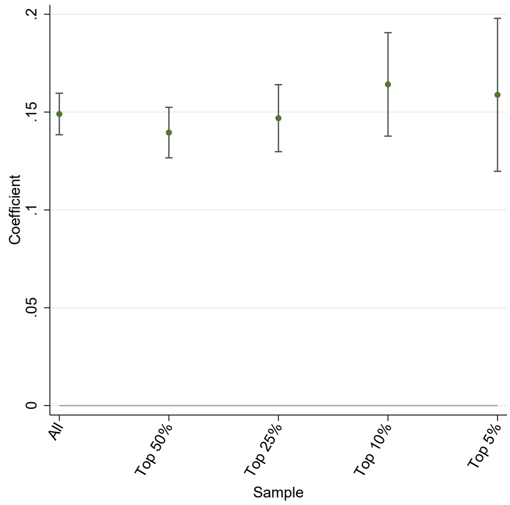
The results are shown in Figure A.7 and Table A.15. Contrary to mortality, we find little evidence of a clear directional bias induced by endogenous fertility. The sibling effects are similar in the baseline sample and in the sample with the highest fertility probabilities. The own price effects are slightly lower, though not significantly different across samples.

Figure A.6: Effects of price variation on health and investment by subsamples of increasing survival probability

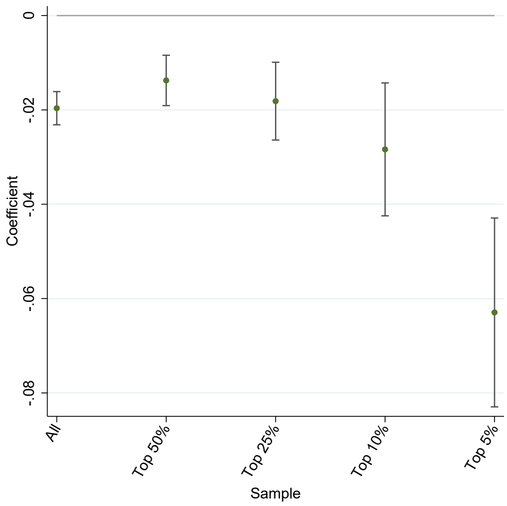
(a) Child health, own in utero prices



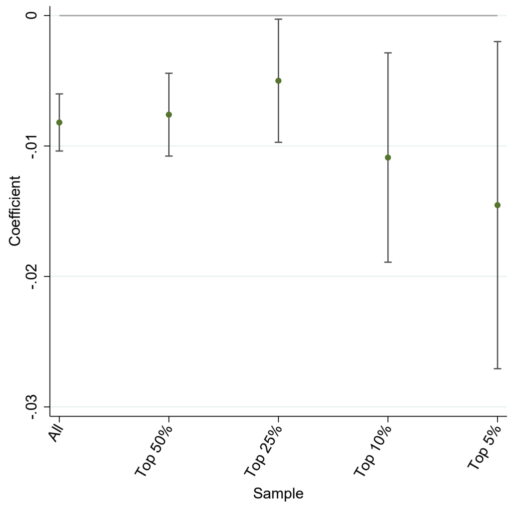
(b) Investments, own in utero prices



(c) Child health, old sibling prices



(d) Investments, old sibling prices



Note: OLS estimation. The unit of observation is a child. In the “Child health” panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the “Health investments” panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. In figures (a) and (b), the dots are averages across coefficients for the child in-utero prices. In figures (c) and (d), the dots are averages across coefficients for the in-utero prices of older siblings. Samples are defined according to the child’s survival probability as predicted by our baseline specification. The regressions include child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

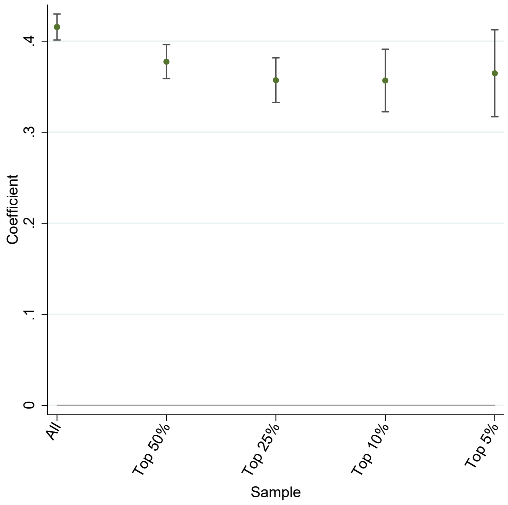
Table A.14: Selection: identification-at-infinity, own mortality, detailed results

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
Child Health								
(1)	All	0.416^a	0.076^a	-0.020^a	0.452^a	0.042^a	501011	0.525
		(0.007)	(0.017)	(0.002)	(0.019)	(0.003)		
(2)	Top 50%	0.422^a	0.190^a	-0.014^a	0.571^a	0.070^b	259871	0.566
		(0.008)	(0.026)	(0.003)	(0.035)	(0.034)		
(3)	Top 25%	0.444^a	0.191^a	-0.018^a	0.566^a	0.015	130408	0.558
		(0.012)	(0.038)	(0.004)	(0.048)	(0.017)		
(4)	Top 10%	0.474^a	0.183^a	-0.028^a	0.545^a	0.025	50008	0.541
		(0.020)	(0.049)	(0.007)	(0.060)	(0.041)		
(5)	Top 5%	0.464^a	0.204^a	-0.063^a	0.476^a	0.013	23429	0.518
		(0.034)	(0.054)	(0.010)	(0.072)	(0.055)		
Health investments								
(1)	All	0.149^a	0.020^b	-0.008^a	0.233^a	-0.028^a	733247	0.463
		(0.005)	(0.009)	(0.001)	(0.012)	(0.003)		
(2)	Top 50%	0.140^a	0.095^a	-0.008^a	0.296^a	-0.013	372763	0.530
		(0.007)	(0.012)	(0.002)	(0.016)	(0.030)		
(3)	Top 25%	0.147^a	0.109^a	-0.005^b	0.291^a	-0.016	183380	0.567
		(0.009)	(0.016)	(0.002)	(0.023)	(0.060)		
(4)	Top 10%	0.164^a	0.114^a	-0.011^a	0.272^a	-0.038	70511	0.588
		(0.013)	(0.022)	(0.004)	(0.031)	(0.032)		
(5)	Top 5%	0.159^a	0.118^a	-0.015^b	0.253^a	-0.022	33723	0.596
		(0.020)	(0.029)	(0.006)	(0.038)	(0.072)		

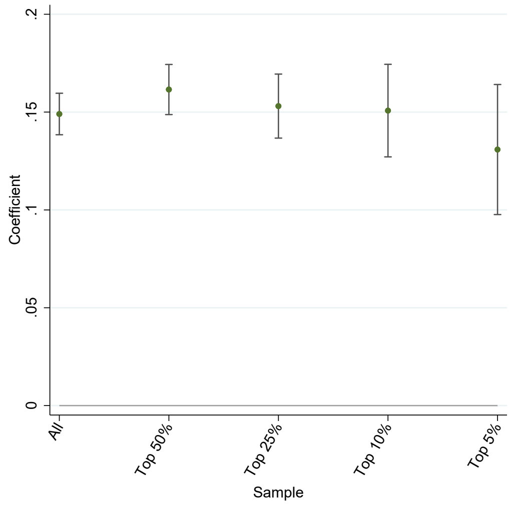
^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. Samples defined by survival probabilities, as predicted by our baseline specification. The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

Figure A.7: Effects of price variation on health and investment by subsamples of increasing birth probability

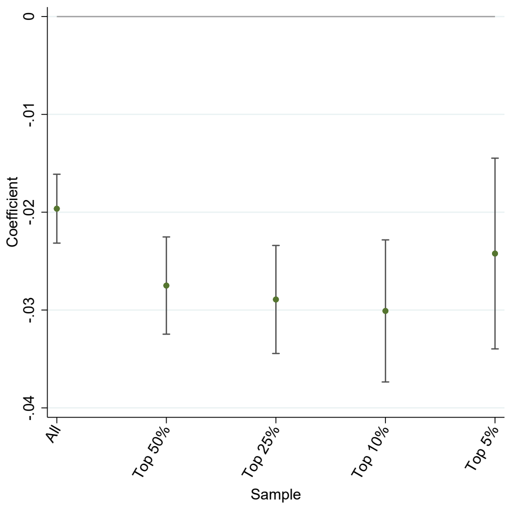
(a) Child health, own in utero prices



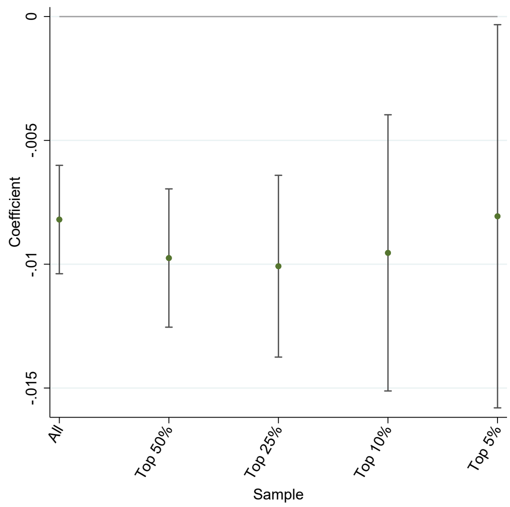
(b) Investments, own in utero prices



(c) Child health, old sibling prices



(d) Investments, old sibling prices



Note: OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months.In figures (a) and (b), the dots are averages across coefficients for the child in-utero prices. In figures (c) and (d), the dots are averages across coefficients for the in-utero prices of older siblings. Samples are defined according to the child's birth probability as predicted by equation 20. The regressions include child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

Table A.15: Selection: identification-at-infinity, fertility, detailed results

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
Child Health								
(1)	All	0.416^a	0.076^a	-0.020^a	0.452^a	0.042^a	501011	0.525
		(0.007)	(0.017)	(0.002)	(0.019)	(0.003)		
(2)	Top 50%	0.378^a	0.069^a	-0.027^a	0.353^a	0.048^a	281208	0.507
		(0.010)	(0.015)	(0.003)	(0.018)	(0.004)		
(3)	Top 25%	0.357^a	0.104^a	-0.029^a	0.333^a	0.047^a	161442	0.516
		(0.013)	(0.015)	(0.003)	(0.019)	(0.004)		
(4)	Top 10%	0.357^a	0.123^a	-0.030^a	0.268^a	0.039^a	74614	0.536
		(0.018)	(0.019)	(0.004)	(0.023)	(0.005)		
(5)	Top 5%	0.365^a	0.101^a	-0.024^a	0.252^a	0.042^a	43652	0.550
		(0.024)	(0.025)	(0.005)	(0.028)	(0.007)		
Health investments								
(1)	All	0.149^a	0.020^b	-0.008^a	0.233^a	-0.028^a	733247	0.463
		(0.005)	(0.009)	(0.001)	(0.012)	(0.003)		
(2)	Top 50%	0.162^a	-0.016^c	-0.010^a	0.177^a	-0.031^a	405381	0.418
		(0.007)	(0.010)	(0.001)	(0.013)	(0.003)		
(3)	Top 25%	0.153^a	0.002	-0.010^a	0.144^a	-0.034^a	232323	0.415
		(0.008)	(0.012)	(0.002)	(0.014)	(0.004)		
(4)	Top 10%	0.151^a	0.021	-0.010^a	0.091^a	-0.029^a	106458	0.434
	(0.012)	(0.017)	(0.003)	(0.017)	(0.005)			
(5)	Top 5%	0.131^a	0.054^b	-0.008^b	0.101^a	-0.026^a	62228	0.449
		(0.017)	(0.022)	(0.004)	(0.024)	(0.006)		

