Misfortunes never come singly: structural change, multiple shocks and child malnutrition in rural Senegal

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Misfortunes never come singly: structural change, multiple shocks and child malnutrition in rural Senegal

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Acronyms

AFDM	African Flood and Drought Monitor
AGNSD	Agence Nationale de la Statistique et de la Démographie (National Agency of Statistics and Demography)
CERDI	Centre d'Etudes et de Recherches en Développement International (Centre for Studies and Research on International Development)
CLM	Cellule de Lutte contre la Malnutrition (Senegalese Unit against Malnutrition)
CPI	Consumer Price Index
EM-DAT	Emergency Events Database
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GOANA	Grande Offensive pour la Nourriture et l'Abondance (Grand Agricultural Offensive for Food and Abundance)
HACPI	Harmonised Average Consumer Price Index
HAFPI	Harmonised Average Food Price Index
HAZ	Height-for-Age Z Score
IHEID	Graduate Institute of International and Development Studies (Institut de Hautes Etudes Internationales et du Développement)
LTM	Long-Term Mean
NGO	Non-Governmental Organisation
OLS	Ordinary Least Squares
PN-PTFM	Programme National Plateformes Multifonctionnelles
PRISE	Pathways to Resilience in Semi-arid Economies
PRN	Programme de Renforcement Nutritionnel (Nutrition Enhancement Programme)
SES	Socioeconomic Status
SPI	Standardised Precipitation Index
UGB	University Gaston Berger
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WAZ	Weight-for-Age Z Score
WFP	World Food Programme
WHO	World Health Organization

Abstract

This study considers the two most pronounced shocks Senegalese subsistence farmers struggle with – namely, increasing purchase prices and droughts. We assess the impact of these shocks on child health in a multi-shock approach to account for concomitance of adverse events from the natural, biological, economic and health sphere. We employ a unique dataset of children living in poor, rural households in eight regions of Senegal in 2009 and 2011 and account for structural changes occurring between survey periods: short-term underweight is triggered mainly by severe shocks such as droughts whereas child height-for-age is more closely associated with (lasting) price and income dynamics. Our multi-shock interaction analysis further reveals that droughts explain up to 43% in the standard deviation of child health and increased prices explain up to 25%. Yet accounting for the concomitance of droughts and increased prices after the structural change indicates the health of children experiencing both shocks is left unaffected. These results are driven by the increase in rural household income from high cash crop prices, as outlined in the agricultural household model. Thus adequate policy responses to shocks do not rely only on the nature but also on the concomitance of hazardous events, depending on the driving pathway of effects.

Keywords: (multiple) shocks; weight-for-age Z-scores; height-for-age Z-scores; Senegal.

JEL: O12; Q54; I12.

1. Introduction

The proverb 'Misfortunes never come singly' claims adverse events are correlated and develop their full potential because of their joint occurrence. The proverb reminds us that natural, biological, economic and health shocks are often concomitant. Accounting for multiple shocks is especially relevant when studying the conditions of poor, shock-prone households in developing countries. Such multiple shocks and their concomitance affect poor people's welfare in terms of income, consumption and health. The existing literature focuses mainly on the effects of a single or limited set of shocks (Yilma et al., 2014). As such, with this work, we add to the academic discussion on the effects of natural and non-natural shocks by adopting a multi-shock framework.

It is difficult to detect the impact of adverse events. On the one hand, likelihood of exposure to shocks may be correlated with unobservable characteristics at the household and individual level (Alderman et al., 2006). Timing and simultaneity of shocks may increase vulnerability and exposure, worsening the effects of a single exogenous shock. On the other hand, households may adopt a variety of strategies in response to shocks (Heltberg et al., 2012; Murdoch, 1995). There is ample evidence for *ex-ante* diversification strategies (Dercon, 1996; Rosenzweig and Udry, 2013) and *ex-post* behaviour-, asset- and assistance-based coping mechanisms (Heltberg and Lund, 2009). Coping strategies may be specifically related to the nature of the shock while mitigating/exacerbating the initial effects (Alderman et al., 2006).

