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Abstract

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 study how variations in parental income in the early life of their children affect subsequent child health and parental investments across siblings, using micro data from multiple waves of the Demographic and Health Survey (DHS) spanning 54 developing 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 durably enjoy better health and receive better human capital (health and education) investments than their siblings. Children whose older siblings were born during favourable income periods receive less investment and exhibit worse health in absolute terms. We interpret these within-household reallocations in light of economic and evolutionary theories that highlight the importance of efficiency considerations in competitive environments. Finally, we study the implications of these for aggregate child health inequality, which is found to be higher in regions exposed to more volatile crop prices.

JEL Classification: O12, I14, I15, D13, J13

Keywords: health, Income, Parental investments, intra-household allocations

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Sweet child of mine: Income, health and inequality*

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This version: February 19, 2020

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1 Introduction

How to allocate limited resources among children is a crucial household decision for children and family well-being. Parents invest in the future value of their off-springs because of, e.g., economic reasons (as a source of future income support) and evolutionary motives (as the vehicle for the transmission of genes). They choose between strategies that aim to equalize quality across children and strategies that favor their 'fittest' child. This trade-off may be particularly strong in poor countries, where survival can be at stake.

In this paper, we shed light on parental incentives to invest in children. 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 and the first year of life, with three objectives in mind. The first is to gauge the impact of such variations on household decisions to invest in the child's health. Second, we aim to assess whether parents direct resources preferentially towards their 'sweet child' – i.e., the one who was born during a period of high income – to the detriment of the other children. Our final objective is to quantitatively assess whether income variability drives intra-household inequality in child health, via the investment channel. Put differently, do areas more exposed to income fluctuations also feature more 'unequal' households? Addressing this question has implications for interventions aimed at reducing poverty.

To guide our empirical investigation, we refer both to economic and evolutionary theories. We combine economic models of parental investment with "Life History" evolutionary theories to explain allocation of resources across siblings in a competitive environment. Under plausible assumptions (e.g., that children born in times of higher income have better health, and in the presence of dynamic complementarities in investments strategies along the entire life of a child), the two theoretical approaches deliver two main predictions that we take to the data: (i) better income conditions in the early life of a child increase the investments received by that child and therefore her future quality (health); (ii) better income conditions in the early life of a child decreases the investments received by subsequent children, and therefore their quality.

The main contribution of the paper is to test these predictions using large-scale individual data on health investment and outcomes. Our analysis contains information on 440 thousands women and more than 700 thousands children (up to five years old) from multiple waves of the Demographic and Health Surveys (DHS), between 1986 and 2016. Because of our empirical design, the sample includes only rural households. We use variations in the world prices of locally produced crops as measures of local income. In particular, we combine monthly world prices of agricultural commodities with geo-referenced data on land suitability for agriculture (from the Global Agro-Ecological Zones dataset) in order to measure local exposure to variation in the prices of produced crops, which represent a major source of income in many developing countries. Such measures of exogenous changes in income have been widely used in recent literature (Adhvaryu et al., 2017; Berman and Couttenier, 2015; McGuirk and Burke, 2017).[1]

We first estimate the effect of these income variations on child mortality, health at birth and during infancy, and investments in children's health at the individual level using the DHS data. The DHS data allows us to compare health outcomes and investments within mother,

[1] Although we look at prices of *produced* crops, these fluctuations could also affect consumption and hence could have the opposite effect of income shocks. Our results are difficult to reconcile with this view. In addition, we will show that restricting our analysis to a subset of cash crops that are not typically consumed delivers similar results.

across siblings. We examine whether children's body size as measured by weight and height indicators varies systematically with early life exposure to the world prices of produced crops. To investigate parental responses, we estimate the impact of the income-related price variables on health investments, such as vaccinations and provision of health treatments. The effect of the price variables is identified under the plausible assumption that siblings' characteristics, while important in driving health outcomes (Almond and Mazumder, 2013), do not affect exposure to the world prices of produced crops.

We find that child health improves significantly with parental income during pregnancy and in the first year of life. Our estimates suggest that the variation in early exposure to crop prices observed in the data can explain around 20% of the average difference in height across siblings. This effect of income variations on child health survives up to five years of age – i.e., the oldest age for which key health indicators are recorded. Parental responses to the initial exposure to crop prices can explain this persistency: siblings that experience higher local prices early in life are more likely to receive vaccinations and deworming. The estimated coefficients imply that differences in early exposure to world crop prices can account for 5 to 10% of the average gap in health interventions across children within the same family. Finally, and consistent with the theoretical predictions, we find that these 'within-mother' results indeed stem from direct competition for resources across siblings: child health and parental health investments deteriorate with the local producer price faced by older siblings at birth. These findings are confirmed in a large set of robustness checks for selection through survival, the influence of time-varying confounders at the local level, migration, and the separate effect of price variations of cash and non-cash crops.

The mechanisms relating income conditions in early life and differential outcomes across siblings are confirmed when looking at education and fertility decisions. In particular, we find that children who receive a higher producer price at birth are more likely to attend school than their siblings. The empirical findings also suggest that having faced positive income shocks during past pregnancies puts women on a 'slower' fertility trajectory: birth spacing widens and mothers are more likely to stop fertility.

The within-mother effects of differences in income during early life vary across the countries in our sample. We make use of the fact that our sample spans over multiples countries and regions to study whether country characteristics affect our main results. We first show that our estimates are quantitatively stronger and statistically more significant in countries where financial markets are relatively underdeveloped. This is in line with our economic theory, where our predictions rely on the assumption that households have no access to credit or savings and therefore cannot smooth income changes over time. Second, we show that our findings hold especially in countries characterized by higher degrees of social competition, as measured by indicators of mortality rates and fractionalization. This highlights the importance of the competitiveness of the environment, as suggested by evolutionary theories.

The positive and persistent health effects of crop prices in early life coming from within-household variation across children can have important consequences for inequalities in child health. The child-level data permits us to identify households where children have the same health status (either all suffer from malnutrition or they do not) and households where siblings report different nutritional outcomes (some are undernourished while others are not). Hence, in the last part of the paper we examine how the variation in exposure to world crop prices affects the poverty mix of households at the regional level within countries. The estimates reveal a strong and quantitatively important effect of variations in the world price of produced crops on the local poverty composition of households. Regions exposed to stronger changes in producer prices across cohorts are found to have significantly higher shares of 'mixed' households where undernourished children live with healthy siblings. The estimates imply that higher price variations are responsible for a 17 percentage-point higher share of mixed household in the average region of our sample.

These findings and the evidence from the child-level regressions shed light on two important observations about the effectiveness of policies that seek to reduce children's malnutrition. These interventions often rely on households as the targeted units (Brown et al., 2017). First, 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. Second, the evidence at the regional level 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 the households that should receive assistance.

Contribution and related literature. In this paper, we provide novel evidence on how variations in the economic environment during early life affects parental investments in the health (and quality) of their children. Our analysis speaks to a vast literature in evolutionary biology and anthropology which studies how parents allocate resources across siblings in humans and other species. In this line of work, Life History (LH) theories highlight the strategies that parents adopt to favour certain traits in their offsprings in order to maximize their survival. Our findings relate to the strand of the evolutionary literature that has applied LH theory to parents' behaviour in humans. Recent contributions support the LH prediction that harsher early life conditions are correlated with weaker parental care. For instance, Lawson et al. (2012) document a negative association between family size (interpreted as a measure of competition for resources across siblings) and parental investments and child survival in Demographic Health Surveys from Sub-Saharan African countries. Several authors have also shown that wealthier parents in poor countries are more likely to concentrate investment in early borns (e.g. Gibson and Sear, 2010 or Hedges et al., 2016; see also the recent survey by Lawson, forthcoming). We contribute to this literature by further providing causal evidence in a unified framework on the impact of income conditions in early life on a large set of LH-relevant characteristics.

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 in economics finding that health investments tend to reinforce initial disparities in child endowment (not necessarily across siblings) especially in developing countries (Rosenzweig and Zhang, 2009; Venkataramani, 2012; Duque et al., 2018; and Almond and Mazumder, 2013; Almond et al., 2018 for recent reviews of the literature). The small literature on parental investments across siblings has produced mixed findings. Yi et al. (2015) find evidence for compensating health investments (i.e., parents investing more in the health of the less healthy child at birth) and for 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.

Our paper contributes to the "fetal origin" literature, which hypothesizes that early life conditions and in particular early nutrition have long term effects on health, educational attainment and labor market outcomes – see the reviews by Almond and Currie (2011) and Currie and Vogl (2013), as well as recent contributions by Groppo and Kraehnert (2016); Dercon and Porter (2014). In particular, our analysis is close to a recent paper by Adhvaryu et al. (2017) showing that high prices of cocoa in Ghana in early life lead to better adult mental health, and that improved investments in children's health is an important channel. We extend their empirical approach by consistently exploiting within-mother variation over time and hence controlling for individual heterogeneity driving, for instance, selection into fertility and health investment decisions.

Our paper also relates to empirical work trying to estimate the causal impact of (contemporaneous) income shocks on child survival and health. Overall, the sign of the empirical relationship seems unclear (see the review by Ferreira, 2009). Baird et al. (2011) find that short-term changes in GDP per capita are positively correlated with infant survival in a panel of developing countries – a result that is confirmed by Benshaul-Tolonen (2018) in Africa and Cogneau and Jedwab (2012) in Cote d'Ivoire –, while Miller and Urdinola (2010) find evidence for counter-cyclical survival in Colombia. We also estimate the effects of income-related variation on child health, and further scrutinize the response of parental health investments.

Finally, the results from our analysis at the regional level speak directly to recent work highlighting the importance of intra-household inequalities in poverty status and children malnutrition. The presence of these disparities poses challenges for the targeting and effectiveness of anti-poverty interventions, which normally treat households as homogenous units (Brown et al., 2017, 2018; de Vreyer and Lambert, 2018).[2] 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 theories in evolutionary studies and in economics that guide our empirical analysis at the micro level. Section 3 describes the health and price data that we use. Section 4 presents the empirical strategy and the main results of our paper on children health and parental investments, and section 5 discusses additional evidence on country heterogeneity. In section 6, we explore the implications of our micro-level evidence for child health inequality at the regional level. Section 7 concludes.

2 Theoretical Background

Our objective is to study how variations in income during pregnancy and the first year of life of a child affect the allocation of resources across siblings, and ultimately their health. To theoretically guide our analysis, we present a simple economic model of parental investment. The economic framework analyzes resource allocation across siblings over time in the absence of credit markets. It can be embedded in more general Darwinian selection theories that extend to humans

[2] More generally, a large body of research has analysed the evolution of child health inequalities. The evidence shows that health inequality among the young has been declining in the U.S. (Currie and Schwandt, 2016b,a) and in Spain (Gonzalez and Rodriguez-Gonzalez, 2018), while it remained stable in France (Currie et al., 2018) and in Canada (Baker et al., 2017). In developing countries, trends are rather mixed (Li et al., 2017; Wang, 2003). These papers focus on inequalities across households or groups with different socioeconomic characteristics (e.g., income, race and gender), but neglect possible intra-household disparities. Vogl (2018) 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.

and other species. We discuss these conceptual approaches and derive some testable predictions that are relevant to our sample of rural households in developing countries.

2.1 Economic theories of parental investments

We first consider a simple economic framework where parents allocate resources across their children. The formal model is presented in more details in section A of the online appendix. Here we convey the main intuition, which relates to an established literature on the health effects of income shocks in early life (see Almond and Mazumder, 2013, for a review).

Consider a situation where parents' utility increases with their children's '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; in period 2, she is born and lives with her parents; and 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. In each period, parents face a trade-off between consumption and investments in the quality of each child. The optimal choice depends crucially 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.

It is the combination of dynamic complementarities and the staggered timing of births that creates competition for resources across siblings and preferences for the child born in 'good times'. 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 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 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 investment response to early income shocks: the child born in 'worse times' receives less investments and hence is of worse quality than her sibling.

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 are proven in the online 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 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.*

We can test these predictions using measures of parental income combined with individual information on child health and parental investments. To measure parental income, we will use arguably exogenous changes in the world price of locally produced crops. Child health will be proxied by several anthropometric indicators (weight-for-age, height-for-age) and by data on child survival, and investments will be captured by information on vaccination, breastfeeding and medication.

A key assumption of the economic model discussed here and in the online appendix is the lack of credit and saving markets. Under complete financial markets, investments should no longer depend on temporary income variations and our predictions should not hold. In section 5, we investigate the influence of country-level financial development (a measure of quality and access to credit markets) on the effect of income variations on parental strategies – i.e., the empirical counterparts of propositions 1 and 2.

2.2 Evolutionary theories of parental investments

The validity of propositions 1 and 2 also crucially depends on the presence of dynamic complementarities in investments. This assumption can be justified in evolutionary theories. Another reason why the theories are useful in our context is that they allow for a broader interpretation of the economic mechanisms (they apply to human and other species), and provide specific additional predictions that can be tested in the data.

In evolutionary biology, the key task faced by all species is the successful utilization of resources – in our setting, income, parental time and energy – in the service of survival and reproduction (Fabian and Flatt, 2012). The Life History (LH) theory (Stearns, 1992; Roff, 1992) studies the strategies that optimize this utilization over the life course in differing environments. These strategies affect LH 'traits' – i.e., those characteristics that determine health, growth, rates of reproduction and ultimately survival. Birth weight and postnatal growth rates are examples of traits that relate to children's health. Breastfeeding duration, birth spacing and other forms of parental investment per child are traits that shape the future survival of children and that can be altered by the parents' allocation of resources.

In this theory, adults maximize their offsprings' genetic fitness (i.e., reproductive success) by adopting strategies that affect LH traits. Like in economic theories, parents face trade-offs: given their maximization objective, they optimally allocate scarce resources across competing life functions – mainly maintenance, growth and reproduction – taking into account their environment (Charnov, 1994; Stearns, 1992). Each choice requires to allocate resources between options having an impact on the transmission of genes (e.g., having more children, or have a child of better quality). Importantly, choices made at early stages of the "life history" of an individual affect her genetic fitness and hence the value of future options. For instance, a well-nourished infant has a lower probability of juvenile death, so grows more thanks to higher parental investment during his juvenile period (Fabian and Flatt, 2012). These reinforcing linkages between choices made by parents at different points in the life of their children are cases of dynamic complementarities in parental investments.

Varying resources availability in early life can trigger different parental investment responses across siblings within the same household. Parents may find it optimal to disproportionately allocate more resources to children conceived during periods in which income is higher, since the genetic fitness of these 'good-time' offsprings pushes towards investing in growth rather than reproduction. Put differently, children born under more favourable economic conditions should be associated with stronger health – e.g., bigger body size – than their siblings thanks to higher parental investments – e.g., longer breastfeeding and other health expenditures. Hence, we obtain a prediction equivalent to Proposition 1 above.

In addition, parents may want to divert resources from the weakest towards the fittest offspring in order to enhance the chances of survival in a highly competitive environment. Offsprings benefiting from a higher amount of resources in the utero period and early childhood are expected to be genetically stronger than their siblings. Thus, parents are expected to give priority to these "good-times" offsprings at the expense of their siblings, as their reproductive value is higher (Hill, 1993).[3] In general, we expect the optimal parental investment strategy on one offspring to be affected by the "life history" of other offsprings through access to resources. When parents increase parental investment in offsprings that have a greater genetic fitness, access to resources for offsprings that appear to be less fit decreases.[4] This rivalry mechanism relates to our proposition 2 above.

Finally, evolutionary theories also predict that LH strategies should vary across human populations, depending on the characteristics of the environment they live in (Stearns, 1992). A key element is the level of competition for resources in the society. In an environment where competition for resources is fierce, parents may want to invest more in their fittest offspring. These strategies allow to generate "contest competitive" offsprings who are able to appropriate resources later on (Ellis et al., 2009). We explore empirically the importance of this factor (and of financial development, as suggested by the economic framework) in section 5.[5]

3 Data

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

3.1 Individual data

Our baseline data on child mortality, health and other individual and household characteristics come from the Demographic and Health Surveys (DHS).[6] We restrict our analysis to country waves

[3] Inter-sibling competition for resources has been widely studied in behavioural ecology and quantitative genetics (Trivers, 1974; Kolliker et al., 2005). In particular, the quantitative genetics approach highlights how parental strategies adjust to maximize the family genetic fitness (Wolf, 2006).

[4] The evolutionary anthropology literature has provided extensive evidence of discriminatory parental investment in offspring in human populations: parents, in poor communities, tend to favour early-born offsprings in terms of educational investment (Gibson and Sear, 2010; hed, 2016), health (Uggla and Mace, 2006) and nutrition (Hampshire et al., 2009)

[5] In a different vein, parents may want to spread their resources equally across children in the presence of pervasive "extrinsic" risk, i.e. risks of mortality which are external to their children's characteristics. In these situations, it might be difficult for parents to assess the likelihood of survival of each child.

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

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. These restrictions leave 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. Within each country, our baseline sample is composed only of rural areas, because it is in those regions that exposure to world prices of agricultural commodities is expected to shift local income.[7] A map showing the countries covered and the location of the households appears in the online appendix, section B.4. Table A.1 contains the numbers 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. We will also use additional data on men when looking at adult health. 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 in most estimations we are interested in the effect of income variations within households, across children of the same mother.

Child health. We make use of two types of information: data on anthropometric indicators (height-for-age, weight-for-age) and on child mortality (or survival) – at birth, in the first year, and at the time of the survey (for survival). Anthropometric measures are available only for children under five years old. We therefore restrict our baseline sample to these children, i.e. a little more than 700 thousands born from about 440 thousands mothers aged between 13 and 49 at the time of the survey. We use as baseline anthropometric indicators (i) the log of weight (height), divided by age-specific population mean; and (ii) under-weight (under-height), defined as weight (height) being at least three standard deviations below the age-specific population mean. Population means are sourced from the WHO.[8]

Health 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 given over the three months preceding the survey (iron pills and deworming), and duration of breastfeeding.

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, health indicators (body-mass index – BMI –, Rohrer index and haemoglobin level), and wealth index.

[7] In sensitivity checks, we confirm the baseline findings in the full sample, including both rural and urban areas (results available upon request). The distinction between rural and urban area is taken from the DHS database and can vary across countries. It normally relies on population thresholds and the type administrative area (e.g., village vs. cities).

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

3.2 Income variations

Our analysis requires to identify income variations which 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 variation in available income. This type of instrument enhances the validity of the empirical strategy for a wide set of developing countries where agriculture is still a major source of household income. Previous work has indeed successfully applied a similar strategy to test for the effects of income shocks on local conflicts (Berman and Couttenier, 2015; McGuirk and Burke, 2017). 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. They might also impact health indirectly through channels other than income, e.g. through their impact on infrastructures. We therefore use exposure to world prices of agricultural commodities as an instrument for local income in reduced-form regressions, and control for the influence of weather variations in robustness checks.