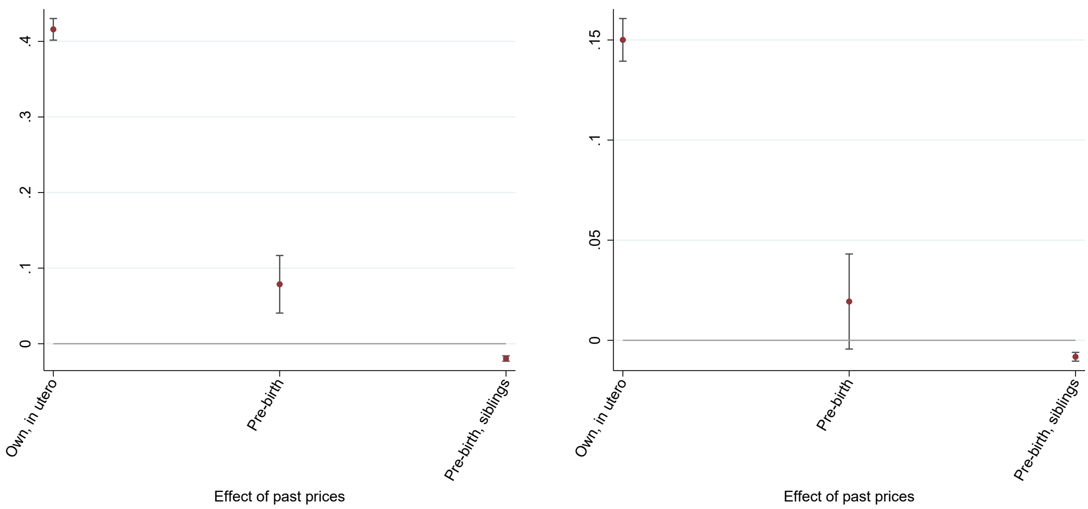
^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. Samples defined by birth probabilities, as predicted by equation 20. The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

D.2 Time-varying controls

We add to our baseline estimations the following time-varying, cell-specific controls: the occurrence of conflict events from UCDP-GED; rainfall, temperature.

Figure A.8: Effect of price variations on child health and investments (additional controls)

(a) Child health (b) Health investments



Note: OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero prices ("Own, in utero"), the prices before birth of the child and outside of any in-utero period ("Pre-birth"), the in-utero prices of older siblings ("Pre-birth,siblings"). The bars represent 95% confidence intervals. The underlying regression controls for gender, twin, month of birth, birth order and age dummies (in months). The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level. These estimations also control for rainfall, temperature, and number of conflict events observed in the cell during in utero periods.

Table A.16: Full baseline results with time-varying controls

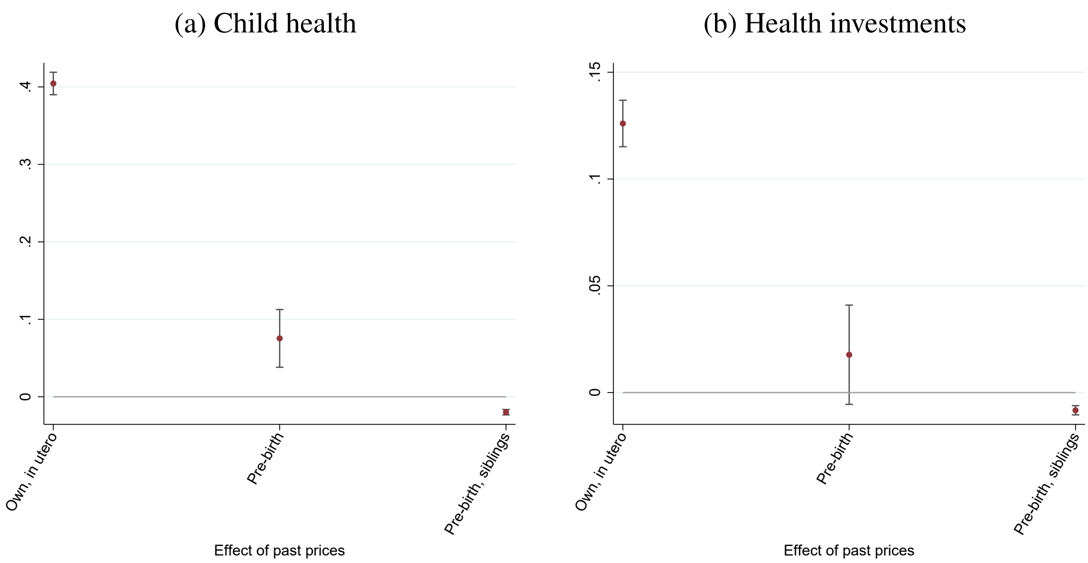
Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.416^a (0.007)	0.079^a (0.016)	-0.020^a (0.002)	0.450^a (0.019)	0.042^a (0.003)	499029	0.525
(2)	Health Investments	0.150^a (0.005)	0.019^b (0.009)	-0.008^a (0.001)	0.232^a (0.012)	-0.028^a (0.003)	730268	0.463

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, of polio vaccine, of the BCG vaccine, of the measles vaccine, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. These estimations also control for rainfall, temperature, and number of conflict events observed in the cell during in utero periods.

D.3 Alternative dimensions of fixed effects

We first replace birth-of-month dummies with country-birth-of-month dummies (Figure A.9 and Table A.17). This more demanding specification controls for country-specific seasonality (e.g., due to geography and climate) that may affect agricultural production and hence local exposure to the world prices of produced commodities. The point estimates on the price variables have the same sign and are similar in size to the ones of our benchmark specifications, suggesting that controlling more precisely for seasonality does not affect our main findings. We then include year×month fixed effects. The results are provided in Table A.18 and Figure A.10.

Figure A.9: Exposure to world crop prices, health outcomes, and parental investments – Birth month-country fixed effects



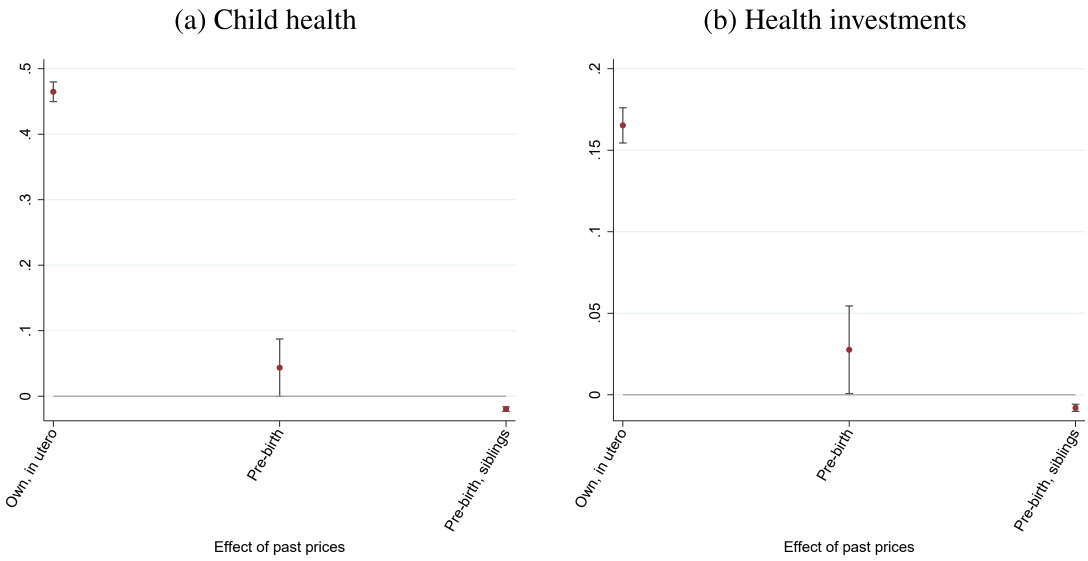
Note: OLS estimation. The unit of observation is a child. In the “Child health” panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the “Health investments” panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero prices (“Own, in utero”, α in eq (5)), the prices before birth of the child and outside of any in-utero period (“Pre-birth”, β^{pre} in eq (5)), the in-utero prices of older siblings (“Pre-birth,siblings”, $\beta^{S,pre}$ in eq (5)). The bars represent 95% confidence intervals. The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the country-month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects, as well as birth month-country fixed effects. Standard errors are clustered at the cell level.

Table A.17: Estimates of the effect of price variations on child health and investments, Birth month-country fixed effects

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.404^a	0.075^a	-0.020^a	0.413^a	0.041^a	501011	0.529
		(0.007)	(0.016)	(0.002)	(0.019)	(0.003)		
(2)	Health Investments	0.126^a	0.018^c	-0.008^a	0.204^a	-0.029^a	733247	0.468
		(0.006)	(0.009)	(0.001)	(0.012)	(0.003)		

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. The sample includes only households that are classified as urban in the DHS data and that report not holding any agricultural land or working in occupations other than agricultural activities. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. All regressions have cell and country-(survey)year fixed effects, as well as country- birth month fixed effects.

Figure A.10: Exposure to world crop prices, health outcomes, and parental investments – year-month fixed effects



Note: OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero prices ("Own, in utero", α in eq (5)), the prices before birth of the child and outside of any in-utero period ("Pre-birth", β^{pre} in eq (5)), the in-utero prices of older siblings ("Pre-birth,siblings", $\beta^{S,pre}$ in eq (5)). The bars represent 95% confidence intervals. The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the country-month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects, as well as year-month fixed effects. Standard errors are clustered at the cell level.