Therefore, especially in shock-prone areas, a multi-shock analysis is required to better understand both the size of the shock impact and the household's ability to cope (Wagstaff and Lindelow, 2013). For one, the occurrence of multiple shocks at the same time may worsen household welfare more than a single shock analysis would predict. At the same time, heterogeneity in the type of shocks experienced by the household as a whole and heterogeneity in the individuals being particularly affected may be a source of differential net effects at the household and individual level.

Most studies that measure household living standards and the effects of shocks on household welfare rely on consumption and income data. However, these data have been found to be particularly sensitive to changes in the survey design across countries and over time. For example, Beegle et al. (2012) analyse the possible sources of reporting error and reveal considerable differences in recorded consumption depending on method of data collection, respondent level of education, length of the reference period and degree of detail in the commodity list. To address the shortcomings of consumption data, Carter and Maluccio (2003) suggest child anthropometrics for children below five years are a better measure for consumption smoothing, thanks to the objectivity of the measurement procedure.

Using child anthropometric data as measures of health status and household welfare in the context of hazardous events has further advantages. First, children are some of the most vulnerable individuals in poor households in developing countries (Bengtsson, 2010; Hoddinott and Kinsey, 2001; Martorell, 1999). Second, getting exact indicators for child nutritional status is less challenging than getting similar measures for adults. Indeed, when assessing the wellbeing of adults, one needs to jointly account for consumption, productivity and income to allow for the possibility that, in times of distress, households allocate scarce resources to adults with a higher marginal product of health and better wages (Dercon and Krishnan, 2000a). Third, low child growth affects individual health and working performance in adulthood, emphasising the relevance of short-term analyses also in a long-term perspective (Hoddinott and Kinsey, 2001; Maccini and Yang, 2008).

Therefore, we focus on child weight- and height-for-age, which are measures of short-term underweight and stunting, to capture wellbeing. Recent works use natural experiments generated by macroeconomic crises (Block et al., 2004; Paxson and Schady, 2005; Pongou et al., 2006), specific natural disasters (del Ninno and Lundberg, 2005; Hoddinott and Kinsey, 2001; Yamano et al., 2005) or commodity price changes (Cogneau and Jedwab, 2012; de Braw, 2011). We add to this literature by analysing the effects of a short-term increase in purchase prices in rural Senegal and conduct a multi-shock analysis accounting for the occurrence of natural hazards (complex extreme events) and biological, economic and health shocks on child anthropometric characteristics.

We employ a unique dataset of children living in poor households in rural Senegal. The two rounds of the dataset were collected in 2009 and 2011 after the second international food price spike

(February 2011). The dataset is particularly suitable to conducting a multi-shock analysis since it contains a very rich shock module for vulnerable, rural households. Since only few children have repeated observations across survey years, we conduct pooled cross-section analyses accounting for village-year fixed effects. After a basic partial shock analysis, we consider the effects of two major adverse events (an increase in purchase prices and droughts) on child weight- and height-for-age while accounting for other natural, biological, economic and health shocks the children's households experienced.

Note we consider shocks that occurred in the period January-June, which corresponds to the dry season in Senegal. During this period, no rain is expected, explaining the weak prevalence of droughts (affecting 3-6% of households) in the dataset. However, Senegalese households also produce crops for the local and export markets in the dry season, therefore dry season droughts may also have negative effects in terms of lower agricultural production.