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 in order 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. We focus on the 15 'crops' for which world price data is available from the World Bank: 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:

$$\mathrm{P}_{kt} = \sum_p \alpha_{pk} \times P^W_{pt} \tag{1}$$

where α_{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 and the first year of life of the child; we will consider later-life prices in our robustness exercises. In one of these sensitivity checks 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 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 α_{pk}, but it could capture better the patterns of agricultural specialisation.

Figure A.2 in the online appendix plots the evolution of world prices of the four most popular (most suitable) 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 clearly correlated, do diverge during certain periods (e.g., during the 2011-2012 crisis). The ensuing analysis exploits this rich variation to identify the causal effects of income-related variation in world prices on child health across siblings in developing countries.

Throughout our analysis, we interpret variations in P_{kt} as positively correlated to local agricultural and individual income. This is the common interpretation in the literature. McGuirk and Burke (2017) provide direct evidence of the effect of such shocks on farmers' income and self-declared poverty using individual data from the Afrobarometer. Berman and Couttenier (2015) show that these variations are positively correlated with GDP per capita at the sub-national level. Yet, if production and consumption patterns are correlated in space, increases in P_{kt} could instead be interpreted as *negative* real income shocks (increase in consumption prices). This is however unlikely, for at least two reasons. First, our results are hard to reconcile with this consumption side interpretation. Second and more importantly, our results hold when we split P_{kt} into two indexes, computed for food crops and for cash crops only. As cash crops are typically not consumed, we interpret these results as further evidence that our price variables are indeed positively correlated with income.

3.3 Descriptive statistics

Table 1 reports summary statistics for the main variables used in the child-level empirical analysis. In our sample of rural 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. In our empirical analysis, we group in the same category children whose birth order is greater than five (around 20% of the sample). Information on mortality is available for 760 thousand children, while anthropometric indicators are non-missing for about 445 thousand children. Underweight affects 7% of the children, while underheight (a measure of stunting) reaches 19% of the sample.

Table 1 also displays statistics on the health investments variables that we use in our empirical analysis. Breastfeeding duration is long on average, as 80% of children are breastfed for at least six months. Basic vaccinations such as those against tuberculosis (BCG vaccine) and measles are more common than medications such as deworming or iron pills (the latter are normally subscribed for children suffering from iron deficiency especially in school age, and hence older than five). Finally, Table 1 shows the summary statistics of variables that are measured at the cell level – our spatial unit. These are the local price index of produced crops (eq. (1)), in logs – our main variable of interest; and other controls, namely: a local index of mineral prices (relevant for only 2% of the sample), a dummy for the presence of conflicts during the in-utero period and first year of life of a child, and measures of rainfall intensity and temperature (see section B in the online appendix for details).

4 Income, child health and early life investment

4.1 Empirical strategy

The theoretical discussion in section 2 delivers two main testable predictions. A higher income

Table 1: Summary statistics

	Obs.	Mean	S.D.	1st Quartile	Median	3rd Quartile
Child-level						
Age (in months)	759781	27.56	17.16	13	27	41
Female (dummy)	759781	0.49	0.50	0	0	1
Birth order	759781	3.67	2.49	2	3	5
Twin	759781	0.03	0.17	0	0	0
Underheight	447484	0.19	0.39	0	0	0
Underweight	446909	0.07	0.26	0	0	0
Height (cm)	447484	81.55	14.44	71.50	82	92.30
Weight (kg)	446909	10.86	3.62	8.20	10.70	13.30
Death Birth	759781	0.03	0.17	0	0	0
Death First year	759781	0.06	0.23	0	0	0
Breastfeeding>6m	469706	0.80	0.40	1	1	1
# Polio vaccines	504036	2.64	1.39	2	3	4
# DPT vaccines	600548	1.97	1.30	1	3	3
BCG vaccine (dummy)	605152	0.80	0.40	1	1	1
Measles vaccine (dummy)	600476	0.60	0.49	0	1	1
Iron pills last 3 months	348824	0.12	0.32	0	0	0
Deworm last 3 months	388520	0.36	0.48	0	0	1
Cell-level						
ln crop prices (GAEZ)	727943	4.44	0.30	4.16	4.50	4.68
ln mineral prices	759781	0.17	0.82	0	0	0
Conflict (dummy)	744278	0.09	0.29	0	0	0
ln rainfall	749694	8.35	1.20	8.16	8.62	8.93
ln temperature	749465	8.40	0.02	8.39	8.41	8.41

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

in the early life of a child: (i) increases the investment she receives and therefore her health in subsequent periods; (ii) worsens the investment and health of children born subsequently through competition effects. In this section we present our empirical strategy to test these predictions. We focus on health and parental investment during childhood (up to five years of life), and investigate the effects of income on education outcomes for children between 6 and 18 years old. For all children, we study the effect of income shocks during pregnancy on the future fertility of the mother.

Income variations and child health. We first want to study the effect of income variations, proxied by world agricultural commodity prices, on child health – child "quality". Local exposure to agricultural world prices may correlate with household behaviour and characteristics which can in turn affect children's health later in life. To control for the influence of time-invariant confounders, our baseline and preferred specifications include mother fixed effects. Despite the fact that each mother and child characteristics are observed only once in our data, the presence of multiple siblings allows us to control for unobserved characteristics common to the same mother. We therefore focus on within-mother variation in exposure to world commodity prices over time. Denote by c a child, located in cell k and born in year t, month m. We estimate a specification of the form:

$$Y_c = \alpha \log \overline{P}_{c,k} + \mathbf{D_c'}\delta + \mu_H + \gamma_{i,t} + \nu_m + \varepsilon_c \quad (2)$$

where Y_c is a mortality or health indicator for child c at time t (month-year), sequentially: a dummy for under-height, which equals 1 if the height-for-age ratio is at least 3 standard deviations below the corresponding z-score from WHO; a dummy for under-weight, which equals 1 if the weight-for-age ratio is at least 3 standard deviations below the corresponding z-score from WHO;[9] the continuous measures of height and weight relative to the WHO reference values (in logs); a dummy for death at birth; a dummy for death in the first year; and a dummy for being alive at the time of the survey.

$\overline{\mathrm{P}}_{k,t}$ is the average of the monthly prices of crops produced in cell k during the in-utero period and in the first year of life (or only during-in utero period when the dependent variable is death at birth). We will also separate the in-utero and first year of life periods, as well as consider subsequent years. Our results show that pregnancy and first-year prices generally have similar effects, while prices in later years have a much lower impact. $\mathbf{D'_c}$ is a vector of child characteristics – age and age squared (in months), gender, twin, birth order. μ_H are mother fixed effects. In our sample, using household fixed effects instead produces very similar results, as 89% of the households in the sample contain only one mother (and 98% contain two mothers at most). $\gamma_{i,t}$ and ν_m are additional fixed effects accounting for country (i) $\times$year (t) of birth, and month-of-birth unobserved factors affecting child health that might be correlated with crop prices. $\gamma_{i,t}$ in particular controls for all country-wide shocks in utero and in the first year of life that might affect health, such as global economic conditions or civil wars. In our sensitivity analysis we will additionally include controls for local weather shocks and other commodity prices shocks (oil and mineral prices in oil or mineral producing regions) that might correlate with $\overline{P}_{c,k}$.

In eq. (2), α is our coefficient of interest. It can be interpreted as the effect of the local price of produced crops on child mortality and health, relative to other children having the same mother. Put differently, the coefficient tells us whether children born during periods of high crop prices are in better health than their siblings. Identifying α requires observing at least two children per mother, i.e. the sample is restricted to households with at least two siblings born over the 5 years before the survey.

When Y_c measures child health, α could either reflect a contemporaneous effect – a high family income during pregnancy and the first year of life improves health at birth and in the first year of life –, or a longer-term impact – beyond their contemporaneous effects, early life income fluctuations affect child health after several years. To answer this question, we estimate the following variant of eq. (2):

$$Y_c = \sum_{a=0}^{4} \alpha^a \mathrm{Age}_c^a \times \log \overline{\mathrm{P}}_{k,t} + \mathbf{D'_c}\delta + \mu_H + \gamma_{i,t} + \nu_m + \varepsilon_c \quad (3)$$

where Age_c^a are dummies which equal 1 if the child is aged $a = (0, 4)$ years at the time of the survey. Since we have anthropometric data on children up to five years of age, we cannot test for the significance of early-life income fluctuations to children's health later in life. The profile of the α^a however informs us about the persistence of early life shocks on health. As an additional test, we can also use the sample of children older than five and for whom we have information on school attendance. In specifications similar to that of eq. (2) but with school attendance as dependent variable, we can identify the effect of early exposure to income variations on education

[9]These definition correspond to "severe" underweight and stunting. Results available upon request are similar when "moderate" underweight and stunting are considered, i.e. two standard deviations below mean.

outcomes.

Parental investments in child health. Specifications (2) and (3) estimate the health effects of early life price shocks, and whether these are persistent. This persistence could come from the direct effect of better nutrition on health and from other health investments. If, as in the theoretical discussion, health investments complement initial conditions or investments, we would expect parents to spend more on the health of their children born during good times – compared to their siblings, potentially in a durable way.

We examine the parental investment responses by looking at whether exposure to the world prices of commodities in utero and during the first year of life affects the parents' investments in the child's health, and for how long. Specifically, we run a specification akin to (2), but replace the dependent variable with a health investment measure:

$$I_c = \beta \log \overline{P}_{c,k} + \mathbf{D_c'}\delta + \mu_H + \gamma_{i,t} + \nu_m + \varepsilon_c \tag{4}$$

where I_c is either a dummy for durable breastfeeding (longer than 6 months); the count of doses of vaccines against polio, DPT, tuberculosis (BCG) and measles; or an indicator for provision of iron pills or deworming in the last three months.[10] A significant β coefficient would suggest that at least part of the effects on children's health that we estimate in eq. (2) is going through parental investments – the I_c variables could be seen as 'bad' controls in specification (2) (Pei et al., 2018).

We also estimate a variant of eq. (4) where the β are split by child age category, similar to what we do for the health indicators in specification (3). This allows us to determine whether the effect of early life shocks on health investment across children is persistent, which itself is an indication of whether early and later life investments are complements. This specific exercise is relevant to the administration of iron and deworm pills, which is observed at the current age of the child. It makes little sense in the case of breastfeeding and vaccinations, which are investments typically taking place upon birth or in the first year of life.

Sibling effects. Eqs. (2) to (4) feature mother fixed effects, i.e. they provide estimates that we can only interpret in relative terms, across children born from the same mother. To investigate further these intra-household adjustments, we modify the baseline specification and isolate sibling effects (Adhvaryu and Nyshadham, 2016). This allows us to directly test Proposition 2 from the theoretical framework: subsequent preferential investment in the 'sweet child' should decrease resources available for the other children.

The within-mother estimates exploit variation in the producer price P received by child c relative to the average producer price received by all the siblings. Therefore, any effect of exposure to producer prices in early life compounds the effect of the 'own' price (received by child c) and that of the siblings' prices (received by all siblings in the households). To disentangle the contributions

[10] Adhvaryu and Nyshadham (2016) uses a similar set of variables to proxy for investment in child health. The DHS also contains a variable coded one if the child received Vitamin A over the last three months: results obtained using this outcome variable are similar to the ones presented in the paper.

of these two components, we estimate specifications of this form (e.g., for health outcomes):

$$Y_c = \alpha \log \overline{P}_{c,k} + \alpha^s \log \overline{P}^s_{c,k} + \mathbf{D'_c}\beta + \mathbf{C'_H}\gamma + \mu_k + \gamma_{i,t} + \nu_m + \varepsilon_c \quad (5)$$

with the s superscript indicating the average of P across the older siblings of child c. Including the price received by older siblings requires relaxing the within-mother specification. The mother fixed effects (μ_H in eq. (2)) are replaced by cell fixed effects (μ_k) in eq. (5). The estimation sample in eq. (5) therefore includes also children with no siblings.[11] We collect controls for the mother's age (and its value squared), level of educational attainment (dummies for primary, secondary and tertiary education), and for her household's wealth index provided by the DHS (dummies for the quintiles of the estimated wealth distribution) in the term C_H. A similar specification is estimated also for health investment outcomes. The coefficient α^s indicates whether having siblings born in 'good' times (high $\overline{\mathrm{P}}^s_{k,t}$) affects the health of child c (conditional on her own price, $\overline{\mathrm{P}}_{k,t}$). Both the evolutionary and economic logics predict α and α^s to be of opposite signs: $\alpha > 0$ and $\alpha^s < 0$.

Econometric issues. We estimate all specifications using least squares; this is the preferred estimator, despite the fact that the dependent variables are often binary or categorical, due to the large dimensions of fixed effects we include. Standard errors are clustered at the cell-level in the baseline. In our robustness we allow the error term to be spatially correlated (within a 500km radius), as well as serially correlated.

There are three main threats to identification in eqs. (2) to (5). The first is omitted variables, which might correlate with world prices and affect child health through channels other than income. In our robustness exercises, we will control for various potential time-varying confounders, such as mineral and oil prices, conflicts and weather shocks. The second threat is selection. In particular, our results suggest that early life income variations affect survival probabilities, which can impact in turn our estimates on survivors' health and parental investments. In our robustness exercises, we will directly control for selection due to endogenous mortality. The third threat is persistence in prices over time. If early life prices are strongly correlated with later life prices, eqs. (2) to (5) might wrongly capture the effect of later prices. We will show that our results are similar when controlling for the full sequence of prices, from the in utero period to the current age of the child.

4.2 Results

Income and child health. Table 2 shows the estimates of the effect of exposure to world prices of produced crops on child health and mortality – coefficient α in specification (2). All regressions exploit within-mother variation, and control for the age (in months) and its value squared, gender and birth order of the child, and whether the child is a twin – the coefficients on these controls are not reported for brevity. Overall, children's health is positively associated to increases in world prices of locally produced commodities in early life. Children exposed to higher crop prices during pregnancy and the first year of life have higher weight and height relative to standard reference values, and are less likely to be stunted or underweight. In our baseline specification, exposed

[11] Restricting the sample to children with at least one sibling, as we do in the within-mother estimations, gives equivalent results (available upon request).

children seem also significantly less likely to die at birth or during the first year of life during high income periods. They are more likely to survive later on as well, at the time of the survey. These results on mortality and survival are however not robust to alternative specifications and data sources, as discussed in section 4.3.

Table 2: Exposure to world crop prices and child health

Dep. var.	(1) Underheight	(2) Underweight	(3) ln height	(4) ln weight	(5) —— Death —— 1^{st} year	(6) At birth	(7) Alive at t
ln crop price	-0.226^a	-0.180^a	0.068^a	0.135^a	-0.008^b	-0.019^a	0.026^a
	(0.042)	(0.028)	(0.010)	(0.021)	(0.003)	(0.006)	(0.007)
Obs.	191823	191513	191795	191487	2256856	2256856	2256856
R^2	0.627	0.586	0.756	0.749	0.281	0.282	0.306
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

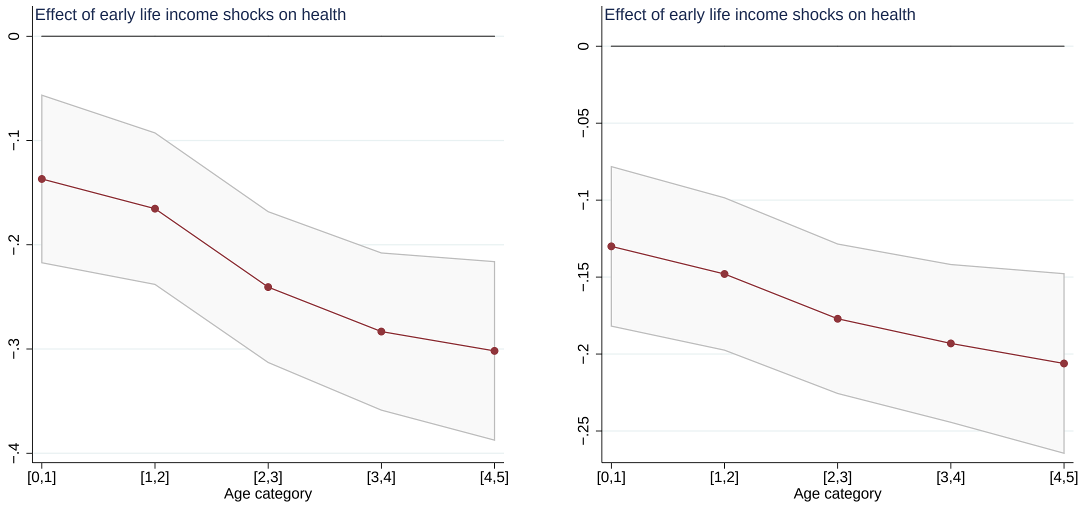
^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. OLS estimations. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include child controls, mother fixed-effects, country × year and month dummies. Child controls include: gender, birth order, twin dummy, age in month, and its value squared. 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, averaged over in utero period and first year of life. In column (5), it is average over the in utero period only. Underheight (respectively underweight) is a dummy which equals 1 if the height-for-age (resp. weight-for-age) ratio is at least 3 standard deviations below the z-score from WHO. ln height (resp. ln weight) are the logs of height (resp. weight) divided by the gender-specific average height (resp. weight) for that particular age in month from WHO. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t).

The estimated coefficients imply sizeable effects of differences in the local level of world prices at birth. Consider the effects on children's height (column (3)). In the estimation sample, the healthiest child in the family is 7% taller than the 'shortest' one (height is standardised by age and sex). The estimated elasticity in column (3) thus suggests that the least healthy sibling could have erased completely the height gap if she would have received a 100% higher crop price than the one received by the healthiest sibling in early life (conditional on the crop prices received by the other siblings). The average within-mother spread in the crop price variable being 20%, our estimates predict that price-related income fluctuations could explain up to 20% of the average differences in height across siblings. Using the estimates from the linear probability model from column (1), we obtain that the 20% higher crop price in early life can lead to 4 percentage-point lower risk of severe stunting. The same calculations lead to somewhat smaller yet important magnitudes for the impact on weight – e.g., differences in early exposure to world prices of produced commodities can explain 10% of the differences in weight across siblings.

These baseline estimates may reflect short-lived effects, i.e. the contemporaneous impact of price variations at birth and in the first year of life, without any prolonged effects in the subsequent years. To assess the persistence of the health impact, we estimate the specification (3) that allows the coefficient on the price variable to vary with the child's years of age. Figure 1 plots the α's coefficients for the two binary health indicators (the results for the continuous indicators are shown in section C.1 of the online appendix). The coefficients increase in absolute terms up to five years, which suggests a protracted impact of early life income variations on health. Figure A.3 in the online appendix confirms the persistence of the effect in the case of the continuous height and weight variables. This persistence over such a short time span could be explained by the transmission of the health in the first year of life to the following years, or by the response of parental health investment. We now explore this latter possibility.