Table A.18: Estimates of the effect of price variations on child health and investments, year-month fixed effects

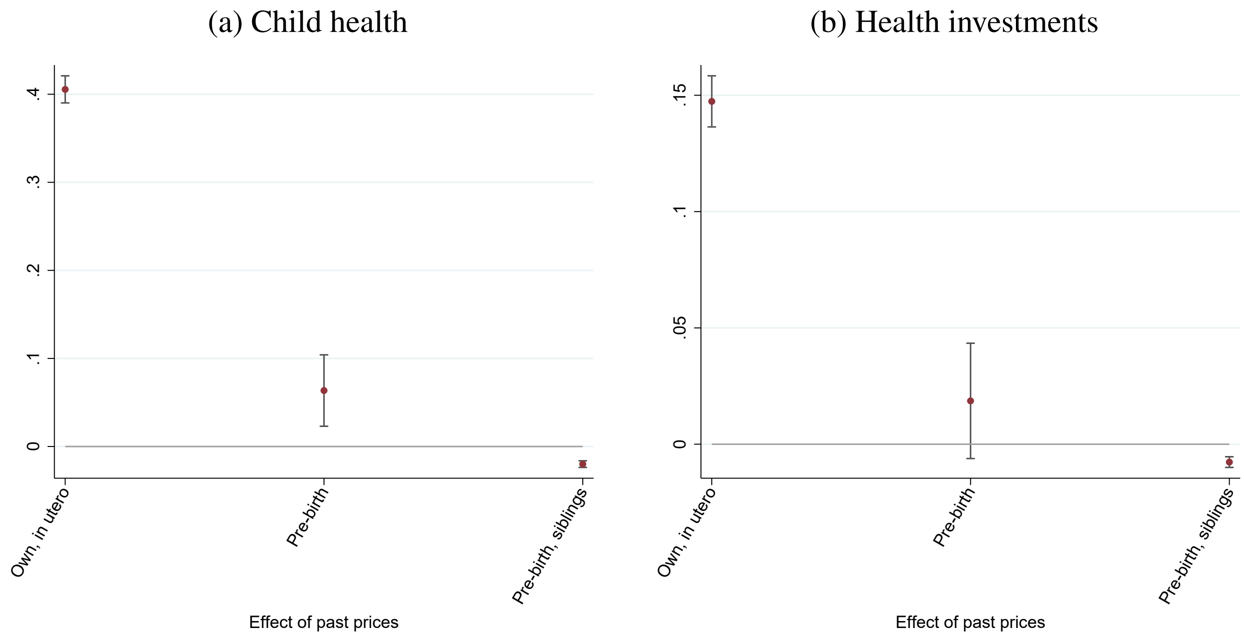
Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.417[a]	0.122[a]	-0.015[a]	0.551[a]	0.023[a]	279945	0.596
		(0.008)	(0.022)	(0.002)	(0.025)	(0.004)		
(2)	Health Investments	0.135[a]	0.048[a]	-0.006[a]	0.268[a]	-0.010[a]	383385	0.582
		(0.006)	(0.010)	(0.001)	(0.012)	(0.003)		

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. The sample includes only households that are classified as urban in the DHS data and that report not holding any agricultural land or working in occupations other than agricultural activities. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. All regressions have cell and country-(survey)year fixed effects, as well as year-month fixed effects.

D.4 Supply shocks and market power

Variations in prices could be triggered by external demand shocks or local supply shocks. Supply shocks may be problematic, as they could correlate with local economic conditions that may affect parental decisions and child health. However, countries in our sample are typically small from a world perspective: the median *maximum* share of a country in a given crop over the entire period is around 4.5%. Using data from the FAO Agro-Stats on international trade in each of the crops we consider, we perform two sensitivity exercises to check that our results are not driven by large crop producers. First, for each cell we compute a market share measure based on each crop suitability and on the share of the country in world trade. The measure equals the average country market share in each crop weighted by cell-specific crop suitability. We remove from the sample all cells belonging to the top decile of this measure and reproduce our estimations. The results, which appear in Figure A.11 and A.19, are very similar to the baseline.

Figure A.11: Effect of price variations on child health and investments, excl. top market share cells



Note: In panel (a), the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In panel (b), the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero prices ("Own, in utero", α in eq (5)), the prices before birth of the child and outside of any in-utero period ("Pre-birth", β^{pre} in eq (5)), the in-utero prices of older siblings ("Pre-birth,siblings", $\beta^{S,pre}$ in eq (5)). The bars represent 95% confidence intervals. The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level. In these estimations, we restrict the sample to cells below top decile of world market share in the crop they are suitable to.

Table A.19: Estimates of the effect of price variations on child health and investments, excluding top market share cells

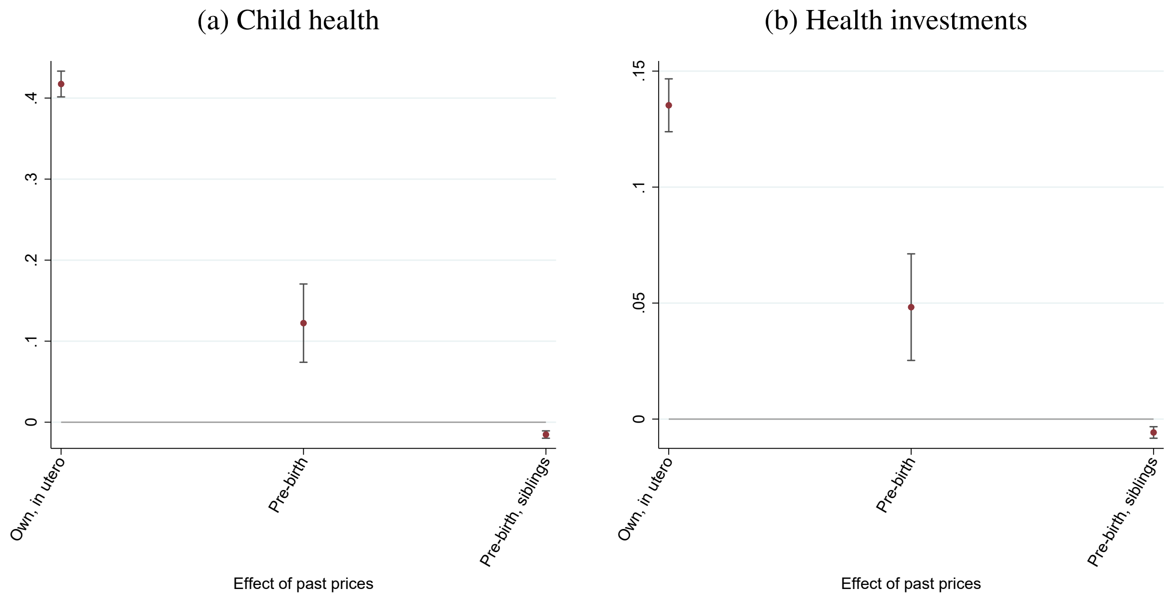
Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.406[a]	0.064[a]	-0.020[a]	0.439[a]	0.044[a]	452592	0.517
		(0.008)	(0.018)	(0.002)	(0.021)	(0.004)		
(2)	Health Investments	0.147[a]	0.019[b]	-0.008[a]	0.238[a]	-0.027[a]	663084	0.466
		(0.006)	(0.009)	(0.001)	(0.013)	(0.003)		

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. The sample includes only households that are classified as urban in the DHS data and that report not holding any agricultural land or working in occupations other than agricultural activities. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. In this table we restrict the sample to cells below top decile of world market share in the crop they are suitable to.

D.5 Children with health card

Measurement error can arise due to the misreporting of the child month of birth in the DHS data. It has also been shown that reporting errors mostly arise when enumerators do not see the health card of the child (Larsen et al., 2019). As an additional robustness, we will run the estimation on the subsample of children whose health card has been seen by the enumerator. The results are shown in Table A.20 and Figure A.12.

Figure A.12: Exposure to world crop prices, health outcomes, and parental investments – health card



Note: OLS estimation. The unit of observation is a child. Sample restricted to children whose health card has been seen by the enumerator. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero prices ("Own, in utero", α in eq (5)), the prices before birth of the child and outside of any in-utero period ("Pre-birth", β^{pre} in eq (5)), the in-utero prices of older siblings ("Pre-birth,siblings", $\beta^{S,pre}$ in eq (5)). The bars represent 95% confidence intervals. The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the country-month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

Table A.20: Estimates of the effect of price variations on child health and investments, health card

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.404[a]	0.075[a]	-0.020[a]	0.413[a]	0.041[a]	501011	0.529
		(0.007)	(0.016)	(0.002)	(0.019)	(0.003)		
(2)	Health Investments	0.126[a]	0.018[c]	-0.008[a]	0.204[a]	-0.029[a]	733247	0.468
		(0.006)	(0.009)	(0.001)	(0.012)	(0.003)		

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Sample restricted to children whose health card has been seen by the enumerator. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. All regressions have cell and country-(survey)year fixed effects, as well as country- birth month fixed effects.

D.6 Conley standard errors

Table A.21: Baseline results, Spatially Correlated s.e.

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.416	0.076	-0.020	0.452	0.042	501011	0.525
	Baseline (cell-level)	(0.007)[a]	(0.017)[a]	(0.002)[a]	(0.019)[a]	(0.003)[a]		
	Spatial, 100km	(0.012)[a]	(0.021)[a]	(0.002)[a]	(0.024)[a]	(0.004)[a]		
	Spatial, 500km	(0.025)[a]	(0.034)[b]	(0.002)[a]	(0.037)[a]	(0.005)[a]		
	Spatial, 1000km	(0.028)[a]	(0.037)[b]	(0.003)[a]	(0.043)[a]	(0.006)[a]		
(2)	Health Investments	0.149	0.020	-0.008	0.233	-0.028	733247	0.463
	Baseline (cell-level)	(0.005)[a]	(0.009)[b]	(0.001)[a]	(0.012)[a]	(0.003)[a]		
	Spatial, 100km	(0.010)[a]	(0.016)	(0.001)[a]	(0.020)[a]	(0.003)[a]		
	Spatial, 500km	(0.019)[a]	(0.033)	(0.002)[a]	(0.034)[a]	(0.005)[a]		
	Spatial, 1000km	(0.022)[a]	(0.039)	(0.002)[a]	(0.039)[a]	(0.005)[a]		

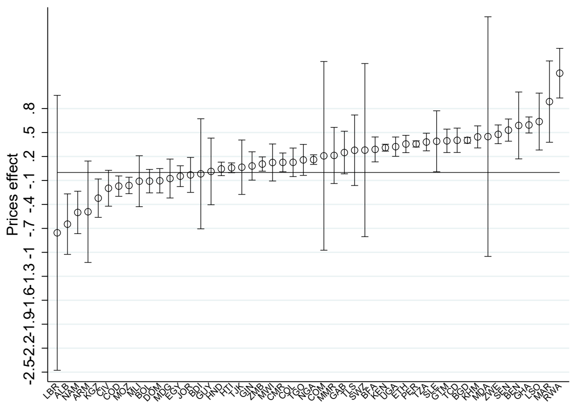
[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level and spatially at different radii. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months.

D.7 Country heterogeneity

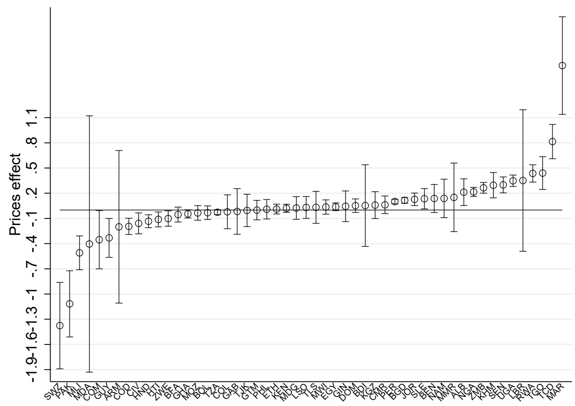
An advantage of our empirical setting is the availability of comparable data on children's health and parental investments across 54 developing countries. We exploit this feature of the data and allow the coefficient on the price variable to vary across countries. This exercise serves also as a further check on the stability of our findings across regions. The results for our main price coefficients – own child in-utero prices and older siblings in-utero prices – are reported in Figures A.13 and A.14. In most countries the estimates are of the same sign as in our baseline results; more precisely, they are positive for the own child in-utero variable and negative for the older siblings in-utero variable. This suggests that our results are not driven by a few specific countries.