Since major changes occurred between the survey rounds, we use an interaction term accounting for the 2011 structural improvements. In particular, we focus on the effects of the increase in purchase prices and drought shocks, while controlling for other adverse events the households experienced. First, we show controlling for more than one shock helps better quantify the effect of the different adverse events. Second, we demonstrate the structural changes in 2011 were not enough to ensure child health if the respective household experienced higher purchase prices or a drought, which are the most prominent threats for child weight-for-age; height-for-age is affected mainly by income dynamics. However, if the household experienced both shocks, the effect of the concomitant adverse events in 2011 is not significant. We explore several channels to further assess these results and argue the concomitance of these two major shocks fosters child health and household food security through the income effects rural agricultural households experience.[1]

The remainder of the paper is structured as follows. Section 2 describes the conceptual framework. Section 3 presents the country background and data while Section 4 outlines the empirical strategy and model specifications. Section 5 reports the main results and Section 6 discusses differential and possible pathways of effects. Section 7 considers key policy messages and Section 8 concludes.

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[1] This implies the assumption that the households in our sample are net food-sellers. Although we do not have comprehensive data on household food production and sales, the households in the sample comprise mainly local farmers who produce at least one main cash crop they can exchange at the local or nearest market (20% of the villages have their own market place, while the average distance to the nearest market for villages without their own market place is about 12 km).

2. Conceptual framework

2.1 Inter-temporal utility maximisation under uncertainty

Theoretically, we base the analysis on an inter-temporal utility model with income uncertainty (Deaton, 1992; Sadoulet and de Janvry, 1995; Townsend, 1994). Risk aversion is assumed and an inter-temporal household utility function over consumption is defined. At each point in time, the realised utility level is unsecure, as an idiosyncratic natural, biological, economic or health shock can occur and reduce consumption. Imposing the standard resource and feasibility constraints, it can be shown that transitory idiosyncratic shocks do not reduce consumption if risk-sharing is possible. Thus, consumption is smoothed and follows permanent income.

However, Townsend (1994) demonstrated consumption-smoothing and thus risk-sharing were not perfect within villages. Whenever contemporaneous own income and transitory shocks influence household consumption, households are not fully able to insure against risk and bear (some of) the consequences of idiosyncratic shocks, which results in variations in the instantaneous utility. Instead of focusing on direct measures of consumption, we take child health, as it can be more accurately measured. Thus, we follow the approach of Thomas (1994) in that we consider health as an input to the utility function.

The next section details the channels along which shocks can influence household utility.

2.2 A multi-shock framework

Idiosyncratic shocks affect household income and thus consumption and child health. We concentrate on two major events: an increase in purchase prices and droughts. In addition, we consider their concomitance with other natural, biological, economic and health shocks. The pathways through which multiple shocks can affect child health are several.

First, if household food security is not ensured and households are net buyers of food, an increase in (produced and imported) food prices may be a large income and health shock to household members. This is particularly true in Senegal, where 20% of the population is undernourished; almost 30% of the population does not have adequate access to food; and food imports account for more than 50% of total merchandise exports (FAO, 2013). If food becomes more expensive and credit constraints are binding, households may be unable to provide children with the necessary food intake. Child health may remain unaffected if households have enough assets/savings to cope with the food price increases. Similar effects could stem from other *economic shocks* such as a decline in sales prices and loss of employment of an adult member.

Second, *natural disasters* may affect household welfare and child health through their impact on agriculture, food security and health (Field et al., 2014). Droughts, floods and extreme cold are likely to affect agriculture and rangeland productivity while potentially triggering losses of infrastructures and lives, especially in the highly vulnerable African continent (Barros et al., 2014). In contexts of subsistence agriculture, household food security will be affected, and this will worsen individual health outcomes depending on the intra-household allocation of resources (Thomas, 1990).

Third, indirect effects on agricultural productivity and health outcomes may also come from the development of vector-/water-/food-borne diseases (*biological shocks*). Natural hazards may provide particular conditions that allow pathogens already existing in the environment to develop and spread or make their life longer than their usual historic range, thus increasing the likelihood of biological hazards such as crop pests and livestock diseases (Anderson et al., 2004; Piao et al., 2010). This applies to parasites affecting human beings as well: vector-borne diseases sensitive to weather changes such as the mosquitoes responsible for malaria and yellow fever as well as diarrhoeal and other infectious diseases may increase owing to the prolonged range and activity of pathogens (Haines et al., 2006). Hence, individuals may be affected in different ways by changes in illnesses and death rates as well as injuries and psychological disorders (*health shocks*) following complex extreme events such as floods, droughts and cold waves (McMichael and Haines, 1997).