Figure 1: Exposure to world crop prices and child health over time

(a) Underheight (b) Underweight



Source: These figures report the coefficient on the ln crop price variables price, split by child age in years, based on the estimation of eq. (3). Shaded areas are 90% confidence bands.

Income and health investment. Table 3 shows the estimates of specification (4), which assesses the impact of income-related price fluctuations on different forms of health investments in children. This exercise speaks directly to the main prediction of our theoretical framework (Proposition in 1 in section 2): parental investments should increase with the child's initial income conditions. By adopting the same specification of the health regression (see eqs. (2) and (4)), we can determine whether the estimates found in Table 2 solely reflect better nutrition and persistence in health conditions, or also a behavioral response of parents through investments in health.

Overall, the results point to a positive effect of exposure to world prices at birth on vaccinations and other investments in the health of children (controlling for their age, gender, birth order and for twin status). The evidence is consistent with parents responding to crop price variations in the early life of the child by investing more in her health. The size of the implied effects is non-negligible. The largest gap in the number of Polio vaccination doses across siblings (dependent variable in column (2)) is on average 0.91. The estimated crop price coefficient in column (2) suggests that this gap would be 5% lower (0.86) if the crop price index at birth for the low-polio child were 20% higher – the sample average largest gap in the price index across siblings. The same within-household changes in prices is associated with a small 1 percentage-point higher likelihood of receiving vaccination against tuberculosis (BCG), and a 4 percentage-point higher chances of being immunized against measles (7% of the sample average). A 20% higher crop price early in life is also associated with a 4 percentage-point higher likelihood of being breastfed for at least six months (8.5% of the sample probability). The null effect on the probability of giving iron pills is not surprising, given that this treatment is recommended to children in school age (older than five), who are not included in the sample. Importantly, children who were born during periods of high crop prices relative to their siblings are significantly more likely to receive deworming treatments – an effect equivalent to 6% of the sample probability.

Table 3: Exposure to world crop prices and health investments

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price	0.178^a	0.211^c	0.331^a	0.065^b	0.201^a	0.015	0.108^a
	(0.058)	(0.110)	(0.096)	(0.027)	(0.038)	(0.022)	(0.037)
Obs.	152427	247317	276227	278902	275395	185373	203771
R^2	0.796	0.813	0.821	0.804	0.797	0.817	0.822
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey).

The positive association between health investments in children and exposure to income variation in utero and at birth can be explained by a path-dependency in parents' behaviour – they had invested more into the child who received a good price in utero and at birth, and they kept this behaviour over time. Economics and evolutionary theories are consistent with this path-dependency. To shed light on this interpretation, in Figure A.4 of online appendix C.1 we split again the effect of crop prices according to the age of the child at the time of the survey, similarly to what we did for the health outcome specifications (see eq. (3) and the results in figure 1). We do this for the last two indicators, iron pills and deworming, the other investments being typically done in the first year of life. Overall, results suggest that the positive coefficient on crop prices is stable or slightly increasing with age, though it is imprecisely estimated in the case of iron pills.

These results suggest that the differential health outcomes of siblings to income variations in utero and at birth is partly driven by parental investment responses. At this stage, none of the results however shows that investments in a child's health and her health outcomes are directly affected by the investments on her siblings, as predicted by the theoretical framework in section 2. We now test this prediction.

Sibling effects. Health outcomes and parental investment may react to the crop price received by the child and to the crop prices received by the other siblings in early life. The within-mother coefficients that are estimated in Tables 2 and 3 compound these two types of effect because they rely on deviations in crop prices with respect to the average crop prices across siblings. In Tables 4, we separate the income-related price of the child from the average income-related price received by her older siblings (specification (5)). As in Adhvaryu and Nyshadham (2016), the objective is to identify the contribution of the shock received by the siblings. The sibling regression for parental investments (Panel B of Table 4) speaks directly to a prediction of the economic framework and of the evolutionary theories summarized in Proposition 2, section 2.

The results, based on within-cell variation, reveal that sibling effects are significant and tend to lower child health and parental investments.[12] Child health decreases significantly with the

[12]The baseline results on children's health and parental investments based on within-mother variation are con-

Table 4: Own and siblings' exposure to world crop prices, child health, and parental investments

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price (own)	-0.295[a]	-0.198[a]	0.089[a]	0.195[a]	-0.010[a]	-0.016[a]	0.026[a]
	(0.025)	(0.016)	(0.007)	(0.015)	(0.003)	(0.005)	(0.007)
ln crop price (older siblings)	0.032[a]	0.013[a]	-0.004[b]	-0.010[a]	0.000	0.002	-0.009[a]
	(0.006)	(0.004)	(0.001)	(0.003)	(0.002)	(0.002)	(0.003)
Obs	263635	261917	263612	261894	1611117	1611117	1611117
R^2	0.135	0.098	0.301	0.311	0.035	0.046	0.080
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price (own)	0.470[a]	0.428[a]	0.538[a]	0.090[a]	0.168[a]	0.075[a]	0.184[a]
	(0.041)	(0.077)	(0.064)	(0.017)	(0.025)	(0.017)	(0.025)
ln crop price (older siblings)	-0.005	-0.062[a]	-0.092[a]	-0.011[b]	-0.020[a]	-0.010[b]	-0.003
	(0.005)	(0.018)	(0.015)	(0.005)	(0.005)	(0.005)	(0.006)
Obs	271036	329136	370119	372696	370036	261528	291275
R^2	0.565	0.361	0.432	0.358	0.435	0.152	0.311
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. Mother controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. 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. ln crop price (older siblings) is the price faced on average by all elder siblings during in utero and during their first year of life. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

price in utero and at birth received by the older siblings, whereas there is no sibling effect on mortality (Panel A). Parents invest less in the health of a child if her older siblings were exposed to a higher prices in utero and at birth (Panel B). These results are consistent with theoretical expectations: parental investments in the health of a child decrease with the income received at birth by her older siblings (and hence with their quality). Parents invest less on a child if the other siblings are 'fitter' (as evolutionary theories would suggest), and if these 'fitter' siblings attract relatively more resources (as economic logic would also suggest).

4.3 Sensitivity analysis

In this section, we show that our main findings – Tables 2, 3, and 4 – are confirmed in a large

firmed in less stringent specifications where we exploit variation within the cell (as in the siblings regressions). The results, reported in Table A.3 of the Online Appendix, thus suggest that the effects of early exposure to higher income are valid across children of different mothers and households.

battery of sensitivity checks. Most of the tables are relegated to the online appendix (section C), where we discuss these results extensively.

Selection through mortality. The samples that we use to estimate the health effects of income-related variations are composed only of children who are observed at the time of the surveys. This selection might influence the interpretation of our findings as the observed children might be stronger and more responsive to health investments than the others who died prematurely. The mortality results in columns (5) to (7) of Table 2 show that indeed a higher income in early life enhances survival prospects. In section C.4 of the online appendix, we investigate directly the influence of selection through survival on the baseline health and parental investments results documented in Tables 2 and 3. The results show that our baseline findings remain unaltered when we control for selection. Together with the estimated effects on mortality, these findings tell us that the higher survival probability enjoyed by children born in periods of higher income cannot explain the reinforcing health investment strategies of the parents (and the related differential health outcomes of their children).

Full sequence of prices. Price are persistent over time. This persistence is an issue in our case, as it implies that we might be capturing the effect of prices in subsequent years on subsequent health and not the effect of early life prices on subsequent health. To solve this problem, we can include the full sequence of prices in our estimations. The results are shown and discussed in section C.5 of the online appendix. We find that (i) our results are statistically robust; (ii) pregnancy and first year prices have quantitatively similar effects; (iii) later-life prices, while being generally significant, have a much more limited impact on health indicators.

Additional controls. Crop prices could correlate with other time-varying, cell-level variables. For instance, Berman and Couttenier (2015) and McGuirk and Burke (2017) show that they impact local conflict. In section C.6 we show that our estimates are virtually unchanged when we control for other time-varying local variables such as exposure to world prices of locally produced minerals, weather conditions (which have been used as income shifters, but are unlikely to co-vary with our constructed price index of produced crops), and incidence of conflicts.

Cash/staple crops. Our empirical strategy and results are consistent with the interpretation of 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 split our price index (see eq. (1)) into the constructed local price of "cash" crops as defined by McGuirk and Burke (2017) (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 online appendix section C.7 we report the results from a specification where the two price variables are included simultaneously as determinants of child health. The coefficients on the 'food' crop price variable has the same sign of and is of similar size to the coefficient on the cash crop price variable, although the cash crop variables' coefficients are less precisely estimated in the case of health investments. This reflects the fact that cash crops account for a small part of our sample. Overall, these results corroborate our empirical assumption that the set of crops in our sample are mainly produced and hence variation in their prices should reflect producers' income (through land suitability).

Long-term persistence. Our baseline results are restricted to children, and in that sense do not speak about the long-term health effect of early life income variations. In section C.8 of the online appendix we estimate the effect of these income variations on adult health. We consider anthropometric information on adults contained in the DHS. We cannot control for household fixed effects in these estimations, as adult members are likely to have left their initial household and to live away from their siblings. We thus rely on within-cell variation in this exercise, and confirm that the effect of early life shocks persists in the long-run consistent with a vast literature (summarised in Almond et al., 2018), which has mostly relied on single-country studies.

Other robustness. In sectionC.9 of the online appendix we use an alternative measure of agricultural specialization from the M3-CROP database (Monfreda et al., 2008). Prices are in this case weighted by the share of harvested area in the cell around 2000. In section C.10 we deal with potential migration by restricting our sample to a subset of the households that did not migrate since the birth of the child. Finally, in section C.11 we allow the errors term to be spatially correlated within a 500km radius (Conley, 1999).[13] Our main findings go through these additional robustness checks.

4.4 Other parental investments

Our conceptual framework discusses the drivers of parents' investment decisions in children's health within the family. Similar mechanisms should nonetheless apply to other types of parental investments affecting the parents' objective function (genetic transmission in evolutionary theories, or future income in the economics literature).

First, while good health is a necessary condition for genetic transmission, most of the research in economics on parental investments has focused on education (e.g., see the review by Almond et al., 2018). In columns (1)-(3) of Table 5, we thus test whether our baseline results on health hold also for children's education. In particular, we regress an indicator for school attendance for children in school age on the crop price variable measured during the in-utero period and the first year of life. As for our baseline specifications (e.g., eq. (2)), we exploit within-mother variation and control for children's characteristics such as gender, age, birth order and twin status. The results show that children who received a higher income-related price at birth are significantly more likely to attend school. The reinforcing investment strategies found for health are thus confirmed for children's education, bolstering the validity of our baseline results.[14] In this case, however, parents' investments in the 'strong' older siblings do not affect directly school attendance

[13] The estimations in this section are based on the STATA package *acreg* developed by Colella et al. (2019).

[14] Yi et al. (2015) find evidence for compensating health investments, and for reinforcing education investments, in their Chinese sample of twins.

of the child (column 3).

Table 5: Early exposure to world crop prices, education and subsequent fertility investments

	(1)	(2)	(3)	(4)	(5)	(6)
Indicators	Schooling			Fertility		
Dep. var.	Dummy for school attendance			Last child dummy	# future children	Future birth spacing
ln crop price (own)	0.067^a	0.033^b	0.030^c			
	(0.020)	(0.015)	(0.017)			
ln crop price (older siblings)			-0.004			
			(0.007)			
ln crop price (all)				0.292^a	-0.137^a	0.807^b
				(0.011)	(0.016)	(0.322)
Obs.	763006	814394	634924	2236859	2236859	1620493
R^2	0.676	0.401	0.400	0.576	0.969	0.919
Child controls	Yes	Yes	Yes	No	No	No
Mother controls	No	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	No	No	Yes	Yes	Yes
Cell FE	No	Yes	Yes	No	No	No

^{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. 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. ln crop price (siblings) is the price faced on average by all elder siblings during in utero and during their first year of life. ln crop price (all) is the average price faced by the child and all elder siblings during their in utero periods and their first year of life.

Second, subsequent fertility decisions could be affected: conditional on having a 'strong' child, mothers might delay having other children – i.e., increase birth spacing. In columns (4) to (6) of Table 5, 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 equal 1 if no further pregnancy is observed in the future (up to the year of the survey); the number of children born in the subsequent years; and the average future birth spacing in months.[15] We find that when existing children faced better economic conditions, women are more likely to stop having children (column 4), have less children in the future (column 4) and, as a consequence, delay subsequent pregnancy(column 6). These patterns support the prediction of the evolutionary theories that positive income shocks should be associated with increased parental effort in current children at the expenses of further reproductive effort. In economics, these findings speak to the literature on the quantity-quality tradeoff and suggest that, in our sample of developing countries, positive income variations 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).

[15]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.

5 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 measures of child health, underweight and underheight, are reported in Figure A.6 of the online appendix (section C.12). Two conclusions arise. First, in most countries the estimates are of the same sign as in our baseline results of Table 2; more precisely, they are of the same sign (negative for the underweight and underheight variables, positive for the log weight and height) in 62-73% of the cases depending on the specification. This suggests that our results are not driven by a few specific countries. Second, important heterogeneity exists across countries: in some countries, the effect is reversed; in many others, it is not statistically significant.

What drives this heterogeneity? As discussed in section 2, two types of country characteristics may matter. First, the level of development of financial markets, which affects households' ability to borrow. The economic framework outlined in section 2 and detailed in the online appendix rests on the assumption of imperfect capital markets. Households are not allowed to borrow or lend. If they could, parents would be able to smooth income changes and neutralise any long-term impact of income variations during the early life of their children. We use World Bank data on private credit over GDP as a proxy for financial development.[16]

Second, in evolutionary theories, the level of social competition for resources is a key factor. Under competitive environments, parents tend to invest more in offsprings with the best genetic fitness – in our case, those who experienced good in utero and early life income conditions. This is because such individuals are more likely to succeed in future competitions. As a proxy for the competitiveness of the environment, we use mortality rates for children with at most 5 years of age, from the World Bank Development Indicators. The idea is that high mortality rates signal high competition for survival, and thus make early parental investments important for future success.

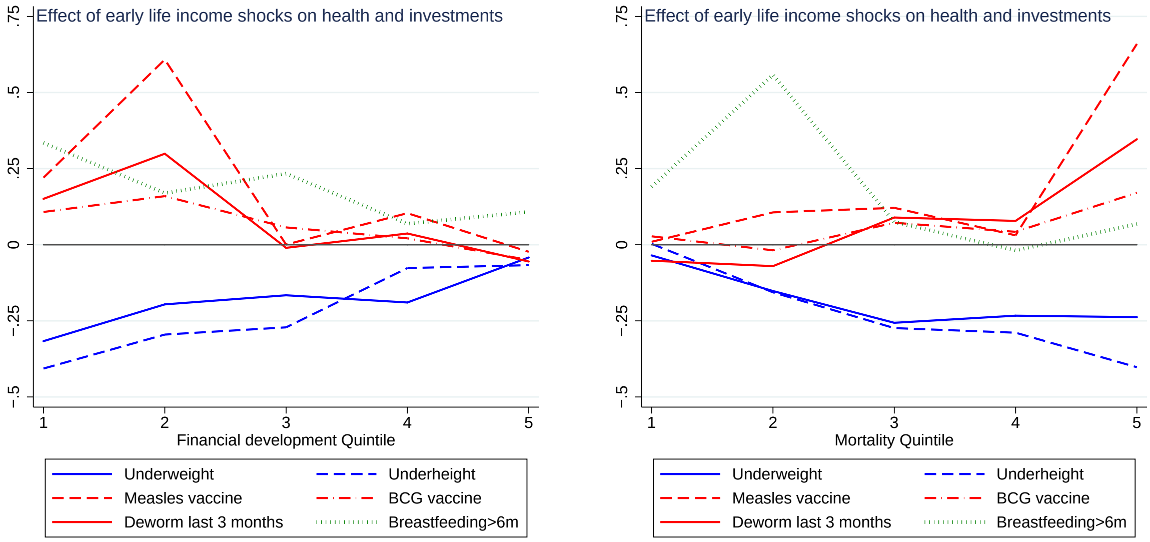
For each indicator we divide countries into quintiles and interact our early life income shock with each of the quintile dummies. The results are reported in Figure 2 below, and in Figures A.7 and A.8 in the online appendix C.12. Figure 2 represent, for each country-specific proxy, the effect of income variations split by quintile, on each of the binary health and health investment measures.[17]

[16] All our country-specific proxies are time-invariant, and computed as the averages of the variable since 1990.

[17] We restrict our analysis to binary measure to permit comparability of the estimates across measures

Figure 2: The role of local characteristics

(a) Financial Development (b) Mortality rate



Note: These figures are based on estimations similar to our baseline tables 2 and 3, except that the coefficient of ln crop price is split by quintile of a given country characteristics. In Figure (a), quintile are based on country's domestic private credit to GDP ratio. In Figure (b), we split the sample in quintiles based on country-level mortality rates at 5 years. Figures A.8 and A.7 in the appendix report the results for each health and investment measure separately, together with confidence intervals.

We first focus on financial development (Figure 2.(a)). For all health and parental investment indicators, the effect of early life income variations is stronger in countries where financial markets are poorly developed. We find that the estimates for the upper quintiles are insignificant, whereas they are always significant and of the expected signs for the lowest two quintiles of financial development (Figure A.7 in the online appendix shows the confidence intervals associated to the estimates). The opposite pattern is found for mortality rates (Figure 2.(b)). Here our estimates are stronger in absolute terms and more statistically significant in countries with high levels of mortality (though the pattern is unclear in the case of breastfeeding). On the other hand, when mortality is low (in the first quintile), the effect of income variations on health and health investment is typically insignificant (Figure A.8).

We have interpreted mortality rates as a proxy for the competitiveness of the environment: in high mortality environments, parents might find it optimal to invest in their fittest child to maximize survival and future reproductive success. As an alternative proxy, in Figure A.9 in the appendix we use a measure of fractionalization, defined as the average level of ethnic, linguistic and religious fractionalization.[18] The intuition of this measure is that more fractionalized societies tend to be less cooperative and characterized by fiercer competition over resources. The results are similar, which further support our interpretation of the mortality variable.[19]

[18]The data come from the Quality of Governance dataset.

[19]Mortality rates could also be interpreted as a measure of "extrinsic risk", i.e. mortality risks external to children characteristics. In this case, evolutionary theories would predict an opposite pattern: favouring a child, even a "strong" one, may not be a good strategy in contexts where extrinsic risk is high, as it is more difficult to determine which offspring will be successful. This should be the case, for instance, in conflict-ridden environments. In figure A.10 in the online appendix, we use cell-specific conflict data from UCDP-GED to compute the total number conflict-related fatalities observed in the cell before the year of birth of the child. Our results are indeed (slightly) weakened in cells with a more intense history of conflict. This result accords well with the extrinsic risk evolutionary interpretation.