Figure A.13: Country-specific coefficients – own child in-utero prices

(a) Child health



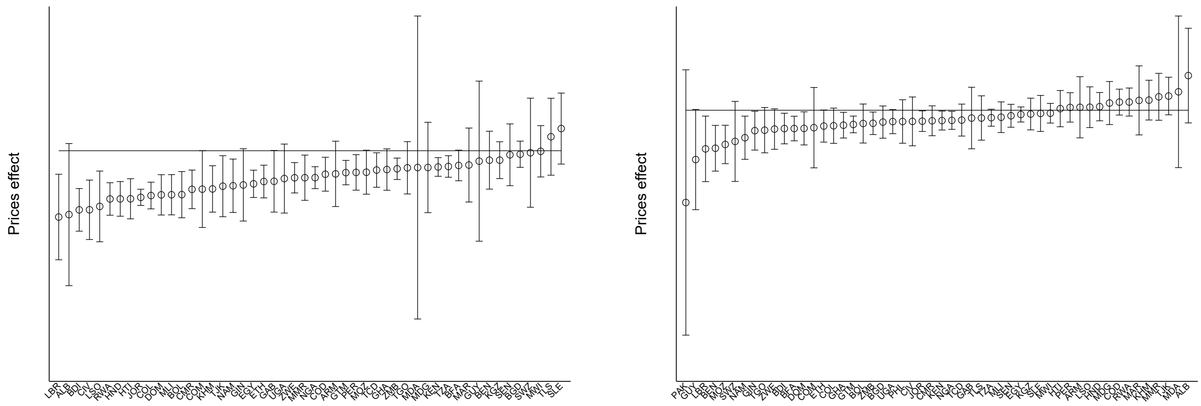
(b) Health investments



Note: OLS estimation. The unit of observation is a child. Each dot and bars refer to a country-specific sample. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the in-utero prices of the child (α_i in eq (5)). The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and (survey)year fixed effects. Standard errors are clustered at the cell level.

Figure A.14: Country-specific coefficients – older siblings in-utero prices

(a) Child health (b) Health investments



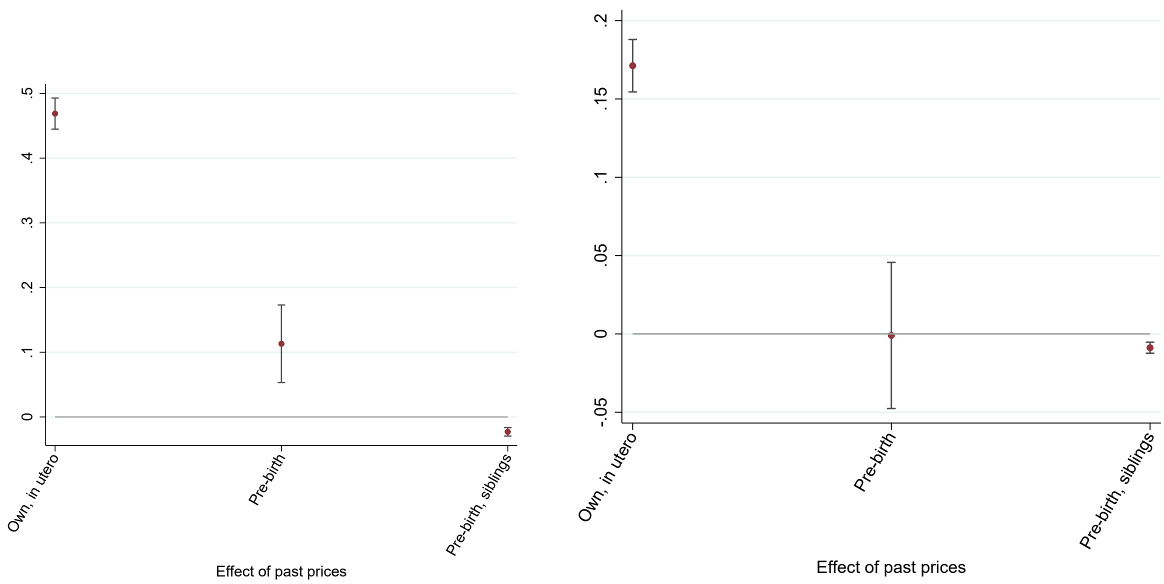
Note: OLS estimation. The unit of observation is a child. Each dot and bars refer to a country-specific sample. In the “Child health” panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the “Health investments” panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the in-utero prices of the older siblings ($\beta_i^{S,pre}$ in eq (5)). The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and (survey)year fixed effects. Standard errors are clustered at the cell level.

D.8 Migration

Given that we look at past income variations, it is possible that the current location of households is different that their location at the time of the child's early life. This could induce measurement error in our agricultural price variable and attenuation bias in our estimates. In this section we restrict the sample to mothers who have been living in their current location at least since the child's birth. This results in a 50% reduction in sample size, mostly because the migration variable is available for only 60% of the observations. Despite this, our results remain stable.

Figure A.15: Effect of price variations on child health and investments, excl. migrants

(a) Child health (b) Health investments



Note: In panel (a), the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In panel (b), the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero prices ("Own, in utero", α in eq (5)), the prices before birth of the child and outside of any in-utero period ("Pre-birth", β^{pre} in eq (5)), the in-utero prices of older siblings ("Pre-birth,siblings", $\beta^{S,pre}$ in eq (5)). The bars represent 95% confidence intervals. The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level. Households who declare they have migrated to the cell are excluded from the sample.

Table A.22: Estimates of the effect of price variations on child health and investments, excluding migrants

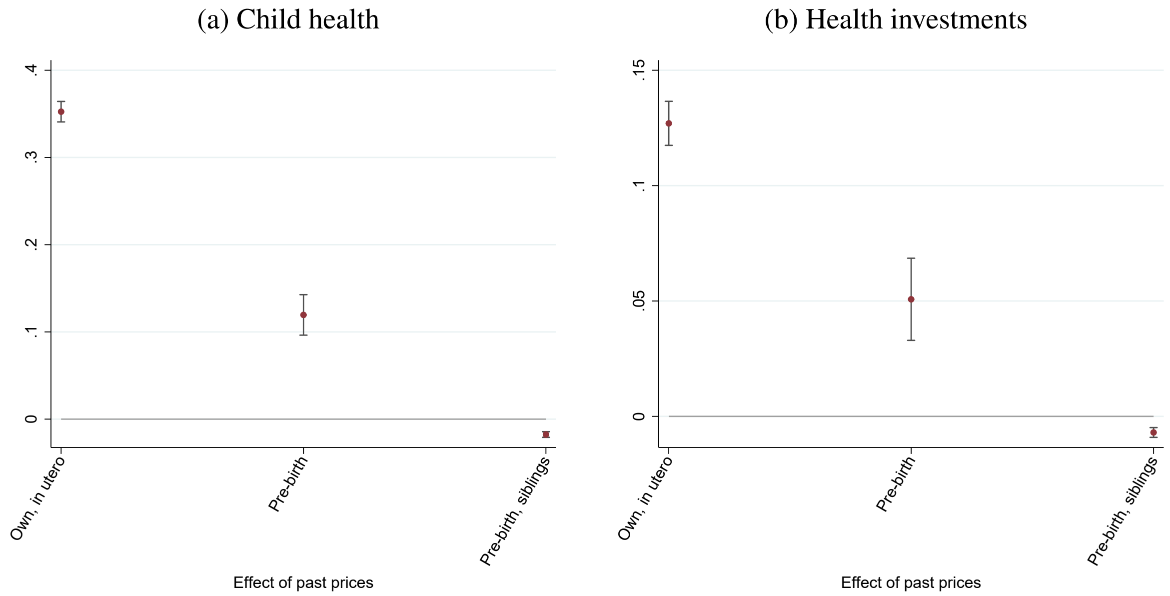
Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.469^a	0.113^a	-0.023^a	0.923^a	0.044^a	227221	0.531
		(0.012)	(0.026)	(0.003)	(0.031)	(0.006)		
(2)	Health Investments	0.171^a	-0.001	-0.009^a	0.433^a	-0.051^a	327536	0.466
		(0.009)	(0.018)	(0.002)	(0.024)	(0.006)		

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. The sample includes only households that are classified as urban in the DHS data and that report not holding any agricultural land or working in occupations other than agricultural activities. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. Households who declare they have migrated to the cell are excluded from the sample.

D.9 Alternative agricultural specialization measure (M3-crop)

In this section, we check the robustness of our results to the use of an alternative measure of agricultural specialization from M3-Crop (Monfreda et al., 2008). M3-crop data contains information on the actual harvested area rather than soil suitability. Prices are in this case weighted by the crop share of harvested area in 2000 in the cell. M3 crop is arguably a more precise measure of specialization, but also a more endogenous one, as agricultural output might be affected by local shocks correlated with health conditions. The results, however, are very similar to our baseline ones.

Figure A.16: Effect of price variations on child health and investments (M3 crop data)



Note: OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero prices ("Own, in utero"), the prices before birth of the child and outside of any in-utero period ("Pre-birth"), the in-utero prices of older siblings ("Pre-birth,siblings"). Prices uses underlying data from M3-crop on cell-level production in 2000. The bars represent 95% confidence intervals. The underlying regression is as in eq (5) and includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level. These estimations also control for rainfall, temperature, and number of conflict events observed in the cell during in utero periods.

Table A.23: Full baseline results – M3 crop data

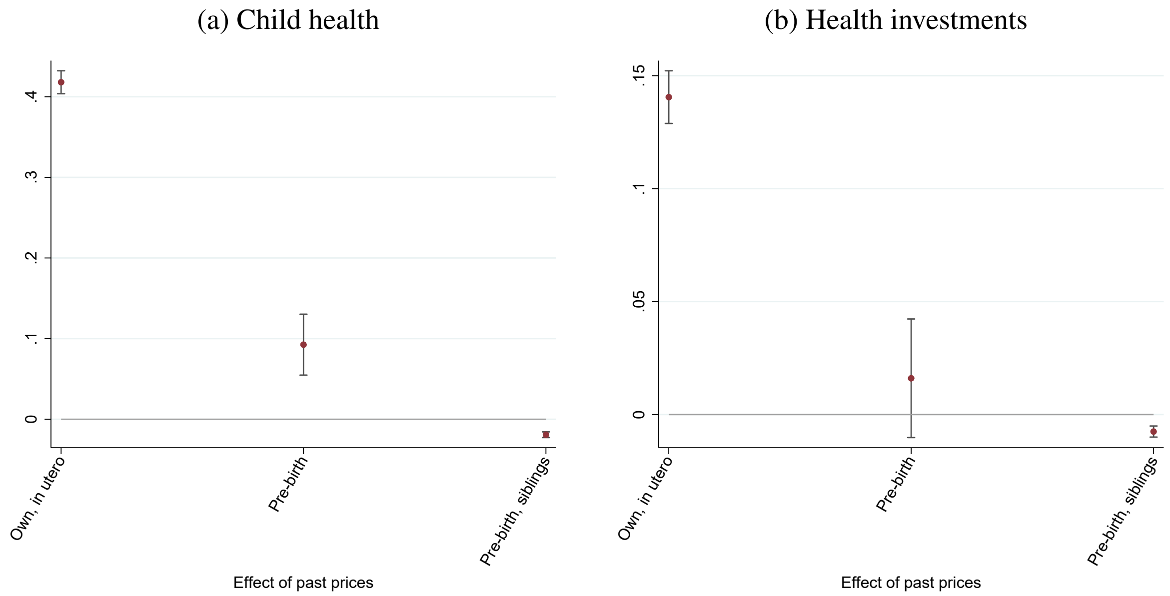
Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.353[a]	0.119[a]	-0.018[a]	0.398[a]	0.041[a]	502708	0.521
		(0.006)	(0.012)	(0.002)	(0.012)	(0.003)		
(2)	Health Investments	0.127[a]	0.051[a]	-0.007[a]	0.195[a]	-0.023[a]	731870	0.462
		(0.005)	(0.007)	(0.001)	(0.009)	(0.003)		

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. Prices uses underlying data from M3-crop on cell-level production in 2000. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. These estimations also control for rainfall, temperature, and number of conflict events observed in the cell during in utero periods.

D.10 Estimation samples

Table A.24 and Figure A.17 report the results obtained when restricting the sample to children for whom both the health index and the investment index are available.

Figure A.17: Effect of price variations on child health and investments – stable sample



Note: OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero prices ("Own, in utero"), the prices before birth of the child and outside of any in-utero period ("Pre-birth"), the in-utero prices of older siblings ("Pre-birth,siblings"), the prices after birth of the child and outside of any in-utero period ("Post-birth"), and the in-utero prices of older siblings ("Post-birth,siblings"). The bars represent 95% confidence intervals. The underlying regression is as in eq (5) and includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level. Estimations include children for whom both the health index and the investment index are available.

Table A.24: Baseline results - stable sample

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.418^a	0.093^a	-0.019^a	0.475^a	0.044^a	498352	0.527
		(0.007)	(0.016)	(0.002)	(0.019)	(0.003)		
(2)	Health Investments	0.141^a	0.016	-0.008^a	0.223^a	-0.026^a	498352	0.477
		(0.006)	(0.010)	(0.001)	(0.013)	(0.003)		

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. Estimations include children for whom both the health index and the investment index are available.

E Interpretation

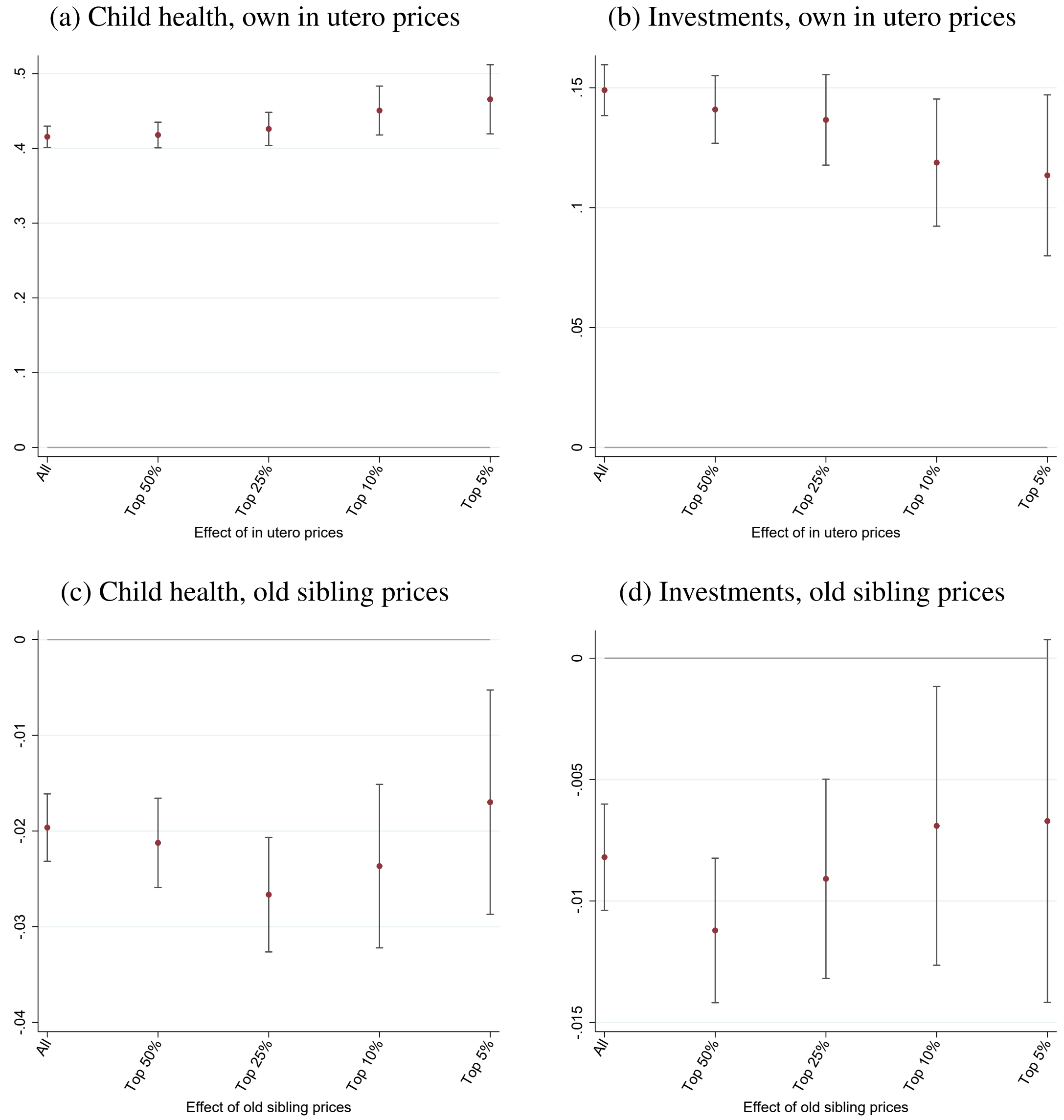
E.1 Sibling mortality and sibling rivalry

In this section we discuss how much of our results come from sibling mortality – the fact that negative shocks affect sibling survival and therefore rivalry. Indeed, our estimates conflate two effects. First, conditional on survival, prices variations in utero affect health investment and child quality, and subsequently the investment in future siblings. Second, in utero price variations may affect mortality. Low prices may trigger death, which frees up resources and diminishes sibling rivalry. Our model and baseline empirical results are consistent with both channels: our estimates encompass the effect of siblings mortality, as we include in utero prices, regardless of whether the siblings are alive at the time of the survey. Here we try to jauge how much of our baseline estimates comes from the sibling selection channel. To do so, we compute child-specific survival probabilities using equation (5). We then restrict the sample to children whose elder siblings have a high survival probability – similarly to what we did in Table A.14, except that samples are defined according to the survival probability of elder siblings rather than of the child himself.[26]

The results are shown in Figure A.18, and the coefficients in Table A.25. Of particular interests are the sibling effects shown in A.18.c and A.18.d. We find that they are slightly smaller, in absolute terms, in samples unaffected by sibling mortality. This is consistent with the fact that sibling rivalry partly goes through mortality. However, even in the more restrictive sample where sibling survival probabilities lie in the top 5 percentiles, the coefficients are quite similar to our baseline: -0.017 versus -0.020 in the case of health ; and -0.007 versus -0.008 in the case of investments. Hence, though sibling rivalry is affected by mortality, the contribution of selection is rather moderate.

[26] First born children, for whom older siblings' survival probability cannot be defined, are included in all samples.

Figure A.18: Effects of price variation on health and investment by subsamples of increasing siblings' survival probability



Note: OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. In figures (a) and (b), the dots are averages across coefficients for the child in-utero prices. In figures (c) and (d), the dots are averages across coefficients for the in-utero prices of older siblings. Samples are defined according to the child's elder siblings' average survival probability, as predicted by our baseline specification. First born children (for whom older siblings' survival probability cannot be defined) are always included. The regressions include child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

Table A.25: Selection: identification-at-infinity, sibling mortality, detailed results

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
Child Health								
(1)	All	0.416[a]	0.076[a]	-0.020[a]	0.452[a]	0.042[a]	501011	0.525
		(0.007)	(0.017)	(0.002)	(0.019)	(0.003)		
(2)	Top 50%	0.418[a]	0.132[a]	-0.021[a]	0.469[a]	0.045[a]	205396	0.564
		(0.009)	(0.024)	(0.002)	(0.031)	(0.006)		
(3)	Top 25%	0.426[a]	0.142[a]	-0.027[a]	0.462[a]	0.049[a]	109134	0.573
		(0.011)	(0.036)	(0.003)	(0.047)	(0.010)		
(4)	Top 10%	0.451[a]	0.134[a]	-0.024[a]	0.402[a]	0.052[a]	47096	0.570
		(0.017)	(0.050)	(0.004)	(0.065)	(0.013)		
(5)	Top 5%	0.466[a]	0.103	-0.017[a]	0.351[a]	0.052[a]	26818	0.561
		(0.024)	(0.063)	(0.006)	(0.080)	(0.016)		
Health investments								
(1)	All	0.149[a]	0.020[b]	-0.008[a]	0.233[a]	-0.028[a]	733247	0.463
		(0.005)	(0.009)	(0.001)	(0.012)	(0.003)		
(2)	Top 50%	0.141[a]	0.066[a]	-0.011[a]	0.238[a]	-0.025[a]	289444	0.486
		(0.007)	(0.011)	(0.002)	(0.016)	(0.005)		
(3)	Top 25%	0.137[a]	0.103[a]	-0.009[a]	0.260[a]	-0.025[a]	151277	0.522
		(0.010)	(0.016)	(0.002)	(0.022)	(0.007)		
(4)	Top 10%	0.119[a]	0.110[a]	-0.007[b]	0.272[a]	-0.018[c]	68713	0.539
		(0.014)	(0.025)	(0.003)	(0.029)	(0.011)		
(5)	Top 5%	0.113[a]	0.081[b]	-0.007[c]	0.233[a]	-0.032[a]	41865	0.596
		(0.017)	(0.033)	(0.004)	(0.034)	(0.012)		

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. Samples defined by elder siblings' survival probabilities, as predicted by our baseline specification. First born children (for whom older siblings' survival probability cannot be defined) are always included. The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

E.2 Health outcomes and parental investments

Table A.26: Correlation between child health and health investments

Dep. var.	(1)	(2)	(3)	(4)	(5)	(6)
	Child health index		No underheight	No underweight	ln height	ln weight
Investments (own)	0.224[a]	0.311[a]	0.066[a]	0.039[a]	0.035[a]	0.076[a]
	(0.004)	(0.005)	(0.002)	(0.001)	(0.001)	(0.001)
Investments (siblings)		-0.088[a]	-0.013[a]	-0.005[a]	-0.010[a]	-0.022[a]
		(0.004)	(0.002)	(0.001)	(0.001)	(0.001)
Observations	514848	276785	274617	273527	274617	273527
R^2	0.453	0.487	0.201	0.158	0.432	0.444
Child controls	Yes	Yes	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Cell, country × year-of-birth, month-of-birth					

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). Underheight (respectively underweight) is a dummy which equals 1 if the height-for-age (resp. weight-for-age) ratio is at least 2 standard deviations below the z-score from WHO. Ln height (resp. ln weight) is the logs of height (resp. weight) divided by the gender-specific average height (resp. weight) for that particular age in month from WHO. "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The "siblings" health investment index is the average of the index across all siblings.