Overall, these results lend additional support to the economic and evolutionary theories discussed earlier. They show that the effect of early life income variations on parental investments and children's health within households depends on country characteristics, in particular on the development of financial markets and on the level of socio-economic competition. This evidence is suggestive and has to be taken with caution, as our sample of countries is relatively small and our proxies are indirect and likely to be correlated with other country characteristics.

6 Child health inequality and policy targeting

The results of the child-level regressions have important implications for aggregate inequalities in child health. A direct implication is that health disparities within households increase with disparities in prices in utero and at birth across. In this section, we assess the importance of local variations in the prices of produced crops for aggregate disparities in child health outcomes that come from within the household. The within-household dimension is all the more important when it comes to the targeting of poverty reduction policies, which often take (under)nutrition as a key poverty indicator. These policies usually target poor households, under the implicit assumption that economic and nutritional outcomes are the same within the household. This strategy and hence the effectiveness of the interventions can thus be jeopardized by changes in the socioeconomic environment (such as income fluctuations) that have asymmetric nutritional and health effects across household members (in our setting, across siblings).

To measure disparities in child health, we use the underweight and underheight indicators, which are employed to evaluate the nutritional status of children. For each indicator, we identify three types of households at the time of the DHS surveys: (i) those where all children are underweight(height) ('all-underweight(height)'); (ii) those where not all children are underweight(height) ('mix-underweight(height)'); and (iii) those where none of the children is underweight(height) ('none-underweight(height)'). Within countries, our measure of local disparities in children's nutritional status is the share of households in an administrative region (*Admin2*) that is classified under each of the three categories. Intuitively, an increase in within-household inequality in child health should lead to a higher share of households where children have different nutritional status. While this regional variable might not identify the influence of small differential changes in nutritional outcomes across children, it reflects the regional consequences of within-households disparities and speaks directly to the policy issue of targeting. Changes in these shares over time are the outcome variable in the following region-level regression:

$$\Delta \text{Share}^D_{rt} = \alpha^D |\Delta \log \overline{\text{P}}_{r,t}| + \sum_{a=2}^{4} \alpha^D_a |\Delta \log \overline{\text{P}}_{a,r,t}| + \beta^D \Delta \mathbf{D'_{rt}} + \mu_t + \gamma_n + \varepsilon^D_{rt} \qquad (6)$$

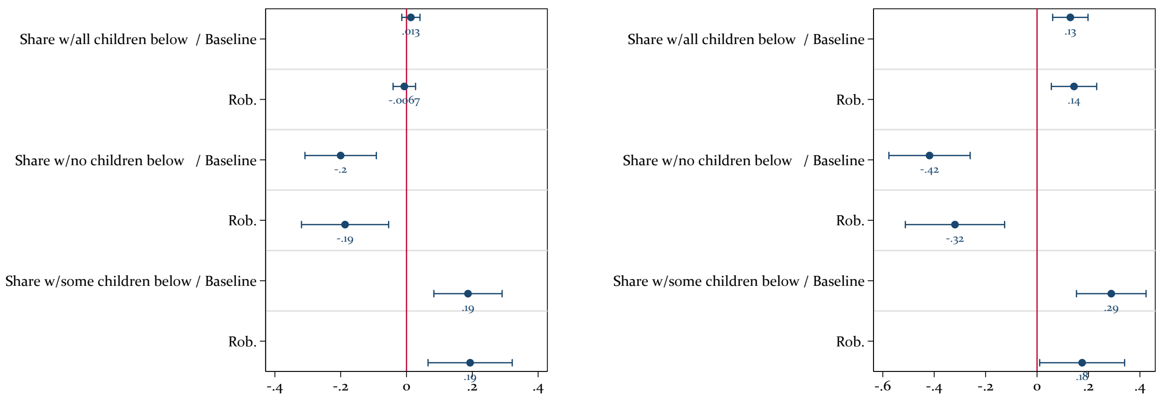
where the unit of observation is now an administrative region r at time t. Δ denotes the first-difference operator, and D indicates one of the three possible shares. To observe changes at the regional level, the estimation sample includes countries with at least two DHS surveys. Since we have data on children up to five years of age, we take a five-year cohort as the time unit. The variable ΔShare thus equals the change in, say, the 'mix-underweight(height)' share of households in region r between two five-year cohorts of children.

The main variable of interest, $|\Delta \log \overline{P}_{r,t}|$ is 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 and their first year of life. The coefficient α^D captures the association between changes in child health inequality and changes in the average price in early life across cohorts. The first-difference specification wipes out time-invariant factors that are specific to region r. Within a five-year cohort, the prices faced in utero and in the first year of life by a child who is, say, two, are the second-year prices of a child who is four. The α_D coefficient might thus pick up the effects of prices at different stages of children's early life. To correct for this, we control for the changes (in absolute value) in average prices faced by children in their second, third, and fourth year of life (the $\Delta \log \overline{\mathrm{P}}_{a,r,t}$ term in eq. (6)). The term D_{rt} collects first-differences of cohort-averaged characteristics (age in months, proportion of female children, of twins, and average number of children per household), and μ_t and γ_n are year of birth and country dummies controlling for aggregate trends.

Figure 3 depicts the estimated coefficient on the price volatility variable in our baseline specification (α^D), and in a robustness check where we replace the country dummies with country-year-of-survey ones. Because the household categories are mutually exclusive, the sum of the coefficients across category shares must equal zero. The results underscore a pro-inequality effect of early exposure to price variations within the household. The share of households where only some children suffer from malnutrition increases with variations in average prices that children faced in utero and during the first year of life within a region.

Figure 3: Exposure to world crop prices and child health inequality at the regional level

(a) Underweight (b) Underheight



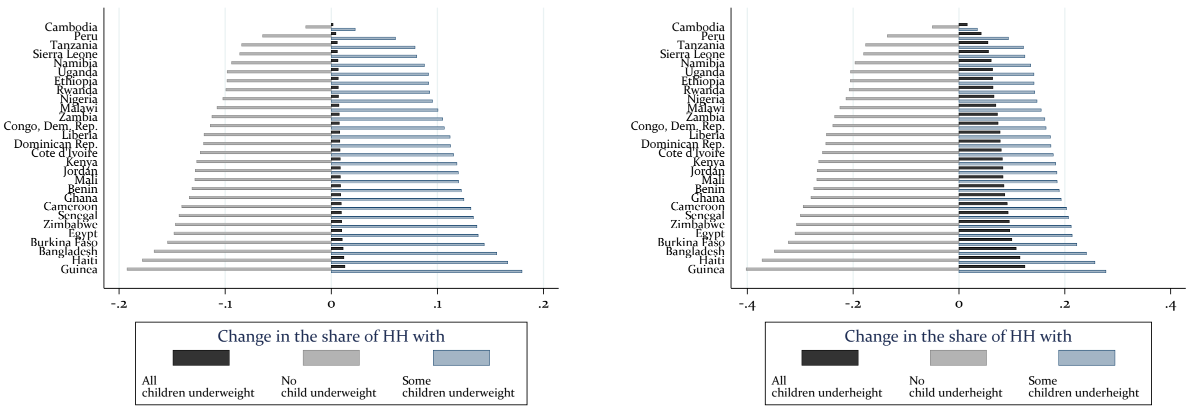
These figures report the coefficient on the ln crop price variable – the absolute value of the (changes in) average prices faced by the cohort of children born in region r in the five years preceding the survey date, during the in utero period and their first year of life –, i.e. α^D in the baseline regression (6). 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.

To assess the quantitative relevance of these results, we use our regression model in (6) to compute the changes in the predicted average shares for each household category and country in our sample under two scenarios. First, we predict shares assuming that there was no change in average crop prices at birth and in utero – i.e., we set $|\Delta \log \overline{\mathrm{P}}_{r,t}| = 0$ in equation (6). This is equivalent to an hypothetical situation where two consecutive cohorts of children faced the same early-life prices within a region. In the second scenario, we simply use the predictions of the regression model using observed price variations. The region-level predictions are then averaged across regions within countries to convey country-level predicted household category shares.[20]

Figure 4 shows the predicted change in each of the three categories of households: ‘no-underweight (height)’, ‘mix-underweight (height)’, and ‘all-underweight (height)’. Price variations increase the share of ‘mixed’ households, where healthy and malnourished siblings co-exist. The increase in the incidence of mixed households is quantitatively larger for underheight, or stunting. The average region in our sample has 17 percentage-point higher ‘mix-underheight’ share of households when we include the effect of price volatility, relative to a situation without any changes in crop prices in early life.[21]

Figure 4: Counterfactual: price variations and child health inequality at the country-level

(a) Underweight (b) Underheight



These figures report the within-country averages of predicted changes in each share of household, computed by comparing the case where $|\Delta \log \overline{P}_{r,t}| = 0$ with the predictions using the actual price variations. Predicted shares at the region-time level are averaged within countries.

The higher relevance of households with children both below and above the malnutrition thresholds owing to differing income situations at birth can have important policy implications. In particular, targeting of poverty reduction interventions (e.g., to tackle children’s malnutrition and stunting in rural areas) is problematic when economic and health conditions vary substantially within the households – the primary unit of targeting. For example, consider an anti-poverty programme tailored to eradicate children’s malnutrition that can only target households with at least one undernourished child. Some of the beneficiary households would include children who are not undernourished. The evidence from the child-level regressions tells us that in these households parents will tend to reinforce the existing health disparities among siblings, by investing the additional resources (e.g., cash transfers) relatively more on the healthy ones. The evidence from the region-level regressions suggests that the divergent health trajectories within the household will make targeting even more difficult, thereby fuelling further the ineffective allocation of resources to tackle poverty and malnutrition. This case scenario shows how differential parental

[20]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.

[21]In section A.11 we report the results in absolute terms, i.e. the predicted shares under each scenarios. This allows to see the actual levels of the shares in the two cases.

investments across siblings and their corresponding divergence in health outcomes can exacerbate the targeting issue of anti-poverty interventions.

7 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 and during the first year of life across siblings within the same household.

The results point to strong positive effects of early exposure to high prices on children's health. Provision of vaccinations and other forms of parental investment in children's health are also increasing in the price received by the child in early life, thus compounding the health effect. The improvements in health and investments received following a positive income variation are partly at the expense of the other siblings. These findings suggest an effect of income-related price fluctuations on child health inequality acting through a widening of disparities within the household. Results from aggregate regressions at the regional level strongly confirm this presumption – income fluctuations during pregnancy and in the first year of life increase the fraction of households where healthy and undernourished children live together. Parents' preferential allocation of resources to their 'sweet child', by increasing disparities across siblings, poses challenges to the targeting of poverty reduction policies.

The finding that parents transfer resources within the household to the strongest child corroborates economic and evolutionary theories of parental investments. In an evolutionary framework, parents invest in their children in order to maximize genetic transmissions across generations. They may favor the children born in good economic times since these are the 'fittest' ones. This strategy is more relevant in more competitive environments. The country heterogeneity results showing that the effect is more pronounced in countries with higher infant mortality and fractionalisation are in line with this interpretation. In economic models such as the one discussed in section 2, parents derive utility from their children's future health and human capital, and can invest in their health while facing uncertainty about their future income. Because of dynamic complementarities, parental investments reinforce initial disparities across siblings, such as the ones stemming from asymmetric income shocks received at birth. This prediction is valid in a framework where parents can't borrow nor lend against future income fluctuations – an insight that is reflected in the evidence of a weakening influence of financial development on the effect of income variations in early life on health across siblings.

The empirical evidence provided in this paper give 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.[22] Second, the evidence at the regional level indicates that income fluctuations

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

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.

References

, 2016. Sending children to school: rural livelihoods and parental investment in education in northern tanzania. Evolution and Human Behavior 37(2), 142 – 151.

Adhvaryu, A., Fenske, J., Nyshadham, A., 2017. Early Life Circumstance and Adult Mental Health. Journal of Political Economy Forthcoming.

Adhvaryu, A., Nyshadham, A., 2016. Endowments at Birth and Parents' Investments in Children. The Economic Journal 126(593), 781–820.

Almond, D., Currie, J., 2011. Killing Me Softly: The Fetal Origins Hypothesis. Journal of Economic Perspectives 25(3), 153–72.

Almond, D., Currie, J., Duque, V., 2018. Childhood Circumstances and Adult Outcomes: Act II. Journal of Economic Literature 56(4), 1360–1446.

Almond, D., Mazumder, B., 2013. Fetal origins and parental responses. Annual Review of Economics 5(1), 37–56.

Baird, S., Friedman, J., Schady, N., 2011. Aggregate income shocks and infant mortality in the developing world. The Review of Economics and Statistics 93(3), 847–856.

Baker, M., Currie, J., Schwandt, H., 2017. Mortality Inequality in Canada and the U.S.: Divergent or Convergent Trends? NBER Working Paper 23514.

Baland, J.M., Bonjean, I., Guirkinger, C., Ziparo, R., 2016. The economic consequences of mutual help in extended families. Journal of Development Economics 123, 38 – 56.

Benshaul-Tolonen, A., 2018. Local Industrial Shocks and Infant Mortality. The Economic Journal Forthcoming.

Berman, N., Couttenier, M., 2015. External shocks, internal shots: The geography of civil conflicts. Review of Economics and Statistics 97(4), 758–776.

Berman, N., Couttenier, M., Rohner, D., Thoenig, M., 2017. This Mine Is Mine! How Minerals Fuel Conflicts in Africa. American Economic Review 107(6), 1564–1610.

Black, S.E., Devereux, P.J., Salvanes, K.G., 2005. The More the Merrier? The Effect of Family Size and Birth Order on Children's Education*. The Quarterly Journal of Economics 120(2), 669–700. https://academic.oup.com/qje/article-pdf/120/2/669/5449009/120-2-669.pdf.

Brown, C., Calvi, R., Penglase, J., 2018. Sharing the Pie: Undernutrition, Intra-household Allocation, and Poverty. Working Paper.

Brown, C., Ravallion, M., van de Walle, D., 2017. Are Poor Individuals Mainly Found in Poor Households? Evidence using Nutrition Data for Africa. NBER Working Paper 24047.

Charnov, E.L., 1994. Life History Invariants. Journal of Evolutionary Biology 7(3), 399–400.

Cogneau, D., Jedwab, R., 2012. Commodity Price Shocks and Child Outcomes: The 1990 Cocoa Crisis in Côte d'Ivoire. Economic Development and Cultural Change 60(3), 507–534.

Colella, F., Lalive, R., Sakalli, S.O., Thoenig, M., 2019. Inference with Arbitrary Clustering. IZA Discussion Papers 12584.

Conley, T., 1999. Gmm estimation with cross sectional dependence. Journal of Econometrics 92(1), 1 – 45.

Cosslett, S.R., 1991. Distribution-Free Estimator of a Regression Model with Sample Selectivity, in: Nonparametric and Semiparametric Methods in Econometrics and Statistics. Cambridge University Press.

Costa, D.L., 2000. Understanding the twentieth-century decline in chronic conditions among older men. Demography 37(1), 53–72.

Currie, J., Hyson, R., 1999. Is the impact of health shocks cushioned by socioeconomic status? the case of low birthweight. American Economic Review 89(2), 245–250.

Currie, J., Schwandt, H., 2016a. Inequality in mortality decreased among the young while increasing for older adults, 1990–2010. Science .

Currie, J., Schwandt, H., 2016b. Mortality Inequality: The Good News from a County-Level Approach. Journal of Economic Perspectives 30(2), 29–52.

Currie, J., Schwandt, H., Thuilliez, J., 2018. Pauvreté, Egalité, Mortalité: Mortality (In)Equality in France and the United States. NBER Working Paper 24623.

Currie, J., Vogl, T., 2013. Early-Life Health and Adult Circumstance in Developing Countries. Annual Review of Economics 5(1), 1–36.

De Haan, M., Plug, E., Rosero, J., 2014. Birth order and human capital development: Evidence from ecuador. Journal of Human Resources 49(2), 359–392. http://jhr.uwpress.org/content/49/2/359.full.pdf+html.

Dercon, S., Porter, C., 2014. Live aid revisited: Long-term impacts of the 1984 ethiopian famine on children. Journal of the European Economic Association 12(4), 927–948.

Duque, V., Rosales-Rueda, M., Sanchez, F., 2018. How Early-life Shocks Interact with subsequent Human Capital Investments? Evidence from Administrative Data. Working Paper.

Ellis, B.J., Figueredo, A.J., Brumbach, B.H., Schlomer, G.L., 2009. Fundamental Dimensions of Environmental Risk. Human Nature 20(2), 204–268.

Fabian, D., Flatt, T., 2012. Life History Evolution. Nature Education Knowledge 3(10).

Ferreira, F.H.G., 2009. Aggregate Economic Shocks, Child Schooling, and Child Health. World Bank Research Observer 24(2), 147–181.

Garg, A., Morduch, J., 1998. Sibling rivalry and the gender gap: Evidence from child health outcomes in ghana. Journal of Population Economics 11(4), 471–493.

Gibson, M.A., Sear, R., 2010. Does wealth increase parental investment biases in child education? evidence from two african populations on the cusp of the fertility transition. Current Anthropology 51(5), 693–701. https://doi.org/10.1086/655954.

Godfray, H.C.J., 1995. Signaling of need between parents and young: Parent-offspring conflict and sibling rivalry. The American Naturalist 146(1), 1–24.

Gonzalez, L., Rodriguez-Gonzalez, A., 2018. Changes in Inequality in Mortality: New Evidence for Spain. Working Papers 1050. Barcelona Graduate School of Economics.

Groppo, V., Kraehnert, K., 2016. Extreme Weather Events and Child Height: Evidence from Mongolia. World Development 86(C), 59–78.

Hampshire, K.R., Panter-Brick, C., Kilpatrick, K., Casiday, R.E., 2009. Saving lives, preserving livelihoods: Understanding risk, decision-making and child health in a food crisis. Social Science and Medicine 68(4), 758 – 765. part Special Issue: Selected research from the XII International Symposium in Medical Geography 2007.

Heckman, J.J., 2007. The economics, technology, and neuroscience of human capability formation. Proceedings of the National Academy of Sciences 104(33), 13250–13255.

Hedges, S., Mulder, M.B., James, S., Lawson, D.W., 2016. Sending children to school: rural livelihoods and parental investment in education in northern Tanzania. Evolution and Human Behavior 37(2), 142–151.

Hill, K., 1993. Life history theory and evolutionary anthropology. Evolutionary Anthropology: Issues, News, and Reviews 2(3), 78–88. https://onlinelibrary.wiley.com/doi/pdf/10.1002/evan.1360020303.