Table A.27: Correlation between child health and health investments (nonlinearities)

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	Child health index		No underheight	No underweight	ln height	ln weight
Investments (own)	0.170[a]	0.239[a]	0.054[a]	0.030[a]	0.027[a]	0.057[a]
	(0.004)	(0.005)	(0.002)	(0.001)	(0.001)	(0.001)
Investments (own)^2	-0.072[a]	-0.095[a]	-0.016[a]	-0.012[a]	-0.010[a]	-0.025[a]
	(0.004)	(0.005)	(0.002)	(0.001)	(0.001)	(0.001)
Investments (siblings)		-0.077[a]	-0.016[a]	-0.006[a]	-0.009[a]	-0.018[a]
		(0.005)	(0.002)	(0.001)	(0.001)	(0.001)
Investments (siblings)^2		0.013[a]	-0.004[b]	-0.001	0.001	0.005[a]
		(0.005)	(0.002)	(0.001)	(0.001)	(0.001)
Observations	514848	276785	274617	273527	274617	273527
R^2	0.453	0.487	0.201	0.158	0.432	0.444
Child controls	Yes	Yes	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Cell, country × year-of-birth, month-of-birth					

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). Underheight (respectively underweight) is a dummy which equals 1 if the height-for-age (resp. weight-for-age) ratio is at least 2 standard deviations below the z-score from WHO. Ln height (resp. ln weight) is the logs of height (resp. weight) divided by the gender-specific average height (resp. weight) for that particular age in month from WHO. "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The "siblings" health investment index is the average of the index across all siblings.

Table A.28: Child health and price variations controlling for parental health investments

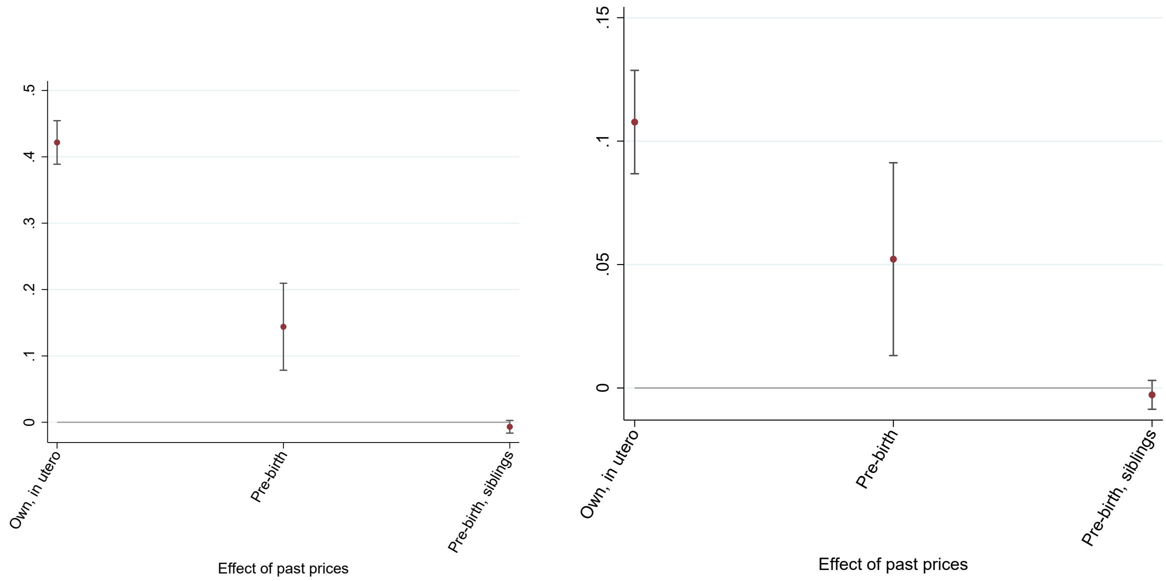
Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Baseline	0.422[a]	0.107[a]	-0.013[a]	0.546[a]	0.026[a]	272386	0.55
		(0.009)	(0.021)	(0.004)	(0.023)	(0.006)		
(2)	Controlling for investment	0.403[a]	0.100[a]	-0.011[a]	0.503[a]	0.028[a]	272386	0.56
		(0.008)	(0.021)	(0.004)	(0.022)	(0.006)		

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. "Controlling for investments" further controls for the investment index of the child and the average index across siblings. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months.

E.3 Urban Sample

Figure A.19: Urban sample: effect of price variations on child health and investments

(a) Child health (b) Health investments



Note: Sample restricted the "urban" househoelds, defined as the set of households that are classified as urban in the DHS data and that report not holding any agricultural land or working in occupations other than agricultural activities. In panel (a), the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In panel (b), the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero prices ("Own, in utero", α in eq (5)), the prices before birth of the child and outside of any in-utero period ("Pre-birth", β^{pre} in eq (5)), the in-utero prices of older siblings ("Pre-birth,siblings", $\beta^{S,pre}$ in eq (5)). The underlying regression includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

Table A.29: Estimates of the effect of price variations on child health and investments (urban)

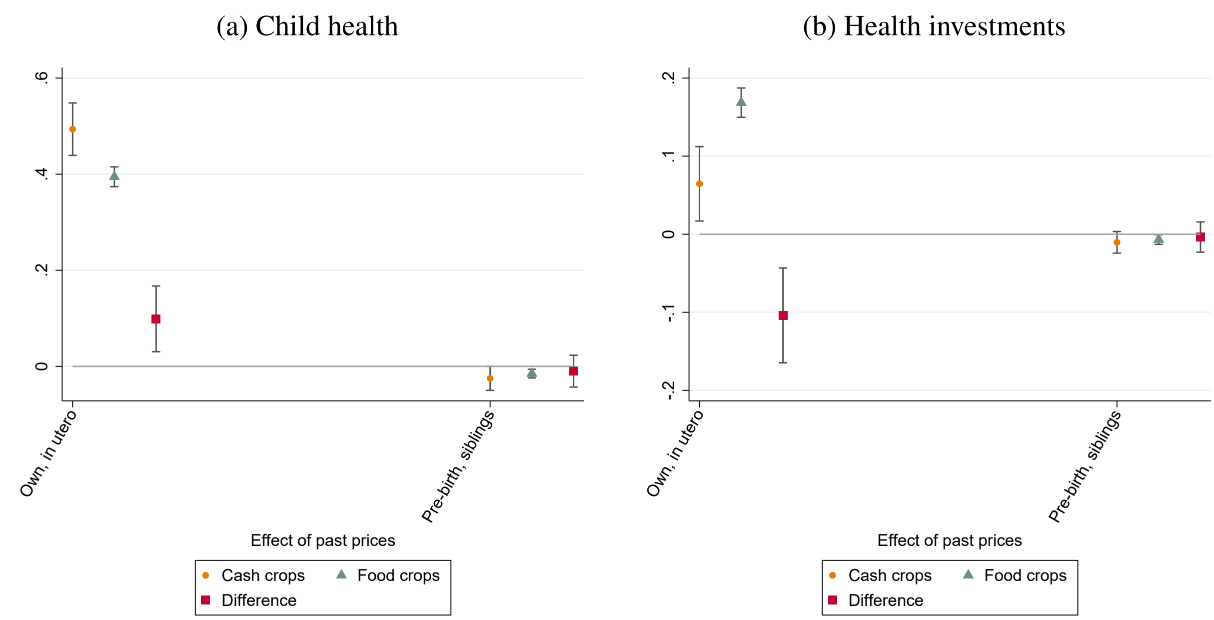
Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.422^a	0.144^a	-0.007	0.602^a	0.044^a	65887	0.518
		(0.017)	(0.039)	(0.005)	(0.033)	(0.009)		
(2)	Health Investments	0.108^a	0.052^b	-0.003	0.196^a	-0.016^b	85122	0.484
		(0.011)	(0.020)	(0.003)	(0.020)	(0.007)		

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. The sample includes only households that are classified as urban in the DHS data and that report not holding any agricultural land or working in occupations other than agricultural activities. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs). "Health investments" is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months.

E.4 Cash vs food crops

Our empirical strategy and results are consistent with the interpretation of variation in the crop price index as a positive shifter of local income. A check on this interpretation consists in splitting our price index (see eq. (1)) into the constructed local price of "cash" crops as defined by McGuirk and Burke (2020) (in our sample, cocoa, coffee, cotton, tea and tobacco) – which should be mainly for production, and the other crops – which could be traded or consumed. We report below the results from specifications specification where the two price variables are included simultaneously as determinants of child health and parental investments. Each price variable is weighted by the share of each type of crops (food or cash) in the cell to make the two variables comparable. The results in Figure A.20 and Table A.30 show that, though estimated less precisely, the effect of cash crop prices is of the same sign and generally slightly larger than that of food crops. A limitation of this exercise is the use of agricultural suitability rather than actual crop production. The GAEZ data that we use to compute crop suitability considers "potential yields". Hence, it might underestimate the weight of cash crops in production: because cash crops are more profitable, they may be produced even when agricultural suitability is relatively low. In Figure A.21 and Table A.31 we perform the same exercise using M3 crop data instead of GAEZ to measure local exposure to world crop prices. M3 crop provides the actual crop production instead of land suitability. While this can raise endogeneity concerns, it avoids the bias coming from GAEZ data when an area produces profitable cash crops even when the land is poorly suitable for it. The results of the cash vs food crops split are much clearer with the M3 crop data. Both the own child and sibling effects are significantly stronger for cash crop than food crop prices.

Figure A.20: Cash vs. food crops: main estimates



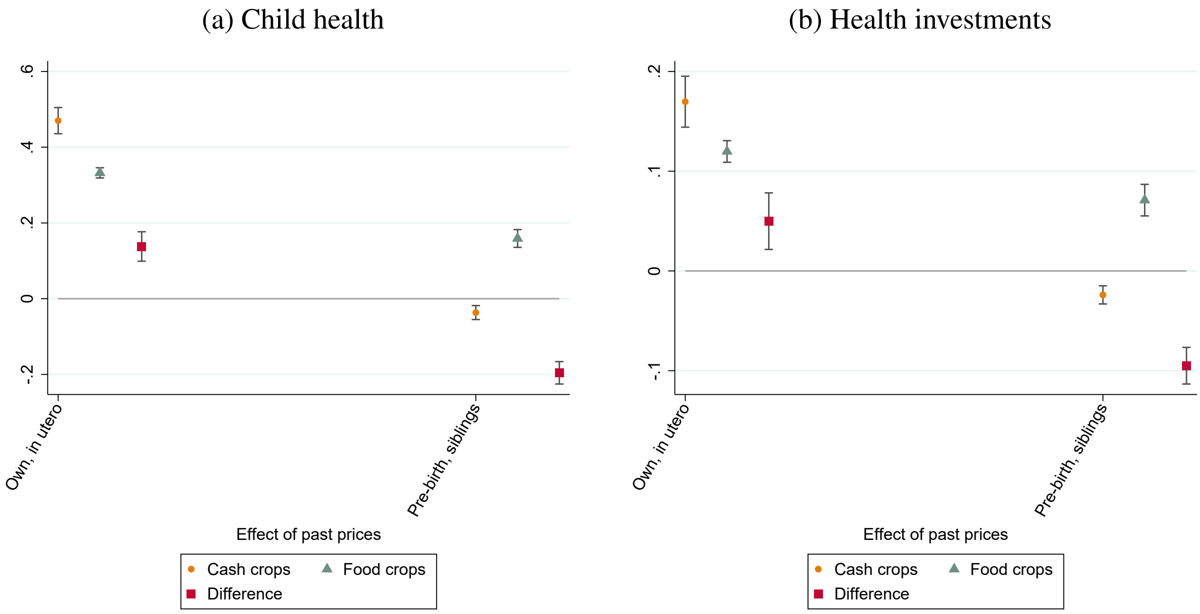
Note: OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero and the older siblings in-utero cash and crop prices, and their differences. The bars represent 95% confidence intervals. The underlying regression include child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