Kolliker, M., Brodie III, E.D., Moore, A.J., 2005. The coadaptation of parental supply and offspring demand. The American Naturalist 166(4), 506–516. pMID: 16224706. https://doi.org/10.1086/491687.

Lawson, D.W., forthcoming. Parental care, in: Koster J., Scelza B., S.M. (Ed.), Human Behavioral Ecology.

Lawson, D.W., Alvergne, A., Gibson, M.A., 2012. The life-history trade-off between fertility and child survival. Proceedings of the Royal Society B – Biological Sciences 279(1748).

Li, Z., Li, M., Subramanian, S.V., Lu, C., 2017. Assessing levels and trends of child health inequality in 88 developing countries: from 2000 to 2014. Global Health Action 10(1), 1408385.

McGuirk, E., Burke, M., 2017. The Economic Origins of Conflict in Africa. Technical Report 23056.

Miller, G., Urdinola, B.P., 2010. Cyclicality, Mortality, and the Value of Time: The Case of Coffee Price Fluctuations and Child Survival in Colombia. Journal of Political Economy 118(1), 113–155.

Monfreda, C., Ramankutty, N., Foley, J.A., 2008. Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000. Global Biogeochemical Cycles 22(1).

Pande, R.P., 2003. Selective gender differences in childhood nutrition and immunization in rural india: The role of siblings. Demography 40(3), 395–418.

Pei, Z., Pischke, J.S., Schwandt, H., 2018. Poorly Measured Confounders are More Useful on the Left than on the Right. Journal of Business & Economic Statistics Forthcoming, 1–12.

Roff, D., 1992. The Evolution of Life Histories: Theory and Analysis. New York: Chappman and Hall.

Rosenzweig, M.R., Zhang, J., 2009. Do population control policies induce more human capital investment? twins, birth weight and china's "one-child" policy. The Review of Economic Studies 76(3), 1149–1174.

Stearns, S., 1992. The Evolution of Life Histories. OUP Oxford.

Trivers, R.L., 1974. Parent-Offspring Conflict. American Zoologist 14(1), 249–264. https://academic.oup.com/icb/article-pdf/14/1/249/5993808/14-1-249.pdf.

Uggla, C., Mace, R., 2006. Parental investment in child health in sub-saharan africa: a cross-national study of health-seeking behaviour. Royal Society Open Science 3.

Venkataramani, A.S., 2012. Early life exposure to malaria and cognition in adulthood: Evidence from mexico. Journal of Health Economics 31(5), 767 – 780.

Vogl, T.S., 2018. Dynamics of child mortality inequality. AEA Papers and Proceedings 108, 348–52.

de Vreyer, P., Lambert, S., 2018. By ignoring intra-household inequality, do we underestimate the extent of poverty? PSE Working Papers.

Wang, L., 2003. Determinants of child mortality in ldcs: Empirical findings from demographic and health surveys. Health Policy 65(3), 277 – 299.

Wolf, J.B., 2006. A maternal-offspring coadaptation theory for the evolution of genomic imprinting. PLoS biology 4(12), 380.

Yi, J., Heckman, J.J., Zhang, J., Conti, G., 2015. Early Health Shocks, Intra-household Resource Allocation and Child Outcomes. The Economic Journal 125(588), F347–F371.

Sweet child of mine:
Income shocks, 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 (Heckman, 2007; 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 in order 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 in-utero period and first year of life: 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.

The income of the household y_t is uncertain and varies over time. Income is independently drawn from a probability distribution function $f(.)$ over $(0;+\infty)$. The expected value of y_t is denoted $\overline{y}$.

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

$$h_c = A\left[\gamma(I_c^{p_1})^{\frac{(s-1)}{s}} + (1-\gamma)(I_c^{p_2})^{\frac{(s-1)}{s}}\right]^{\frac{s}{(s-1)}}$$

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. 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:

$$h_c = A(I_c^{p_1})^{\gamma}(I_c^{p_2})^{1-\gamma}$$

The specific functional form we use embeds some assumptions: first, as already said, 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 since the work of Currie and Hyson (1999) and Costa (2000), health investments during pregnancy and the first year of life are particularly important for further development (see e.g. Almond and Currie, 2011, for a review of this literature). We hence assume that $\gamma > \frac{1}{2}$.

Parents' preferences and budget constraint. Parents value investments as long as they increase quality. Since investment goes also through nutrition, we are implicitly assuming that, in each period, investment is high enough to guarantee survival. Investment is traded-off against parental consumption. In particular, the inter-temporal utility function of the parents has the following form[4]:

$$u_p = log\,(C_1) + log\,(C_2) + log\,(C_3) + h_{c1} + h_{c2}$$

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:

$$\begin{gathered} C_1 + pI_{c1}^{p_1} \leq Y_1 \\ C_2 + p\,(I_{c1}^{p_2} + I_{c2}^{p_1}) \leq Y_2 \\ C_3 + pI_{c2}^{p_2} \leq Y_3 \end{gathered}$$

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

A.2 Parental optimal investment and realised quality

Optimal Investment without income fluctuations. Assume that income is fixed, i.e. that $y_1 = y_2 = y_3 = \overline{y}$. In this case, when maximizing their utility over time, parents can choose the optimal investment path in period 0. They solve simultaneously the system of first order conditions for interior investment solutions and want to equalize marginal returns of investment to the marginal utility of consumption. In particulalr, parents solve simultaneously the following system of first order conditions:

$$\begin{array}{rcl} -\frac{1}{Y-I_{c1}^{p_1}} + \gamma A(I_{c1}^{p_1})^{\gamma-1}(I_{c1}^{p_2})^{1-\gamma} & = & 0 \\ -\frac{1}{Y-I_{c1}^{p_2}-I_{c2}^{p_1}} + (1-\gamma)A(I_{c1}^{p_1})^{\gamma}(I_{c1}^{p_2})^{-\gamma} & = & 0 \\ -\frac{1}{Y-I_{c1}^{p_2}-I_{c2}^{p_1}} + \gamma A(I_{c2}^{p_1})^{\gamma-1}(I_{c2}^{p_2})^{1-\gamma} & = & 0 \\ -\frac{1}{Y-I_{c2}^{p_2}} + (1-\gamma)A(I_{c1}^{p_1})^{\gamma}(I_{c1}^{p_2})^{-\gamma} & = & 0 \end{array} \tag{7}$$

With constant income, $\gamma > \frac{1}{2}$ and the two children overlapping in period 2, it follows immediately that $I_{c1}^{p_1} > I_{c2}^{p_1} > I_{c2}^{p_2} > I_{c1}^{p_2}$. Moreover, $\frac{I_{c1}^{p_1}}{I_{c2}^{p_1}} > \frac{I_{c2}^{p_2}}{I_{c1}^{p_2}}$. This implies that the human capital of the first child is higher than the human capital of the second child (for a given level of income) – there is a relationship between investment in a child health and her birth rank.

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]. 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 now study how income variability affects optimal investment.

[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 developped countries (Black et al., 2005), while there is some evidence on the relationship working in the opposite direction in developping 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).

Optimal Investment under uncertainty. We allow income to vary over time in ways that parents cannot predict ex-ante. Consider a situation where income in future periods can take on three values (i.e., states of the world): "low" (L), "medium" (M) and "high" (H). Parents maximise their utility equalizing marginal rates of consumption and investment under each state of the world. However, when deciding period 1 investments, they are now uncertain about the level of investment of the second period.

Income uncertainty modifes the FOCs of the parents problem for the first year investment in the following way:

$$\begin{array}{rcl} -\frac{1}{Y_1^j - I_{c1}^{p_1,j}} + \gamma A(I_{c1}^{p_1,j})^{\gamma-1}[p_L(I_{c1}^{p_2,L})^{1-\gamma} + p_M(I_{c1}^{p_2,M})^{1-\gamma} + p_H(I_{c1}^{p_2,H})^{1-\gamma}] & = & 0 \\ -\frac{1}{Y_2^k - I_{c1}^{p_2,k} - I_{c2}^{p_1,k}} + (1-\gamma)A(I_{c1}^{p_1,j})^{\gamma}(I_{c1}^{p_2,k})^{-\gamma} & = & 0 \\ -\frac{1}{Y_2^k - I_{c1}^{p_2,k} - I_{c2}^{p_1,k}} + \gamma A(I_{c2}^{p_1,k})^{\gamma-1}[p_L(I_{c2}^{p_2,L})^{1-\gamma} + p_M(I_{c2}^{p_2,M})^{1-\gamma} + p_H(I_{c2}^{p_2,H})^{1-\gamma}] & = & 0 \\ -\frac{1}{Y_3^l - I_{c2}^{p_2,l}} + (1-\gamma)A(I_{c2}^{p_1,k})^{\gamma}(-I_{c2}^{p_2,l})^{-\gamma} & = & 0 \end{array} \quad (8)$$

where Y_1^j, Y_2^k and Y_3^l are income realizations in periods 1, 2 and 3 respectively, and $I_c^{p,j}$ the corresponding investment for child c in period p, with j, k and l in L, M, H.

Due to our specific functional form that implies risk-aversion, the uncertainty related to period 2 investment for the second child decreases his period 1 investment. This, is turn, decreases the resource constraint faced by the first child in period 2. Due to dynamic complementarities, the increase in period 2 investment should drive period 1 investment up for the first child. However, the income uncertainty pushes period 1 investment down: so the overall effect of introducing uncertainity on period 1 investment for the first child is ambiguous.

We now consider the effects of a positive income realization $y_t > \overline{y}$[8] 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 $\overline{y}$[9]. The comparative statics exercise speaks directly to the empirical analysis in the paper. An increase in income has a direct positive effect on investment for all children living in that period. The increase in investment implies also an indirect effect for the child that is in his first period of life when the increase in income occurs: thanks to dynamic complementarities , a positive income shock increases investment also in period 2.

A.3 Propositions and Proofs

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 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 is the following:

$$\begin{array}{rcl} \frac{\partial I^{p_1,j_{c1}}}{\partial Y_1} & = -\frac{\frac{\partial U^P}{\partial Y_1}}{\frac{\partial U^P}{\partial I^{p_1}}} = & \frac{h_{c1}}{(Y_1^j - I_{c1}^{p_1,j})I_{c1}^{p_1,j}} > 0 \\ \frac{\partial I_{c1}^{p_2,j}}{\partial Y_1} & = \frac{\partial I^{p_2,j}}{\partial I^{p_1,j}}\frac{\partial I^{p_1,j}}{\partial Y_1} = & \frac{\partial I^{p_2,j}}{\partial I^{p_1,j}}\frac{h_{c1}}{(Y_1^j - I_{c1}^{p_1,j})I_{c1}^{p_1,j}} > 0 \end{array} \quad (9)$$

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

[9]This assumption mimic our main empirical specification that relies on household fixed effects to get rid of unobservables. Once fixed effects are introduced, we study the effects, for each child, of price deviations from mean prices during pregnancy and first year of life of all children

The second derivative is positive because $\frac{\partial I^{p_2,j}}{\partial I^{p_1,j}} > 0$ – $I^{p_1,j}$ increases the return of investing in period 2 for the same child, as the first order conditions show.

Turning to the second child, an income shock occurring in his first period of life correspond to a shock to y_2: we assume now that the income realization in the second period is $y_2 > \overline{y}$ 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 the following:

$$\begin{aligned} \frac{\partial I^{p_1,j_{c2}}}{\partial Y_2} &= -\frac{\frac{\partial U^P}{\partial Y_2}}{\frac{\partial U^P}{\partial I^{p_1,j_{c2}}}} = \frac{h_{c2}}{(Y_2^k - I_{c1}^{p_2,k} - I_{c2}^{p_1,k}) I_{c2}^{p_1,k}} > 0 \\ \frac{\partial I_{c2}^{p_2,j}}{\partial Y_2} &= \frac{\partial I^{p_2,j}}{\partial I^{p_1,j}} \frac{\partial I^{p_1,j}}{\partial Y_2} = \frac{\partial I^{p_2,j}}{\partial I^{p_1,j}} \frac{h_{c2}}{(Y_2^k - I_{c1}^{p_2,k} - I_{c2}^{p_1,k}) \partial I^{p_2,j}} > 0 \end{aligned} \tag{10}$$

We can further study the 'sibling effect" – the marginal effect of an income shock in the first period (the in-utero and first year of life for the older child) 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. The effect of an increase in investment in the first child on the second child investment are given by:

$$\begin{aligned} \frac{\partial I_{c2}^{p_1,j}}{\partial Y_1} &= -\frac{\frac{\partial U^P}{\partial I_{c1}^{p_2,j}} \frac{\partial I_{c1}^{p_2,j}}{\partial Y_1}}{\frac{\partial U^P}{\partial I_{c2}^{p_1,j}}} = -\frac{h_{c2}}{(Y_2^k - I_{c1}^{p_2,k} - I_{c2}^{p_1,k}) I_{c2}^{p_1,k}} \frac{\partial I_{c1}^{p_2,j}}{\partial Y_1} < 0 \\ \frac{\partial I_{c2}^{p_2,j}}{\partial Y_1} &= \frac{\partial I^{p_2,j}}{\partial I^{p_1,j}} \frac{\partial I_{c2}^{p_1,j}}{\partial Y_1} \frac{\partial I^{p_1,j}}{\partial Y_2} = \frac{\partial I^{p_2,j}}{\partial I^{p_1,j}} \frac{\partial I_{c2}^{p_1,j}}{\partial Y_1} \frac{h_{c2}}{(Y_2^k - I_{c1}^{p_2,k} - I_{c2}^{p_1,k}) \partial I^{p_2,j}} < 0 \end{aligned} \tag{11}$$

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).[10] We downloaded all country waves containing information on the geo-location of households as of July, 2017. These data leave us with 54 countries, surveyed between 1986 and 2016. We restrict the sample to rural areas. A map showing the countries covered and the location of the households appears in the online appendix, section B.4. Table A.1 contains the numbers of survey waves, mothers and children for each country 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[11]. For 14 country waves the data come from the Malaria Indicator Survey (MIS) Questionnaires[12] and for 2 country waves they come from the Aids Indicator Survey (AIS) Questionnaires[13]. 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 recored 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.

B.2 Agricultural specialization and producer prices

Agricultural specialization. We compute our baseline measure of agricultural specialization from the FAO's Global Agro-Ecological Zones (GAEZ).[14] 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.

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

[11] 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 databse, that may differ from the label reported on the DHS website when downloading the data.

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

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

[14] http://gaez.fao.org/Main.html

International crop prices. Data on the monthly international market prices of each crop come from the World Bank Commodities Dataset.[15] Figure A.2 displays the time variations of the most produced crops.

B.3 Other data

Time-varying cell-specific information. We compute a number of cell-specific controls. First, we get information on mineral production location from Berman *et al.* (2017) and combine this information with data on month world prices of minerals from the World Bank Commodity dataset. Second, 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 from GPCC[16] and GHCN CAMS[17].

Country-specific variables. In section 5 we study how our results vary with country-specific characteristics. We use data on Mortality rate under 5 years (per 1,000 live births), domestic credit to private sector (as % of GDP) and GDP per capita (constant 2010 USD) from the World Bank Development Indicators. We compute the average of these indicators over the post 1990 period. We also compute an index of country-specific fractionalization, defined as the average of ethnic, linguistic and religious fractionalization from the Quality of Governance dataset.[18]

[15] http://databank.worldbank.org/data/databases/commodity-price-data

[16] https://opendata.dwd.de/climate_environment/GPCC/html/fulldata-monthly_v2018_doi_download.html

[17] https://www.esrl.noaa.gov/psd/data/gridded/data.ghcncams.html

[18] urlhttps://qog.pol.gu.se/data/datadownloads/qogstandarddata

B.4 Statistics

Figure A.1: Location of DHS households

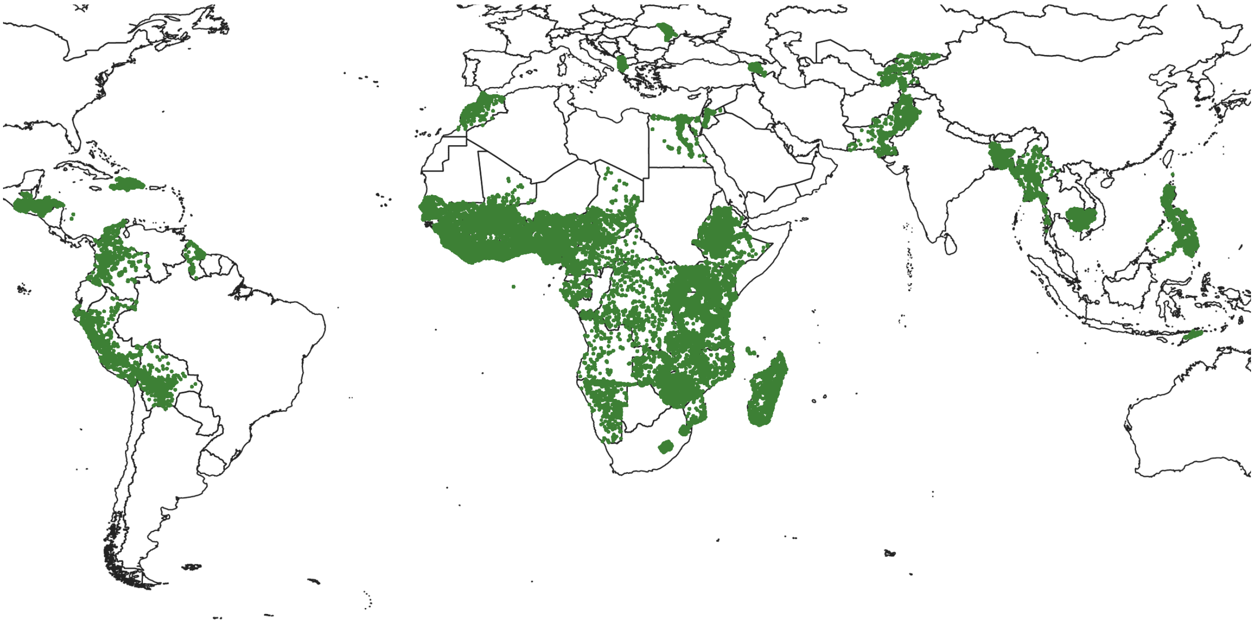


Figure A.2: World prices of the most produced crops

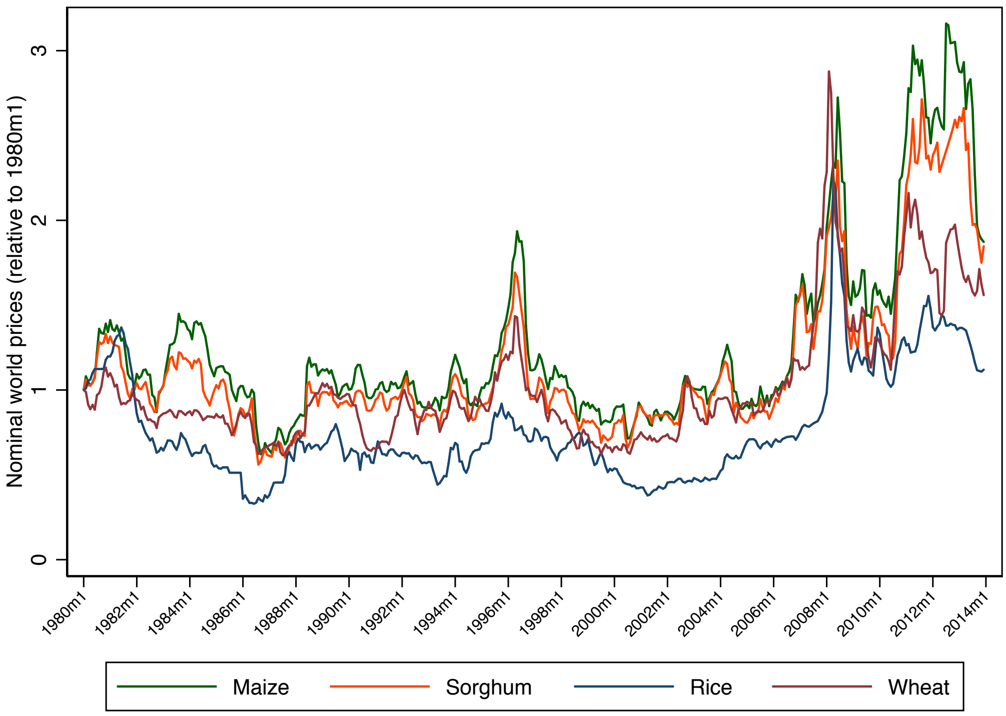


Table A.1: Country-level statistics

Country	Waves	# mothers	# children (6-18 years)	# children (0-5 years)	Country	Waves	# mothers	# children (6-18 years)	# children (0-5 years)
Albania	1	7013	4489	901	Kyrgystan	1	11918	6169	3237
Angola	1	14747	7461	6067	Lesotho	3	32042	17245	8704
Armenia	2	7235	3578	1247	Liberia	4	48093	24676	15118
Bangladesh	4	102565	56890	19943	Madagascar	4	56972	25330	25836
Benin	3	44151	26194	12249	Malawi	4	159513	89822	45254
Bolivia	1	19957	12013	4225	Mali	3	62598	33957	22828
Burkina Faso	4	78719	46059	20728	Moldova	1	5038	2772	728
Burundi	1	22586	11904	8062	Morocco	1	17899	10006	3498
Cambodia	2	92442	56774	19638	Mozambique	1	25112	13844	7494
Cameroon	3	43380	24230	12007	Myanmar	1	18072	10619	3805
Chad	1	54341	32808	14652	Namibia	3	30562	17125	8433
Colombia	1	32358	18402	6431	Nigeria	4	180284	98472	52792
Comoros	1	7297	4203	2076	Pakistan	1	19144	10143	6033
Congo Democratic Republic	2	59026	32476	18632	Peru	3	58862	34207	11567
Cote d'Ivoire	2	19175	10859	5198	Philippines	2	33538	19744	7632
Dominican Republic	2	31615	17595	6076	Rwanda	3	67306	38830	18955
Egypt	4	106079	59175	25082	Senegal	3	70017	39632	20404
Ethiopia	3	104279	61781	26787	Sierra Leone	3	51473	28111	16466
Gabon	1	9327	4862	2354	Swaziland	1	8474	4476	2089
Ghana	6	34359	18639	10189	Tajikistan	1	13242	7169	3470
Guatemala	1	35126	19857	8165	Tanzania	4	84765	43988	27846
Guinea	3	41266	24428	9997	Timor-Leste	1	27897	16664	7602
Guyana	1	8510	4850	1771	Togo	3	19701	11638	4993
Haiti	3	54514	31681	13403	Uganda	3	84398	46265	26421
Honduras	1	32611	18713	7209	Zambia	2	44438	25089	12787
Jordan	3	35069	20488	8612	Zimbabwe	4	52720	29061	14394
Kenya	3	95240	54527	25318					

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.

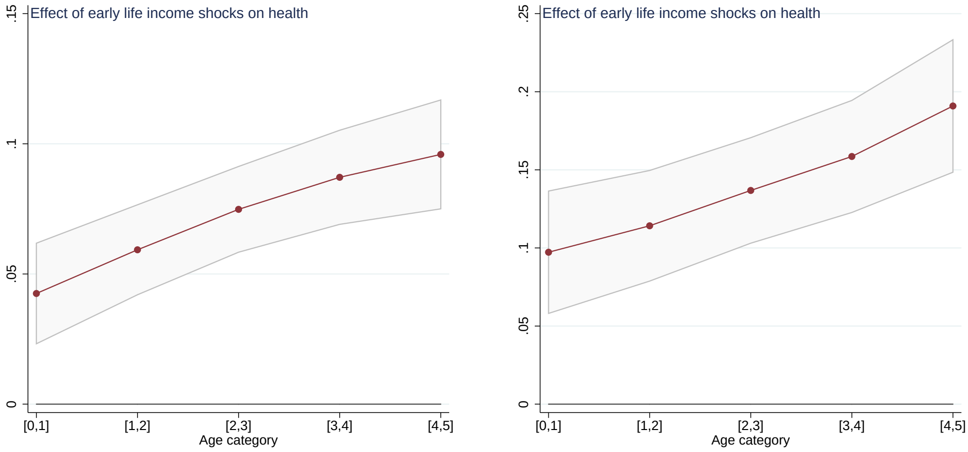
C Additional results

C.1 Baseline results: additional figures

The figures below split the effect of early life income variations on child health and parental investments by age of the child. We do not consider vaccination and breastfeeding, as these are investments which are made in the very first years of life. Except in the case of iron pills, we find that all coefficients are increasing in age: early life income variations positively affect child health and investments directed to that child, and these effect become stronger as the child ages.

Figure A.3: Exposure to world crop prices on health over the age profile (continuous health measures)

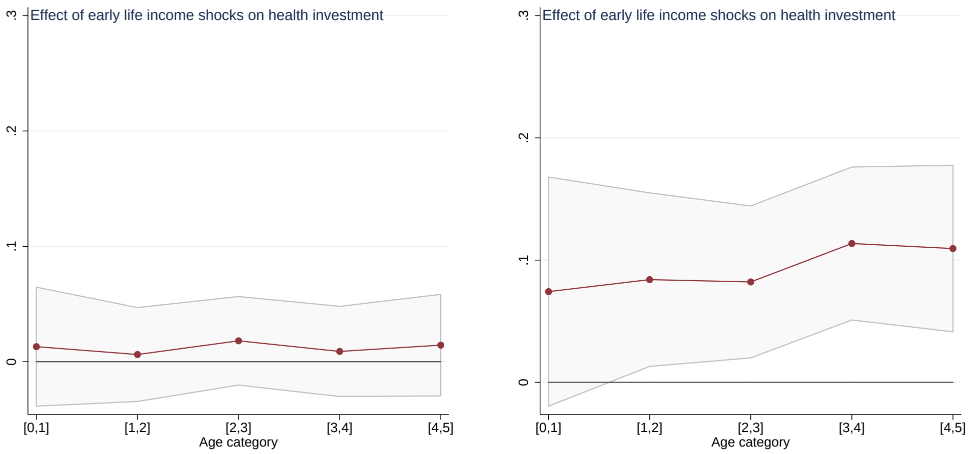
(a) log height (b) log weight



Source: These figures report the coefficient on the ln crop price variables price, split by child age in years, based on the estimation of equation (3). Shaded areas are 90% confidence bands.

Figure A.4: Exposure to world crop prices on health investment over the age profile

(a) Iron pills (b) Deworming



Source: These figures report the coefficient on the ln crop price variables price, split by child age in years, based on the estimation of equation (3). Shaded areas are 90% confidence bands.

C.2 Cell fixed-effects results

Table A.3 below reproduces our main estimations, replacing mother fixed effects with cell fixed-effects. In these estimations, the effect of income variations is identified across children and households, rather than within household. The results we find as similar to our baseline, suggesting that child health does not only improve in relative terms (i.e. relative to the child's siblings) but also in absolute terms.

Table A.3: Exposure to world crop prices, health outcomes, and parental investments – Cell fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price	-0.307^a	-0.217^a	0.098^a	0.220^a	-0.010^a	-0.019^a	0.027^a
	(0.024)	(0.015)	(0.007)	(0.015)	(0.003)	(0.005)	(0.006)
Observations	335987	334641	335957	334611	2206897	2206897	2206897
R^2	0.131	0.095	0.299	0.308	0.032	0.044	0.079
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price	0.468^a	0.443^a	0.554^a	0.081^a	0.161^a	0.075^a	0.170^a
	(0.039)	(0.072)	(0.062)	(0.015)	(0.024)	(0.016)	(0.023)
Obs	345748	417011	473588	477255	473824	332671	371519
R^2	0.553	0.361	0.430	0.355	0.441	0.151	0.309
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. Household controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. 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. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

C.3 School attendance

In Table A.4, we test whether our baseline results on health hold also for children's educational investments. We regress an indicator for school attendance for children in school age (older than 5), on the crop price variable measured during the in utero period and the first year of life. As for our baseline specifications (e.g., eq. (2)), we exploit within-mother variation and control for children's characteristics such as gender, age, birth order and twin status. The results show that children who received a higher income-related price at birth are significantly more likely to attend school. The reinforcing investment strategies found for health are thus confirmed for children's education. In this case, however, parents' investments in the 'strong' older siblings do not affect significantly directly school attendance of the child. This lack of sibling effect is shown by the insignificant coefficient on the siblings' price variable in column (3). These results suggest that parents invest more in their 'sweet' child's education than in her siblings, but without taking resources away from the siblings' education.

Table A.4: Exposure to world crop prices and school attendance

	(1)	(2)	(3)
ln crop price (own)	0.067^a	0.033^b	0.030^c
	(0.020)	(0.015)	(0.017)
ln crop price (older siblings)			-0.004
			(0.007)
Obs.	763006	814394	634924
R^2	0.676	0.401	0.400
Child controls	Yes	Yes	Yes
Mother controls	No	Yes	Yes
Mother FE	Yes	No	No
Cell FE	No	Yes	Yes

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. The unit of observation is a child between 6 and 17 years of age. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and dummies for age in years. Household controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. 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. ln crop price (siblings) is the price faced on average by all elder siblings during in utero and during their first year of life.

C.4 Child mortality and selection bias

Our results show a small and at times statistically significant effect of early life crop price variations on mortality at birth and in the first year of life, and on survival later on. In this section we examine whether this selective mortality affects our baseline results on child health and parental investments in child health. More precisely, we try to account for a potential selection bias by including a selection correction term in our estimations. Given the structure of our selection equation (which includes two high dimensional sets of fixed effects), we cannot use probit or other maximum likelihood estimators to implement a standard Heckman procedure. The variables being the same in our baseline equations and in the selection equation, we have to rely on some nonlinear transformation of the predicted probabilities to correct for selection. We follow 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. In Tables A.5 and A.6, we include in our baseline specifications dummies for 100 bins corresponding to each centile of the predicted survival probabilities as correction terms. The survival probabilities are computed from the specification in Panel A, column (7) of Tables 2 and 4 (for the sibling regressions). For both child health and parental investments, the estimated coefficients on the price index variable specific to the child are very close from the benchmark ones. We have also tried, as an alternative methodology, to weight our estimation by survival probabilities; the results were similar.

Table A.5: Crop prices, child health and parental investments – selection on mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight			
ln crop price	-0.223[a]	-0.168[a]	0.068[a]	0.125[a]			
	(0.043)	(0.029)	(0.010)	(0.021)			
Observations	191823	191513	191795	191487			
R^2	0.627	0.586	0.756	0.750			
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price	0.179[a]	0.182	0.309[a]	0.069[b]	0.192[a]	0.019	0.110[a]
	(0.059)	(0.112)	(0.097)	(0.027)	(0.039)	(0.022)	(0.038)
Observations	152427	247317	276227	278902	275395	185373	203771
R^2	0.797	0.813	0.822	0.804	0.797	0.817	0.822
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[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 as correction terms 100 bins corresponding to each centile of the predicted survival probabilities, estimated from the regression in column (7), Table 2. Child controls include: gender, birth order, twin dummy, and age in month and its value squared. Mother controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. 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. In Panel A: 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. In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

Table A.6: Own and siblings' exposure to world crop prices, child health and parental investments – selection on mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight			
ln crop price (own)	-0.286^a	-0.199^a	0.087^a	0.196^a			
	(0.026)	(0.017)	(0.007)	(0.016)			
ln crop price (older siblings)	0.032^a	0.015^a	-0.004^b	-0.010^a			
	(0.006)	(0.004)	(0.002)	(0.004)			
Observations	263635	261917	263612	261894			
R^2	0.135	0.099	0.301	0.311			
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price (own)	0.471^a	0.427^a	0.545^a	0.104^a	0.155^a	0.061^a	0.167^a
	(0.042)	(0.079)	(0.066)	(0.017)	(0.025)	(0.018)	(0.026)
ln crop price (older siblings)	-0.006	-0.064^a	-0.097^a	-0.015^a	-0.019^a	-0.007	0.000
	(0.006)	(0.019)	(0.016)	(0.005)	(0.006)	(0.005)	(0.007)
Observations	271036	329136	370119	372696	370036	261528	291275
R^2	0.565	0.361	0.433	0.359	0.436	0.153	0.311
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

^{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 as correction terms 100 bins corresponding to each centile of the predicted survival probabilities, estimated from the regression in column (7), Panel A, Table 4. Child controls include: gender, birth order, twin dummy, and age in month and its value squared. Mother controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. 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. ln crop price (older siblings) is the price faced on average by all elder siblings during in utero and during their first year of life. In Panel A: 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. In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

C.5 Robustness: full sequence of prices

Price are persistent over time. This persistence is an issue in our case, as it implies that we might be capturing the effect of prices in subsequent years on subsequent health and not the effect of early life prices on subsequent health. To solve this issue, we can include the full sequence of prices in our estimations, i.e. control for the prices observed when the child is 2, 3 or 4 years old.[19] Equation (2) becomes:

$$Y_c = \alpha \log \overline{P}_{c,k} + \sum_{a=2}^{4} [\beta_1^a \log \overline{\mathrm{P}}_k^a + \beta_2^a \ln \overline{\mathrm{P}}_k^a \times I_k^a] + \mathbf{D_c'}\delta + \mu_H + \gamma_{i,t} + \nu_m + \varepsilon_c \tag{12}$$

Equation (12) includes the full sequence of prices $\overline{\mathrm{P}}_k^a$ for children in their second, third and fourth years. Because not all children reached that age, we interact $\overline{\mathrm{P}}_k^a$ with an indicator variable which equal 1 if child k is aged a or more. The set of coefficient β_2^a represents effect of prices variations in later life. β_1^a, on the other hand, should generally be insignificant.

The results on health are shown in Table A.7, while those on health investments are in Table A.8. Four elements are worth mentioning. First, prices during pregnancy and first year remain significant and keep the same signs as in the baseline estimations, which means we were not picking up the effect of price persistence. Second, prices during pregnancy and in the first year have quantitatively similar effects, thereby supporting the choice of lumping them together in a single price variable. Third, prices in later years, while being generally significant, have a quantitatively much more limited impact on health indicators. Fourth, the non interacted prices are in most cases insignificant, which is in line with expectations.

Finally, in Figure A.5 we show that the results on the effect of early life price variations on health and health investment over time are robust to the inclusion of the full sequence of prices.

[19] Note that in our empirical specification the mother fixed effects de facto absorb the effect of prices at the time of the survey. The estimates in specification (12) are thus relative to this benchmark prices at the year of the survey.

Table A.7: Exposure to world crop prices and child health – By year of the price shock

	(1)	(2)	(3)	(4)
Dep. var.	Underheight	Underweight	ln height	ln weight
Prices observed before time of the survey:				
ln crop price (pregnancy)	-0.144[a]	-0.108[a]	0.042[a]	0.113[a]
	(0.039)	(0.025)	(0.012)	(0.024)
ln crop price year 1	-0.149[a]	-0.073[a]	0.052[a]	0.072[a]
	(0.034)	(0.023)	(0.010)	(0.020)
ln crop price year 2 × age ≥ 1	-0.093[a]	-0.036[c]	0.026[a]	0.022
	(0.028)	(0.018)	(0.010)	(0.021)
ln crop price year 3 × age ≥ 2	-0.104[a]	-0.018	0.019[a]	0.007
	(0.028)	(0.017)	(0.006)	(0.014)
ln crop price year 4 × age ≥ 3	-0.045[c]	-0.005	0.003	-0.009
	(0.026)	(0.018)	(0.007)	(0.015)
ln crop price year 2	-0.003	0.004	-0.009	0.018
	(0.047)	(0.031)	(0.016)	(0.032)
ln crop price year 3	0.024	-0.001	0.002	0.039
	(0.043)	(0.027)	(0.012)	(0.025)
ln crop price year 4	0.016	-0.026	0.007	0.041[c]
	(0.027)	(0.019)	(0.010)	(0.023)
Obs	185526	185176	185526	185176
R^2	0.614	0.579	0.712	0.705
Child controls	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes

[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 country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age dummies (one for each year). 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. 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) are the logs of height (resp. weight) divided by the gender-specific average height (resp. weight) for that particular age in month from WHO. Age refers to the age of the child (in years) at the time of the survey – e.g., "age≥1" includes all children that are 1 or older at the time of the survey (i.e., they are in their second year of life).