Table A.30: Cash vs food crops: detailed estimates

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health: cash crops	0.493^a	0.097^b	-0.025^c	0.702^a	0.086^a	481635	0.495
		(0.028)	(0.039)	(0.013)	(0.040)	(0.016)		
	food crops	0.395^a	0.173^a	-0.015^a	0.473^a	0.029^a		
		(0.011)	(0.019)	(0.005)	(0.018)	(0.007)		
(2)	Health Invest.: cash crops	0.065^a	0.050	-0.010	0.287*a*	-0.036^b	709648	0.464
		(0.024)	(0.034)	(0.007)	(0.031)	(0.016)		
	food crops	0.169^a	0.057^a	-0.007^b	0.247^a	-0.025^a		
		(0.010)	(0.013)	(0.003)	(0.014)	(0.007)		

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. All estimations include child controls (gender, birth order dummies, twin dummy, age in month dummies), mother controls (age and age squared, number of children dummies, education dummies, wealth categories dummies), cell fixed-effects, country × year-of-birth fixed effects and month-of-birth fixed effects. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The reported estimates are averages across coefficients for the child in-utero, pre-birth, older siblings in-utero, post-birth and younger siblings in-utero cash and food crop prices.

Figure A.21: Cash vs. food crops: main estimates (M3-crop)



Note: OLS estimation. The unit of observation is a child. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The dots are averages across coefficients for the child in-utero and the older siblings in-utero cash and crop prices, and their differences. The price variables are computed using M3 crop data. The bars represent 95% confidence intervals. The underlying regression include child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

Table A.31: Cash vs food crops: detailed estimates (M3-crop)

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health: cash crops	0.470[a]	0.238[a]	-0.037[a]	0.521[a]	0.018	494603	0.522
		(0.018)	(0.028)	(0.009)	(0.029)	(0.013)		
	food crops	0.332[a]	0.159[a]	-0.014[a]	0.422[a]	0.046[a]		
		(0.007)	(0.012)	(0.002)	(0.012)	(0.004)		
(2)	Health Invest.: cash crops	0.170[a]	0.057[a]	-0.024[a]	0.196[a]	-0.081[a]	714860	0.464
		(0.013)	(0.019)	(0.005)	(0.023)	(0.014)		
	food crops	0.120[a]	0.071[a]	-0.004[a]	0.201[a]	-0.014[a]		
		(0.006)	(0.008)	(0.001)	(0.009)	(0.003)		

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. All estimations include child controls (gender, birth order dummies, twin dummy, age in month dummies), mother controls (age and age squared, number of children dummies, education dummies, wealth categories dummies), cell fixed-effects, country × year-of-birth fixed effects and month-of-birth fixed effects. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The reported estimates are averages across coefficients for the child in-utero, pre-birth, older siblings in-utero, post-birth and younger siblings in-utero cash and food crop prices. Price indexes are computed using M3 crop data.

E.5 Export weights in the local price index

In this section we pursue an alternative strategy to show that our price index indeed affects farmer income, especially when the crops are internationally traded. We compute a version of the price index where prices are not only weighted by a cell's agricultural suitability ((1)), but also by the share of that crop in the country's total exports at the beginning of the period (before 2000). We include both our baseline price index and the export weighted price index in our estimations. As shown in Table A.32, we do find significant results on the export-weighted price index, controlling for the baseline price index. This suggests that the effect is indeed magnified for crops that are exported more – i.e., for which sales matter more.

Table A.32: Child health, parental investments and early life export-weighted crop prices

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health: Export weighted prices	0.796^a	-0.046	-0.032	0.569^a	-0.261^a	500754	0.526
		(0.090)	(0.092)	(0.031)	(0.132)	(0.053)		
	Baseline prices	0.375^a	0.096^a	-0.018^a	0.456^a	0.051^a		
		(0.009)	(0.016)	(0.002)	(0.018)	(0.004)		
(2)	Health Invest.: Export weighted prices	0.407^a	-0.344^a	-0.066^a	0.937^a	-0.081^c	732820	0.466
		(0.057)	(0.071)	(0.020)	(0.089)	(0.045)		
	Baseline prices	0.121^a	0.045^a	-0.005^a	0.229^a	-0.026^a		
		(0.006)	(0.010)	(0.001)	(0.013)	(0.004)		

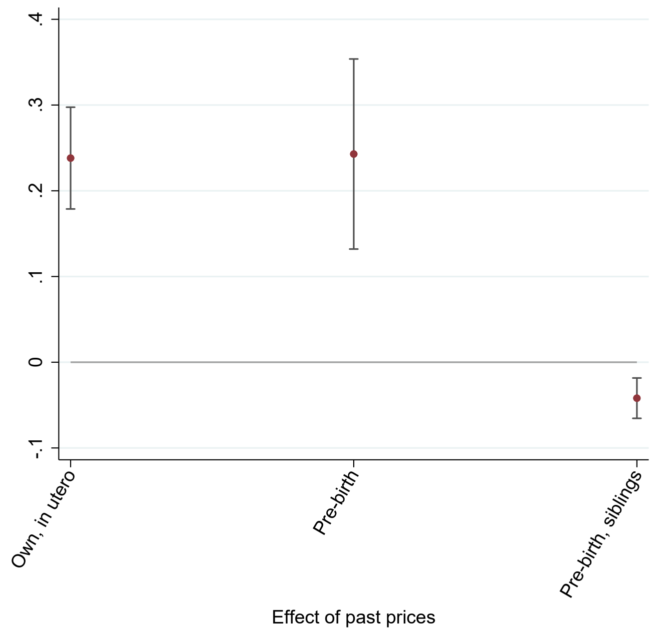
^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. All estimations include child controls (gender, birth order dummies, twin dummy, age in month dummies), mother controls (age and age squared, number of children dummies, education dummies, wealth categories dummies), cell fixed-effects, country $\times$ year-of-birth fixed effects and month-of-birth fixed effects. In the "Child health" panel, the outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). In the "Health investments" panel, the outcome variable is the average of the following child-specific health investment indicators, all standardized: a dummy for being breastfed in the first six months of life, a dummy for having received the expected doses of the DPT vaccine, polio vaccine, BCG vaccine, measles vaccines, a dummy for having received vitamin A supplement in the last six months, a dummy for receiving deworming treatment in the last six months. The reported estimates are averages across coefficients for the child in-utero, pre-birth, older siblings in-utero, post-birth and younger siblings in-utero export-weighted and baseline crop prices. In the export-weighted crop prices, world crop prices are weighted by the crop share of suitable land and by the crop share of agricultural exports at the country level.

F Other parental investments

F.1 LSMS Results - child and parental time use

Child health. We first use the LSMS data to replicate our baseline estimations. The results, shown in Figure A.22 and Table A.33, are similar to our baseline.

Figure A.22: Baseline results: effect of price variations on child health (LSMS)



Note: OLS estimation. LSMS data. The unit of observation is a child. The outcome variable is the average of the standardized and age-adjusted child weight and height (both in logs). The dots are averages across coefficients for the child in-utero prices ("Own, in utero", α in eq (5)), the prices before birth of the child and outside of any in-utero period ("Pre-birth", β^{pre} in eq (5)), the in-utero prices of older siblings ("Pre-birth,siblings", $\beta^{S,pre}$ in eq (5)), the prices after birth of the child and outside of any in-utero period ("Post-birth", β^{post} in eq (5)). The bars represent 95% confidence intervals. The underlying regression is as in eq (5) and includes child-level controls for gender, twin dummy, age dummies (in months), dummies for birth order and for the month of birth. The model also includes the age of the mother (its level and squared), dummies for the education of the mother, for the wealth of the mother, for the number of children of the mother, and for the classification of the region as urban or rural. All regressions have cell and country-(survey)year fixed effects. Standard errors are clustered at the cell level.

Parental time use. Table A.34 shows the results of the estimation of equation (6) (see main text). The table reports the average estimated β^u, β^{nu} and differences between the two. We also shows that the results are similar when allowing for spatially correlated error term.

Table A.33: Baseline results (LSMS data)

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Child Health	0.238	0.243	-0.042	0.174	0.002	14936	0.453
		$(0.030)^a$	$(0.074)^a$	$(0.012)^b$	$(0.057)^a$	(0.022)		
		$[0.039]^a$	$[0.086]^a$	$[0.010]^a$	$[0.067]^a$	[0.022]		

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. LSMS data. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses; or allowing for spatial correlation within a 500km radius and infinite serial correlation in brackets. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period. In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-uteor periods. "Child health" is the average of the standardized and age-adjusted child weight and height (both in logs).

Table A.34: Parental time use (LSMS data)

Est.	Hours working inside HH		Working outside HH	
	Father	Mother	Father	Mother
Past prices (excl. pregnancies)	0.187	-0.250	-0.021	0.108
	(0.120)	$(0.196)^b$	(0.046)	$(0.056)^b$
	$[0.112]^c$	$[0.115]^b$	[0.057]	[0.070]
Past prices (pregnancies)	0.004	0.019	0.006	-0.008
	(0.007)	$(0.007)^b$	(0.005)	(0.006)
	[0.005]	$[0.002]^a$	[0.005]	[0.005]
Difference in coef.	-0.183	0.269	0.027	-0.116
	(0.119)	$(0.196)^a$	(0.047)	$(0.056)^b$
	$[0.107]^c$	$[0.115]^b$	[0.058]	[0.071]
Obs.	13662	13695	21489	21526
Fixed effects	Cell, country × year, month			

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. LSMS data. The unit of observation is an adult (father or mother). Standard errors clustered at the cell-level in parentheses; or allowing for spatial correlation within a 500km radius and infinite serial correlation in brackets. Parental controls include: age of mother, age of father, dummies for the number of children. Past prices "excl. pregnancies" is the average coefficient across 10 lagged prices observed outside pregnancy periods. Past prices during "pregnancies" is the average coefficient across 10 lagged prices observed during pregnancy periods. The "difference in coef." equals the difference between "pregnancies" and "non-pregnancies" prices. In columns (1) and (2) the dependent variable is the number of hours worked in the household during the last week. In columns (3) and (4) the dependent variable is an indicator for whether the individual worked outside the household in the last week.

F.2 Education: detailed results

Table A.35: Education results

Est.	Prices coef.	In utero	Pre-birth	Pre-birth siblings	Post-birth	Post-birth siblings	Obs.	R^2
(1)	Schooling	0.064^a (0.004)	0.025^a (0.009)	-0.014^a (0.001)	-0.010^c (0.005)	-0.002^a (0.001)	1202833	0.399

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") is the average coefficient across lagged prices observed during the pregnancy period (prices lags from 5 to 15 years). In utero prices of older siblings ("pre-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") is the average coefficient across lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the average coefficient across those on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the average coefficient across those on lagged prices after the child birth and outside in-utero periods. The outcome variable is an indicator for school attendance. The estimation include children of age 5 to 18 at the time of the survey.