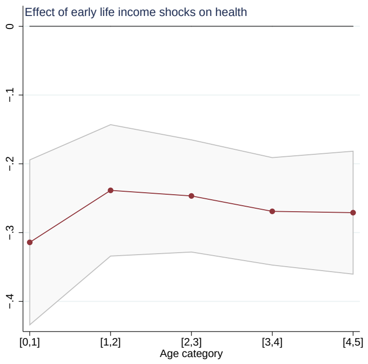
Table A.8: Exposure to world crop prices and health investments – By year of the price shock

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
Prices observed before time of the survey:							
ln crop price (pregnancy)	0.130^b	0.252^a	0.381^a	0.038^c	0.100^a	0.002	0.089^a
	(0.065)	(0.081)	(0.072)	(0.021)	(0.028)	(0.017)	(0.028)
ln crop price year 1	0.161^a	0.080	0.064	0.027	0.107^a	0.008	0.070^b
	(0.045)	(0.086)	(0.078)	(0.021)	(0.027)	(0.017)	(0.027)
ln crop price year 2 × age ≥ 1	0.167^a	0.100	0.048	-0.002	0.064^b	-0.032	0.042
	(0.031)	(0.066)	(0.064)	(0.017)	(0.027)	(0.023)	(0.043)
ln crop price year 3 × age ≥ 2	0.186^a	0.099	0.165^a	0.021	0.062^a	-0.019	-0.047
	(0.030)	(0.066)	(0.058)	(0.017)	(0.022)	(0.022)	(0.032)
ln crop price year 4 × age ≥ 3	0.051^b	0.009	-0.052	0.030^c	-0.004	-0.005	0.011
	(0.023)	(0.058)	(0.052)	(0.017)	(0.020)	(0.018)	(0.030)
ln crop price year 2	-0.125^b	0.212^c	0.376^a	0.043	-0.026	0.049^c	0.033
	(0.055)	(0.111)	(0.105)	(0.027)	(0.036)	(0.027)	(0.047)
ln crop price year 3	-0.096^b	0.190^b	-0.051	-0.032	-0.002	0.026	0.083^b
	(0.044)	(0.095)	(0.082)	(0.025)	(0.032)	(0.022)	(0.033)
ln crop price year 4	-0.045	0.119^b	0.219^a	0.004	-0.027	0.010	-0.010
	(0.037)	(0.057)	(0.053)	(0.013)	(0.021)	(0.011)	(0.019)
Obs	152416	243516	270892	273337	269867	176714	194656
R^2	0.801	0.814	0.822	0.806	0.803	0.821	0.828
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

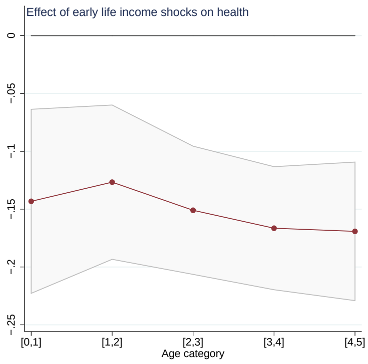
[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. OLS estimations. In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey).

Figure A.5: Income, child health and parental investments over the age profile (full price sequence)

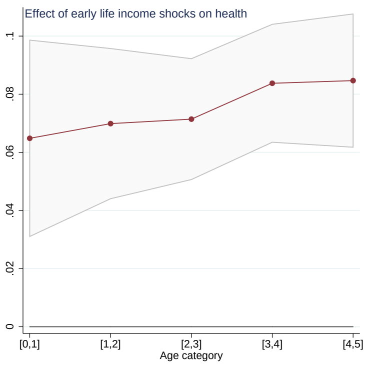
(a) Underheight



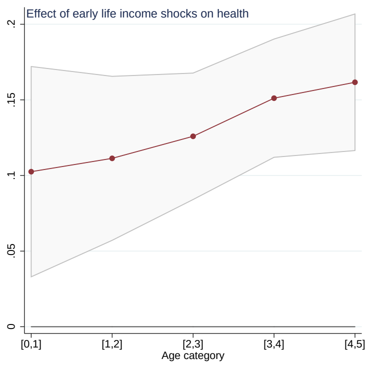
(b) Underweight



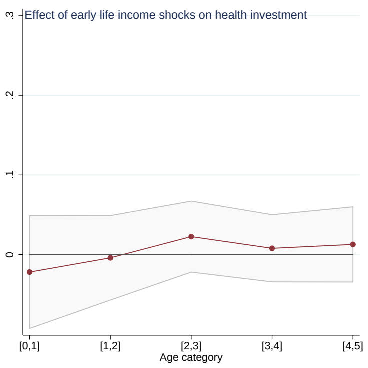
(c) log height



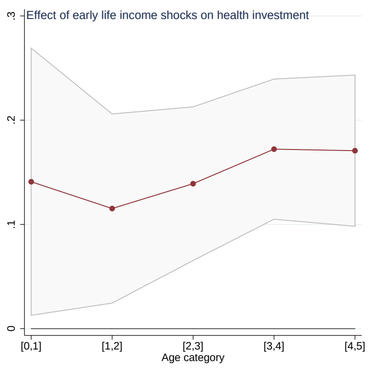
(d) log weight



(e) Iron pills



(f) Deworming



Source: These figures report the coefficient on the ln crop price variables price, split by child age in years, based on the estimation of equation (3), but including the full sequence of later life prices as in equation (12). Shaded areas are 90% confidence bands.

C.6 Time-varying controls

In this section we add to our baseline estimations a number of time-varying, cell-specific controls that might correlate with crop prices: prices of minerals produced in the cell (as computed by Berman et al. (2017)); the occurrence of conflict events from UCDP-GED; rainfall and temperature. All variable are taken during pregnancy and first year of life. The estimated coefficients on these controls variables (not reported in the tables below) are unstable and mostly insignificant. On the other hand, our coefficients of interest are stable.

Table A.9: Exposure to world crop prices, child health, and parental investments – Cell-level controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price	-0.227^a	-0.185^a	0.067^a	0.135^a	-0.008^b	-0.017^b	0.019^b
	(0.042)	(0.029)	(0.010)	(0.021)	(0.004)	(0.007)	(0.008)
Observations	191788	191478	191760	191452	1820014	1820070	1820070
R^2	0.627	0.586	0.756	0.749	0.318	0.316	0.336
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price	0.257^a	0.280^a	0.355^a	0.080^a	0.194^a	0.027	0.129^a
	(0.049)	(0.098)	(0.083)	(0.024)	(0.033)	(0.021)	(0.034)
Observations	213801	299882	340995	344281	339943	210880	231541
R^2	0.784	0.779	0.789	0.766	0.767	0.763	0.784
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-varying controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. Cell-level controls include: Prices of minerals, rainfall, temperature, and conflicts. 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, averaged over in utero period and first year of life. In column (5) Panel A, it is average over the in utero period only. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

Table A.10: Own and siblings' exposure to world crop prices, child health, and parental investments – cell-level controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price (own)	-0.302^a	-0.205^a	0.090^a	0.198^a	-0.010^a	-0.012^b	0.011
	(0.025)	(0.017)	(0.007)	(0.015)	(0.003)	(0.006)	(0.007)
ln crop price (older siblings)	0.032^a	0.013^a	-0.004^b	-0.009^a	0.001	0.002	-0.009^a
	(0.006)	(0.004)	(0.001)	(0.003)	(0.002)	(0.002)	(0.003)
Observations	191788	191478	191760	191452	1820014	1820070	1820070
R^2	0.627	0.586	0.756	0.749	0.318	0.316	0.336
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price (own)	0.469^a	0.423^a	0.542^a	0.091^a	0.166^a	0.073^a	0.187^a
	(0.041)	(0.077)	(0.064)	(0.017)	(0.025)	(0.017)	(0.025)
ln crop price (older siblings)	-0.005	-0.062^a	-0.092^a	-0.011^b	-0.020^a	-0.010^b	-0.003
	(0.005)	(0.018)	(0.015)	(0.005)	(0.005)	(0.005)	(0.006)
Observations	271008	329107	370085	372663	370002	261496	291246
R^2	0.565	0.361	0.432	0.358	0.435	0.152	0.311
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-varying controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. Cell-level controls include: Prices of minerals, rainfall, temperature, and conflicts. 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, averaged over in utero period and first year of life. In column (5) Panel A, it is average over the in utero period only. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

C.7 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. 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 split our price index (see eq. (1)) into the constructed local price of "cash" crops as defined by McGuirk and Burke (2017) (in our sample, cocoa, coffee, cotton, tea and tobacco) – which should be mainly for production –, and the other crops – which could be also 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 coefficients on the 'food' crop price variable has the same sign of and is of similar size to the coefficient on the cash crop price variable. The estimates on the cash crop variables are of the same sign as the food crops ones, though they are more imprecisely estimated in the investment regressions (Panel B of Tables A.11 and A.12). This reflects the fact that cash crops account for a small part of our sample. Overall, these results corroborate our empirical assumption that the set of crops in our sample are mainly produced and hence variation in their prices should reflect producers' income (through land suitability).

Table A.11: Exposure to world crop prices, child health and parental investments – 'Cash' vs. 'food' crops

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price (food)	-0.247^a	-0.198^a	0.065^a	0.122^a	-0.006	-0.016^b	0.025^a
	(0.045)	(0.031)	(0.011)	(0.022)	(0.004)	(0.007)	(0.009)
ln crop price (cash)	-0.197^a	-0.145^a	0.072^a	0.134^a	-0.011^c	-0.026^a	0.028^b
	(0.064)	(0.046)	(0.015)	(0.033)	(0.006)	(0.009)	(0.012)
Observations	184675	184345	184647	184319	2183982	2183982	2183982
R^2	0.627	0.586	0.755	0.747	0.281	0.281	0.305
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price (food)	0.238^a	0.229^c	0.383^a	0.092^a	0.227^a	0.012	0.143^a
	(0.065)	(0.120)	(0.106)	(0.029)	(0.043)	(0.024)	(0.041)
ln crop price (cash)	0.011	0.129	0.061	0.018	0.111^c	0.006	0.009
	(0.091)	(0.164)	(0.145)	(0.043)	(0.060)	(0.031)	(0.057)
Obs	145877	240171	267018	269561	266136	182288	200470
R^2	0.799	0.812	0.820	0.804	0.796	0.818	0.822
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. 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. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

Table A.12: Own and siblings' exposure to world crop prices, child health, and parental investments – 'Cash' vs. 'food' crops

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price (food, own)	-0.352[a]	-0.214[a]	0.097[a]	0.191[a]	-0.008[b]	-0.011[b]	0.019[b]
	(0.028)	(0.019)	(0.008)	(0.016)	(0.004)	(0.007)	(0.009)
ln crop price (food, older siblings)	0.052[a]	0.016[a]	-0.008[a]	-0.006	0.008[a]	0.024[a]	-0.045[a]
	(0.009)	(0.006)	(0.002)	(0.005)	(0.002)	(0.003)	(0.003)
ln crop price (cash, own)	-0.224[a]	-0.213[a]	0.067[a]	0.211[a]	-0.011[c]	-0.023[b]	0.032[b]
	(0.059)	(0.037)	(0.016)	(0.033)	(0.007)	(0.011)	(0.015)
ln crop price (cash, older siblings)	-0.025[a]	-0.006	0.005[b]	-0.002	-0.009[a]	-0.025[a]	0.042[a]
	(0.009)	(0.006)	(0.002)	(0.005)	(0.002)	(0.003)	(0.003)
Obs	245562	243780	245539	243757	1500998	1500998	1500998
R^2	0.136	0.098	0.302	0.309	0.035	0.046	0.081
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price (food, own)	0.503[a]	0.478[a]	0.612[a]	0.128[a]	0.216[a]	0.092[a]	0.285[a]
	(0.043)	(0.093)	(0.077)	(0.021)	(0.029)	(0.021)	(0.030)
ln crop price (food, older siblings)	0.023[a]	-0.081[a]	-0.104[a]	-0.020[a]	-0.030[a]	-0.010	0.010
	(0.007)	(0.028)	(0.022)	(0.007)	(0.008)	(0.007)	(0.010)
ln crop price (cash, own)	0.510[a]	0.279	0.040	-0.024	-0.133[b]	0.049	-0.248[a]
	(0.063)	(0.206)	(0.183)	(0.055)	(0.063)	(0.046)	(0.067)
ln crop price (cash, older siblings)	-0.030[a]	0.040	0.033	0.015[c]	0.016[c]	-0.001	-0.015
	(0.007)	(0.031)	(0.024)	(0.008)	(0.009)	(0.008)	(0.010)
Obs	251468	304371	344236	346636	344134	246739	275130
R^2	0.567	0.359	0.431	0.361	0.436	0.152	0.310
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. Household controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. 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. ln crop price (older siblings) is the price faced on average by all elder siblings during in utero and during their first year of life. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

C.8 Long-term persistence

In this section we test long-term effect the effect of early life income variations on adult health. We consider health information on adults contained in the DHS. For all waves, we have anthropometric data (Rohrer index, BMI, haemoglobin levels) on women living in the households at the time of the survey. For the most recent DHS waves (DHS7) we also have information for men, for part of the countries (only on BMI and haemoglobin level). Because adult members might have left the household, we rely on within-cell variation in this exercise, rather than the more stringent within-mother variation that we have used for children. Table A.13 show a positive and significant effect of early exposure to world prices of produced crops and contemporaneous health outcomes for adults, as proxied by BMI, the Rohrer index, and haemoglobin level. This long-term persistence of in-utero and early life income shocks confirms the evidence of a vast literature (summarised in Almond et al., 2018), which has mostly relied on single-country studies.

Table A.13: Early exposure to world crop prices, individual health and age at first birth – adult data

	(1)	(2)	(3)
Indicators	——— Adult health ———		
Dep. var.	Rohrer	BMI	ln hemogl.
ln crop price	0.252^{b}	0.829^{a}	0.044^{a}
	(0.119)	(0.123)	(0.007)
Obs.	238954	257965	150969
R^2	0.272	0.306 0.299	
Individual 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 an adult individual. Standard errors clustered at the cell level in parentheses. All estimations include country × year of birth and month of birth dummies and dummies for age of the adult (in years). Rohrer index, BMI, and ln haemoglobin are the individual's Rohrer index, BMI and level of haemoglobin (in log) at the time of the survey. ln crop price is the price faced by the individual in utero and in the first year of life. Individual controls include child's gender, birth order, twin dummy, age in month and its square, dummies for the education attainment and wealth quintiles of the household where the household lives.

C.9 Alternative agricultural specialization measure

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 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.

Table A.14: Exposure to world crop prices, child health, and health investments – M3 crop data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price	-0.122[a]	-0.101[a]	0.035[a]	0.076[a]	-0.005[c]	-0.013[a]	0.010[c]
	(0.030)	(0.022)	(0.007)	(0.015)	(0.002)	(0.004)	(0.005)
Observations	193256	192907	193228	192881	2262596	2262596	2262596
R^2	0.627	0.586	0.756	0.750	0.281	0.281	0.305
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price	0.178[a]	0.187[b]	0.272[a]	0.052[b]	0.128[a]	0.015	0.044[c]
	(0.042)	(0.078)	(0.070)	(0.020)	(0.028)	(0.015)	(0.026)
Obs	153790	246654	277090	279729	276272	183213	201795
R^2	0.797	0.814	0.822	0.804	0.797	0.816	0.822
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. 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 cell's harvested area, calculated from the M3 crop database. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

Table A.15: Own and siblings' exposure to world crop prices, child health, and parental investments – M3 crop data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price (own)	-0.179^a	-0.112^a	0.053^a	0.114^a	-0.008^a	-0.014^a	0.016^a
	(0.018)	(0.012)	(0.005)	(0.011)	(0.002)	(0.004)	(0.005)
ln crop price (older siblings)	0.032^a	0.014^a	-0.004^a	-0.008^a	0.001	0.004^b	-0.012^a
	(0.005)	(0.003)	(0.001)	(0.003)	(0.001)	(0.002)	(0.002)
Observations	263806	262054	263783	262031	1739769	1739769	1739769
R^2	0.135	0.098	0.302	0.312	0.034	0.045	0.078
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price (own)	0.355^a	0.232^a	0.367^a	0.074^a	0.109^a	0.025^b	0.091^a
	(0.030)	(0.058)	(0.050)	(0.013)	(0.018)	(0.011)	(0.018)
ln crop price (older siblings)	-0.004	-0.049^a	-0.065^a	-0.007^c	-0.017^a	-0.010^b	-0.007
	(0.004)	(0.016)	(0.013)	(0.004)	(0.005)	(0.004)	(0.006)
Obs	270004	328222	369447	372015	369387	259158	289190
R^2	0.566	0.364	0.433	0.359	0.437	0.154	0.312
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. Household controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. 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 cell's harvested area output, calculated from the M3 crop database. ln crop price (older siblings) is the price faced on average by all elder siblings during in utero and during their first year of life. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

C.10 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 is 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.

Table A.16: Exposure to world crop prices, child health and parental investments – Excluding migrants

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price	-0.224^{a}	-0.157^{a}	0.047^{a}	0.049	-0.016^{a}	-0.033^{a}	0.047^{a}
	(0.066)	(0.044)	(0.016)	(0.033)	(0.005)	(0.009)	(0.012)
Observations	91414	90117	91414	90117	954504	954504	954504
R^2	0.628	0.592	0.755	0.752	0.289	0.289	0.309
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price	0.193^{a}	0.197^{c}	0.326^{a}	0.064^{b}	0.207^{a}	0.017	0.115^{a}
	(0.061)	(0.113)	(0.099)	(0.027)	(0.039)	(0.022)	(0.038)
Obs	133167	229689	256275	258791	255523	175762	191610
R^2	0.798	0.816	0.824	0.808	0.798	0.817	0.823
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. 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. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

Table A.17: Own and siblings' exposure to world crop prices, child health, and parental investments – Excluding migrants

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price (own)	-0.255^{a}	-0.172^{a}	0.044^{a}	0.095^{a}	-0.021^{a}	-0.027^{a}	0.040^{a}
	(0.037)	(0.026)	(0.011)	(0.023)	(0.005)	(0.010)	(0.012)
ln crop price (older siblings)	0.020^{b}	0.008	-0.003	-0.004	-0.001	0.001	-0.005
	(0.010)	(0.006)	(0.003)	(0.006)	(0.003)	(0.004)	(0.005)
Observations	126581	124023	126581	124023	499533	499533	499533
R^2	0.149	0.118	0.319	0.350	0.043	0.059	0.105
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price (own)	0.400^{a}	0.377^{a}	0.730^{a}	0.041	0.140^{a}	0.038	0.155^{a}
	(0.045)	(0.108)	(0.097)	(0.028)	(0.037)	(0.031)	(0.041)
ln crop price (older siblings)	-0.028^{a}	-0.038	-0.073^{a}	-0.004	-0.005	0.002	0.019
	(0.008)	(0.029)	(0.026)	(0.008)	(0.009)	(0.009)	(0.012)
Obs	165003	152897	170477	171281	169978	89504	108866
R^2	0.579	0.369	0.444	0.356	0.451	0.179	0.328
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

^{c} significant at 10%; ^{b} significant at 5%; ^{a} significant at 1%. The unit of observation is a child. Standard errors clustered at the cell level in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. Household controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. 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. ln crop price (older siblings) is the price faced on average by all elder siblings during in utero and during their first year of life. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

C.11 Conley standard errors

Table A.18: Exposure to world crop prices, child health and parental investments – Spatially correlated std. errors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price	-0.226[a]	-0.180[a]	0.068[a]	0.135[a]	-0.009	-0.025[b]	0.032[b]
	(0.053)	(0.038)	(0.013)	(0.030)	(0.007)	(0.011)	(0.016)
Obs	369765	368605	369734	368574	651287	651287	651287
R^2	0.077	0.034	0.328	0.311	0.017	0.018	0.017
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price	0.178	0.211	0.331[c]	0.065[c]	0.201[a]	0.015	0.108[b]
	(0.125)	(0.229)	(0.201)	(0.034)	(0.076)	(0.021)	(0.054)
Obs	384386	452489	515553	519403	515618	337351	376241
R^2	0.093	0.029	0.030	0.007	0.042	0.001	0.015
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. The unit of observation is a child. Spatially correlated standard errors in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. 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. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

Table A.19: Own and siblings' exposure to world crop prices, child health, and parental investments – Spatially correlated std. errors

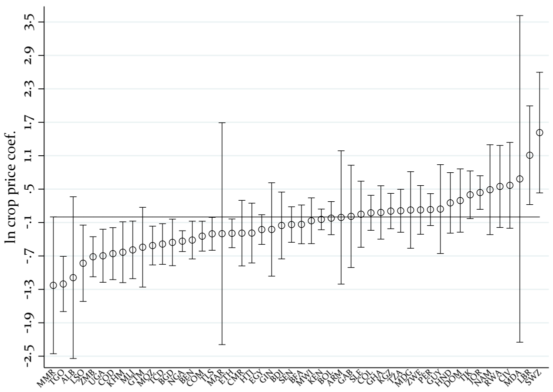
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Child health							
Dep. var.	Underheight	Underweight	ln height	ln weight	—— Death ——		Alive at t
					1^{st} year	At birth	
ln crop price (own)	-0.295[a]	-0.198[a]	0.089[a]	0.195[a]	-0.005	-0.008	0.007
	(0.078)	(0.044)	(0.023)	(0.048)	(0.005)	(0.009)	(0.012)
ln crop price (older siblings)	0.032[a]	0.013[a]	-0.004[c]	-0.010[b]	0.006[c]	0.010[c]	-0.019[a]
	(0.007)	(0.004)	(0.002)	(0.004)	(0.003)	(0.006)	(0.007)
Obs	263668	261952	263644	261928	452322	452322	452322
R^2	0.035	0.017	0.172	0.176	0.018	0.017	0.016
Panel B: Investments							
Dep. var.	Breast.	– Vaccines (# doses) –		– Vaccines –		Other investments	
		Polio	DPT	BCG	Measles	Iron	Deworm
ln crop price (own)	0.470[a]	0.428[c]	0.538[b]	0.090[a]	0.168[b]	0.075[b]	0.184[a]
	(0.158)	(0.248)	(0.210)	(0.033)	(0.076)	(0.030)	(0.056)
ln crop price (older siblings)	-0.005	-0.062[a]	-0.092[a]	-0.011[c]	-0.020[a]	-0.010	-0.003
	(0.008)	(0.023)	(0.023)	(0.006)	(0.007)	(0.006)	(0.008)
Obs	271122	329154	370145	372722	370062	261549	291302
R^2	0.095	0.032	0.033	0.017	0.058	0.002	0.021
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%. The unit of observation is a child. Spatially correlated standard errors in parentheses. All estimations include country × year and month dummies. Child controls include: gender, birth order, twin dummy, and age in month. Household controls include: mother's age and age square, education dummies, and dummies for quintiles of the wealth distribution. 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. ln crop price (older siblings) is the price faced on average by all elder siblings during in utero and during their first year of life. In Panel A: 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. Death is a dummy which equals 1 if the child dies at birth (col. 5) or in her/his first year (col. 6), 0 otherwise. Alive at t is a dummy that equals 1 if the child is alive at the time of the survey (t). In Panel B: In the first column the dependent variable takes the value 1 is the child has been breastfed for at least 6 months, 0 otherwise. In the next two columns the dependent variables are the number of doses taken by the child of Polio (max. 4 doses), and DPT (max. 3 doses). In columns (4) to (7) the dependent variables are dummies taking the value 1 if the child has taken all required doses of particular vaccines (Measles and DPT), iron pills, and deworming drugs (these last two during the three months preceding the survey.

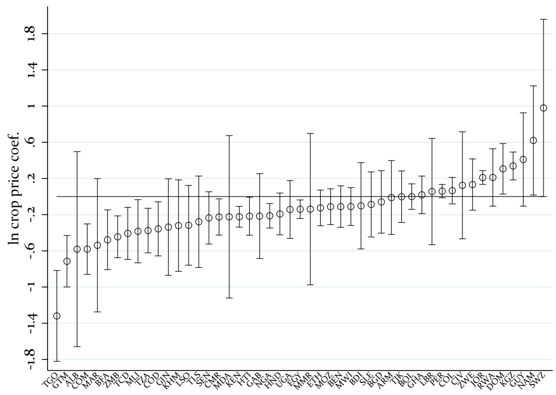
C.12 Country heterogeneity

Figure A.6: Country-specific coefficients

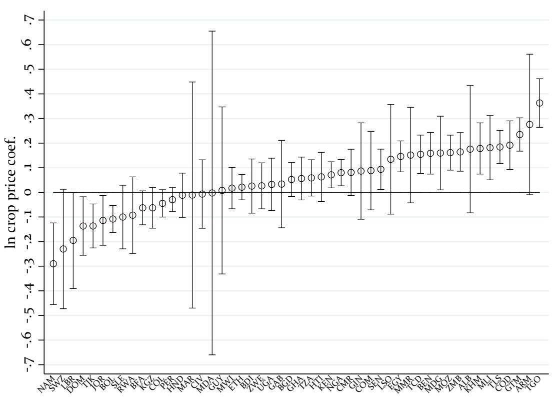
(a) Underheight



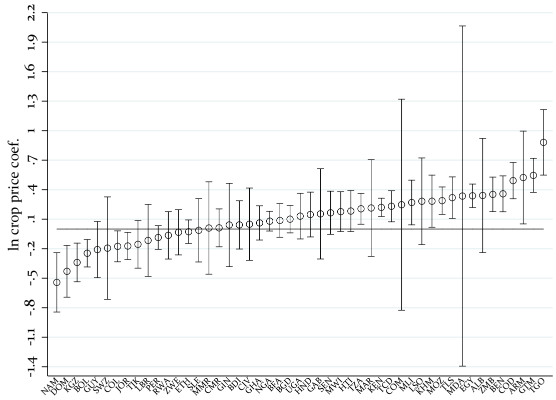
(b) Underweight



(c) ln height



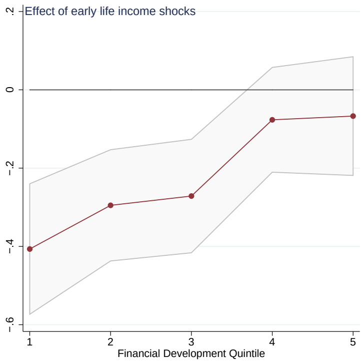
(d) ln weight



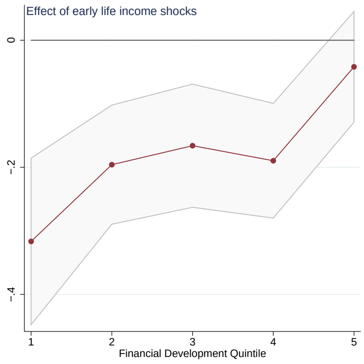
Source: These figures report the coefficient and 90% confidence interval on the ln crop price variable specific to each country in the sample. The estimates are from the baseline regressions (2), Panel (A), columns (1) to (4), except that the price variable is interacted with country dummies.

Figure A.7: Country heterogeneity (financial development)

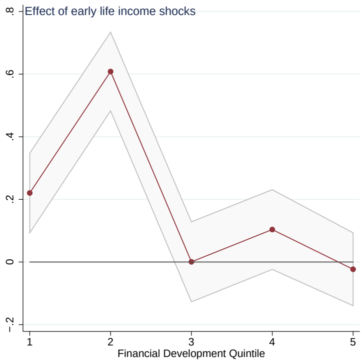
(a) Underheight



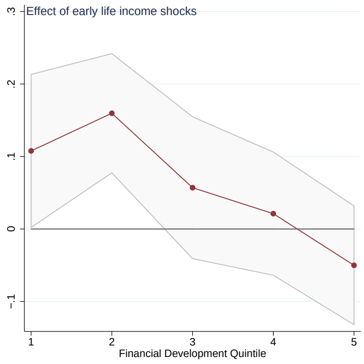
(b) Underweight



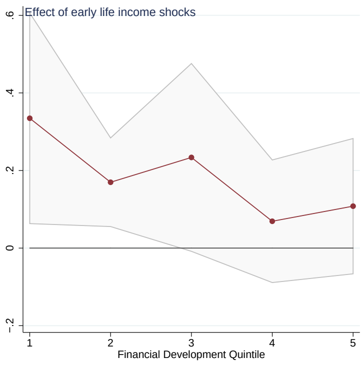
(c) Measles vaccine



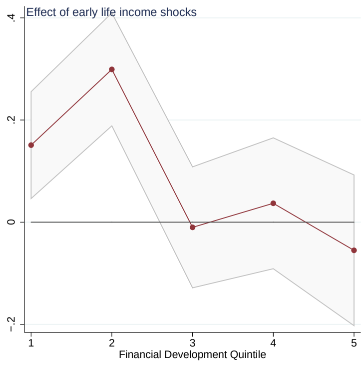
(d) BCG vaccine



(e) Breastfeeding > 6m



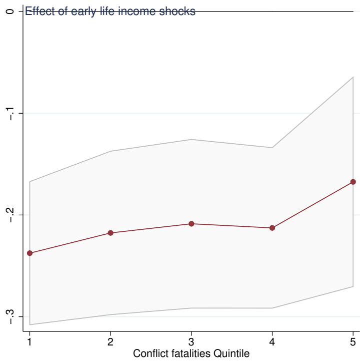
(f) Deworm last 3m



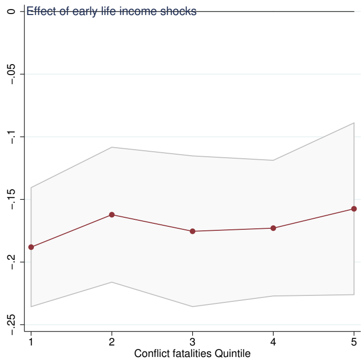
Note: These figures are based on estimations similar to our baseline tables 2 and 3, except that the coefficient of ln crop price is split by quintile of a given country characteristics - private credit over GDP here.

Figure A.8: Country heterogeneity (mortality at 5 years)

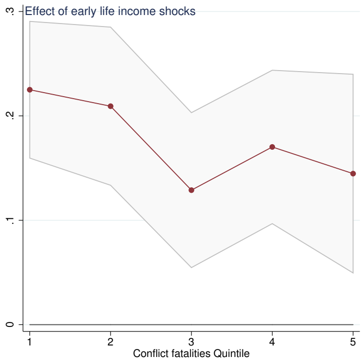
(a) Underheight



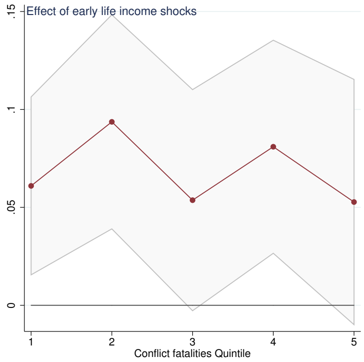
(b) Underweight



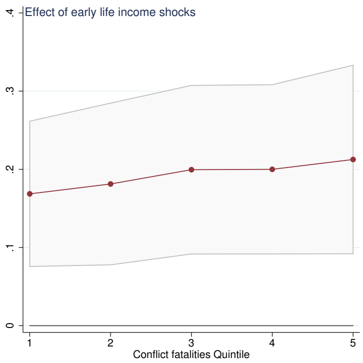
(c) Measles vaccine



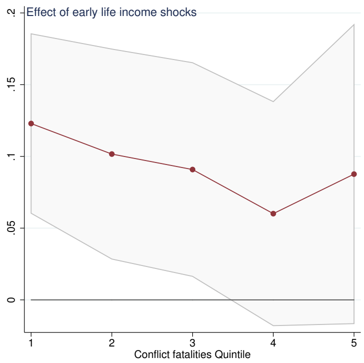
(d) BCG vaccine



(e) Breastfeeding > 6m



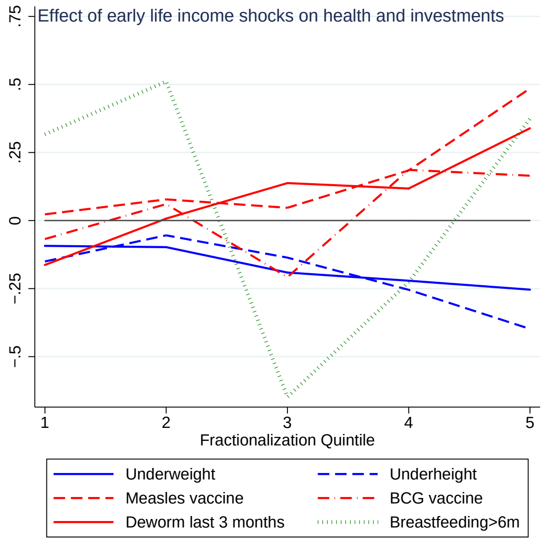
(f) Deworm last 3m



Note: These figures are based on estimations similar to our baseline tables 2 and 3, except that the coefficient of ln crop price is split by quintile of a given country characteristics - mortality at 5 years here.

Figure A.9: The role of country characteristics

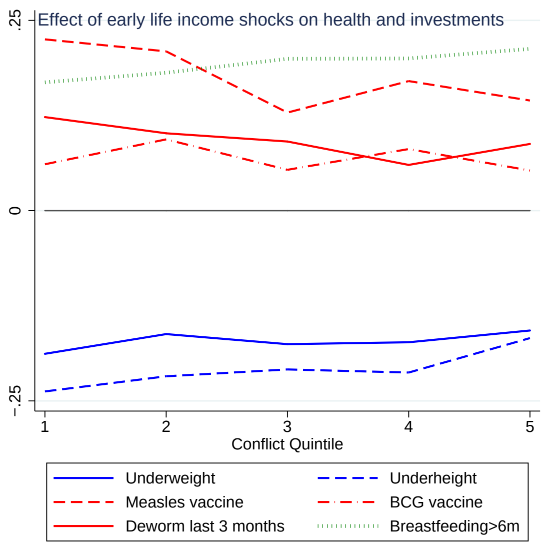
(a) Fractionalization



Note: This figure is based on estimations similar to our baseline tables 2 and 3, except that the coefficient of ln crop price is split by quintile of a given country characteristics. Here we use the level of fractionalization, computed as the average of religious, ethnic and linguistic fractionalization.

Figure A.10: The role of local characteristics

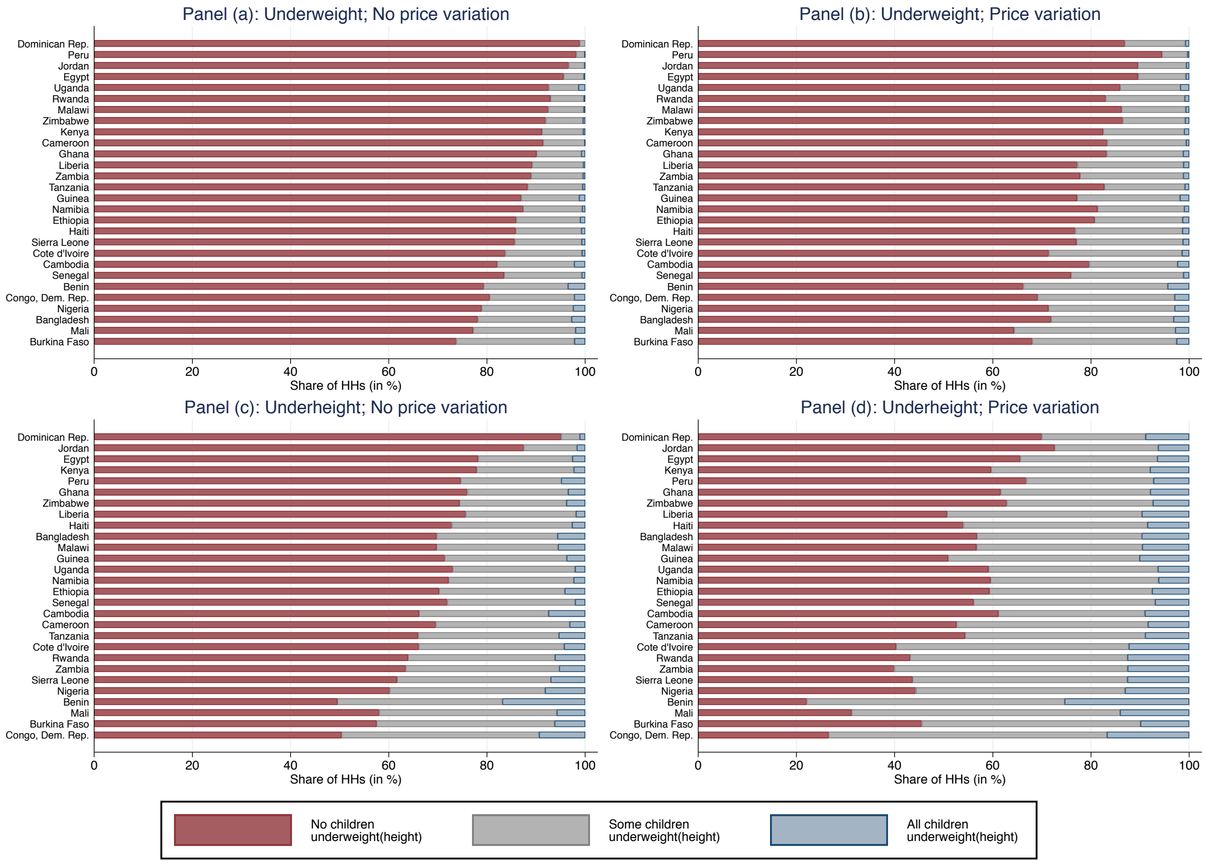
(a) Conflict-related fatalities



Note: This figure is based on estimations similar to our baseline tables 2 and 3, except that the coefficient of ln crop price is split by interval of a local characteristic. Here we use the cumulated number of fatalities in the cell from UCDP-GED, between 1989 (the first year of conflict data available) and the year of birth of the child. The first bin contains all cells where no fatality is ever recorded, i.e. more than half for the cells. The rest of the cells is split in quartiles. Children born before 1990 are dropped from the estimations.

D Child health inequality at the country level: counterfactuals

Figure A.11: Predicted household category shares at the country level



These figures report the within-country averages of predicted shares from the region-level regression in (6). In Panels (a) and (c), the effect of the early life price variable ($|\Delta \log \overline{\mathrm{P}}_{r,t}|$) is set to zero. Predicted shares at the region-time level are averaged within countries, and normalized to sum up to one.