Table A.36: Education results: detailed coefficients

Dep. var.	(1) Schooling Health Coef.	SE
Own prices, in utero prices		
t-5	0.071[c]	(0.037)
t-6	0.150[a]	(0.006)
t-7	0.152[a]	(0.006)
t-8	0.112[a]	(0.005)
t-9	0.073[a]	(0.006)
t-10	0.035[a]	(0.006)
t-11	0.027[a]	(0.005)
t-12	0.012[c]	(0.006)
t-13	0.038[a]	(0.006)
t-14	0.033[a]	(0.006)
t-15	0.006	(0.006)
Pre-birth prices		
t-6	0.095[a]	(0.030)
t-7	0.016	(0.027)
t-8	-0.052[b]	(0.025)
t-9	-0.073[a]	(0.025)
t-10	0.012	(0.026)
t-11	-0.008	(0.023)
t-12	0.097[a]	(0.024)
t-13	0.093[a]	(0.023)
t-14	0.127[a]	(0.027)
t-15	-0.062[b]	(0.030)
Pre-birth prices, siblings in utero		
t-6	-0.020[a]	(0.005)
t-7	-0.025[a]	(0.004)
t-8	-0.037[a]	(0.003)
t-9	-0.018[a]	(0.003)
t-10	-0.024[a]	(0.002)
t-11	-0.006[a]	(0.002)
t-12	-0.007[a]	(0.002)
t-13	-0.005[a]	(0.002)
t-14	-0.003	(0.002)
t-15	0.006[a]	(0.002)
Post-birth prices		
t	-0.013	(0.013)
t-1	-0.081[a]	(0.010)
t-2	-0.073[a]	(0.012)
t-3	-0.115[a]	(0.012)
t-4	-0.085[a]	(0.013)
t-5	0.047[a]	(0.014)
t-6	-0.029[b]	(0.014)
t-7	-0.022	(0.016)
t-8	0.006	(0.018)
t-9	0.097[a]	(0.022)
t-10	0.082[a]	(0.023)
t-11	-0.071[a]	(0.024)
t-12	-0.044[c]	(0.025)
t-13	-0.057[b]	(0.024)
t-14	-0.012	(0.027)
t-15	0.213[a]	(0.037)
Post-birth prices, siblings in utero		
t	-0.008[a]	(0.001)
t-1	-0.004[a]	(0.001)
t-2	-0.003[a]	(0.001)
t-3	0.001	(0.001)
t-4	0.004[a]	(0.001)
t-5	0.010[a]	(0.002)
t-6	0.003	(0.002)
t-7	0.008[a]	(0.002)
t-8	0.002	(0.002)
t-9	0.003	(0.002)
t-10	0.000	(0.002)
t-11	-0.002	(0.002)
t-12	-0.008[a]	(0.002)
t-13	-0.011[a]	(0.003)
t-14	-0.011[a]	(0.003)
t-15	-0.015[a]	(0.004)
Observations	1202833	
R^2	0.399	

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell-level in parentheses. Child controls include: gender, birth order dummies, twin dummy, age in month dummies. Mother controls include age and age squared, number of children dummies, education dummies, wealth categories dummies. In utero prices of the own child ("in utero") are the coefficients of lagged prices observed during the pregnancy period (prices lags from 5 to 15 years). In utero prices of older siblings ("pre-birth siblings") are the average coefficients of lagged prices observed during in-utero periods for older siblings. In utero prices of younger siblings ("post-birth siblings") are the coefficients ofs lagged prices observed during in-utero periods for younger siblings. "Pre-birth" indicates the coefficients of on lagged prices prior to the child birth and outside in-utero periods. "Post-birth" indicates the coefficients of lagged prices after the child birth and outside in-utero periods. The outcome variable is an indicator for school attendance. The estimation include children of age 5 to 18 at the time of the survey.

F.3 Fertility: gender-specific results

Table A.37 shows the results of the estimation of the fertility specification (presented in table 3) modified to explore gender differences in sibling rivalry driven by preferences for sons. More specifically, we interact the aggregate past prices (in utero and excluding in utero) with the sex ratio (computed as the number of female children over the number of male children) of the children in the family. The results suggest that increases in prices have a lower effect – in absolute terms – when there is a larger number of girls in the siblinghood. We interpret this result as the sibling rivalry being less prominent for girls than for boys.

Table A.37: Effect of price variations on subsequent fertility investments - the role of gender

	(1)	(2)	(3)
Indicators	Fertility		
Dep. var.	Last child dummy	# future children	Future birth spacing
Past prices (exc. in utero)	-0.052^a	0.025^a	-0.943
	(0.002)	(0.002)	(0.834)
× sex ratio	-0.001	-0.000	0.413
	(0.001)	(0.000)	(0.510)
Past prices (in utero)	0.042^a	-0.037^a	3.246^a
	(0.001)	(0.001)	(0.783)
× sex ratio	-0.003^a	0.001^b	-0.409
	(0.001)	(0.001)	(0.476)
Obs.	3196848	3196848	2276968
Child controls	Yes	Yes	Yes
Mother controls	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child (aged 6 to 17 in columns 1 to 3). Standard errors clustered at the cell level in parentheses. All estimations include country × year-of-birth and month-of-birth dummies. Child controls include: gender, birth order, twin dummy, and dummies for age in years. Mother controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. Last child dummy is a dummy taking the value 1 if no other children is ever born from that particular mother in the subsequent years. # future children is the number of children born from that mother in the subsequent years. Future birth spacing is the average birth spacing observed in subsequent periods. "Past-prices (exc. in utero)" indicates the coefficient of the average of the lagged prices prior to the child birth and outside in-utero periods. "Past-prices (in utero)" is the coefficient of the average of lagged prices observed during in-utero periods for older siblings and for the child.

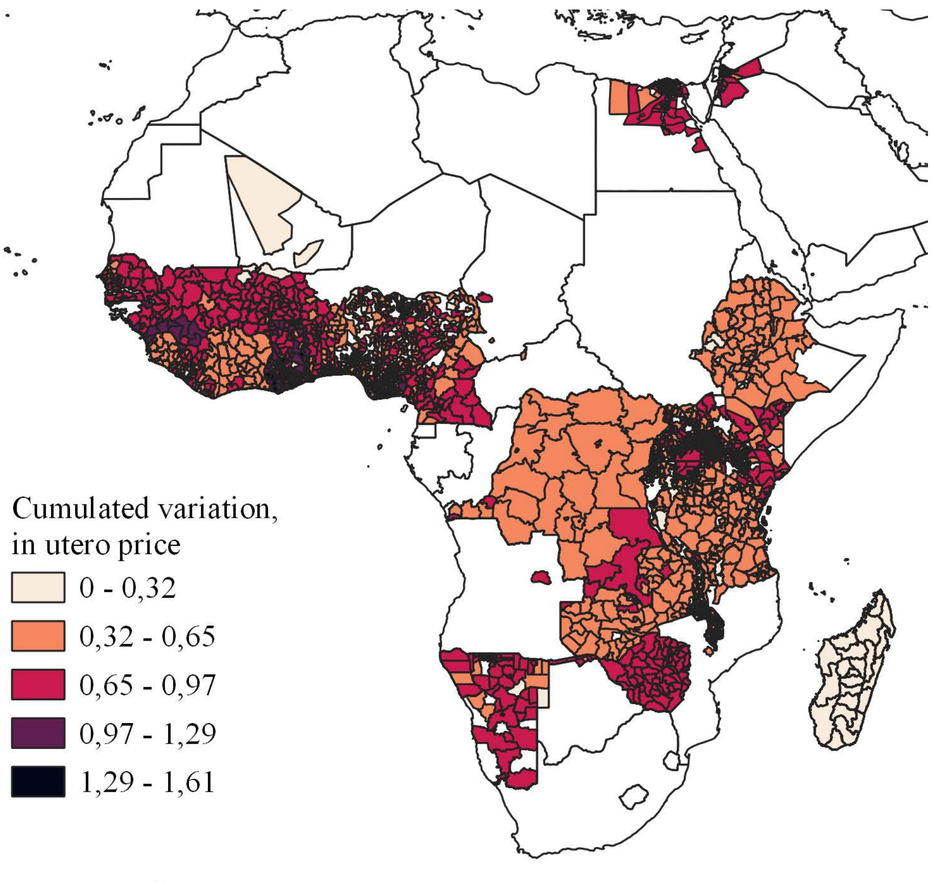
G Aggregated Child health inequality

Table A.38: Summary statistics (regional level)

	Obs.	Mean	S.D.	1st Quartile	Median	3rd Quartile
Share w/no children undernourished	8873	0.68	0.25	0.50	0.71	0.89
Δ	5378	0.05	0.31	-0.13	0.04	0.24
Share w/all children undernourished	8873	0.06	0.11	0.00	0.00	0.08
Δ	5378	-0.01	0.15	-0.04	0.00	0.00
Share w/some children undernourished	8873	0.26	0.22	0.08	0.25	0.39
Δ	5378	-0.04	0.28	-0.20	-0.02	0.11
$\lvert\Delta\overline{\mathrm{P}}_{r,t}\rvert$	4931	0.34	0.21	0.18	0.32	0.50

Source: Authors' computations from DHS, GAEZ and World Bank data. Share w/no children undernourished, Share w/all children undernourished, and Share w/some children undernourished respectively denote the share of households, at the Country-Admin-2-year level, that contain no children undernourished (underweight, underheight, or both), all children undernourished, and some children undernourished. Δ denote change over time, between two DHS surveys. $\overline{\mathrm{P}}_{r,}$ is the average crop prices faced by the cohort of children born in region r in the five years preceding the survey date, during the in utero period.

Figure A.23: Price volatility



Note: This map plot the region-specific variation in $\lvert\Delta\overline{\mathrm{P}}^{u}_{r,t}\rvert$.

Table A.39: Price volatility and aggregate inequality

Est.	Δ Share HH with					
	All children undernourished		No child undernourished		Some children undernourished	
$\lvert\Delta\overline{\mathrm{P}}^{u}_{r,t}\rvert$	0.083[a]	0.157[a]	-0.234[a]	-0.340[a]	0.151[a]	0.183[c]
	(0.030)	(0.050)	(0.066)	(0.108)	(0.057)	(0.102)
$\lvert\Delta\overline{\mathrm{P}}_{r,t}\rvert$		-0.103[b]		0.137		-0.034
		(0.045)		(0.107)		(0.098)
Observations	4884	4848	4884	4848	4884	4848
Fixed effects	Country, av. birth year					
HH controls	Yes					

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. The unit of observation is an administrative region-year. Standard errors clustered at the Admin 1-level in parentheses. The dependent variables are: the share of households with all children undernourished in column (1) and (2); the share of households with no child undernourished in column (3) and (4); the share of households with part of the children undernourished in columns (5) and (6). HH controls include: change in the regional child sex ratio, share of twins, and average number of children per household. $\lvert\Delta\overline{\mathrm{P}}^{u}_{r,t}\rvert$ is the absolute value of the change in the average price faced in utero by the cohort of children born in region r in the five years preceding the survey date. $\lvert\Delta\overline{\mathrm{P}}_{r,t}\rvert$ is the absolute change in the average monthly price of the last five years, including non in utero periods.