Finally, note that, depending on the context, wetter/drier and/or warmer/colder weather may result also in positive effects on household welfare. For example, Hsiang et al. (2013) suggest lower temperatures may help reduce intergroup conflict risk.[2] Moreover, certain adverse events may result in positive effects through resource

[2] This effect could work through increased production in semi-arid and arid areas since lower temperatures reduce stress to crops (Harari and la Ferrara, 2014) and labour inputs related to morbidity to malaria and other climate-related diseases (Cervellati et al., 2016).

redistribution within the household. For example, the migration of an unemployed member and/or the death of an unproductive member may allow resources previously allocated to that member to be redistributed to the remaining members. Depending on the additional income from the migrated member, pre-death medical expenses or funeral costs, and the earnings' ability of the dead member, household food security and welfare may improve (de Braw, 2011; Grimm, 2010).

In light of this discussion, analysing the impact of shocks as stand-alone events may provide an unclear and incomplete picture of what is occurring to household welfare in shock-prone areas as a result of the concomitance of shocks. A multi-shock analysis is needed to explore the combined effect of shocks on child health outcomes.

In the next section, we discuss in more detail the existing findings on child health and shocks.

2.3 Child health outcomes and shocks: empirics

According to the World Health Organization (WHO) and the UN Children's Fund (UNICEF) (2009), major differences in the growth of infants and children are based largely on environmental characteristics rather than on ethnic differences. Following the meta-analysis of Charmarbagwala et al. (2004), determinants of child growth can be classified into three categories:

1. Biological or child-specific characteristics such as sex, age, birth order or genotype characteristics;
2. Socioeconomic status (SES) or household characteristics such as demographic composition of the household, level of education of the mother or household wealth status;
3. Environmental quality, cultural factors and community characteristics such as availability of clean drinking water, hazardousness of the locality where the household lives and quality of service provided to the households.

The 35 studies considered for the meta-analysis constitute a sub-sample of studies focusing on height-for-age as indicator for long-term chronic malnutrition in the period 1980-2003. Of a total of 61 studies that Charmarbagwala et al. (2004) collected, only two explicitly include natural hazards (Bairagi, 1986; Quisumbing, 2003) and only seven explicitly account for variations in the prices of staples – a possible economic shock indicator in the recent literature (Barrera, 1990; Carter and Maluccio, 2003; Christiaensen and Alderman, 2004; Mackinnon, 1995; Marini and Gragnolati, 2003; Senauer and Garcia, 1991; Thomas et al., 1996) – as possible determinants of child anthropometric characteristics. Thus, while there is an emerging academic interest in the impact of shocks on child health, the literature is still rather limited.

Studies on the effects of *economic shocks* on child health focus on aggregate income shocks. In general, domestic economic crises in developing countries are found to have negative effects on child health outcomes (Ferreira and Schady, 2009). However, the effect depends on village social capital or government/donors expenditures in health and services (Carter and Maluccio, 2003; Paxson and Schady, 2005). Recent studies focus on the effect of a change in commodity prices showing mixed procyclical or countercyclical child health variations. For example, Cogneau and Jedwab (2013) find the 1990 cut of the administered cocoa producer price in Côte d'Ivoire reduced child health through a decrease in household income, while Miller and Urdinola (2010) analyse coffee prices in Colombia and find countercyclical child mortality. We add to the literature on economic shocks concentrating on the effects of an increase in purchase prices in rural Senegal. Moreover, we acknowledge concomitance of economic and other shocks may exacerbate the effects on child health.

Bengtsson (2010) points out recent studies on shocks and child health outcomes focus on specific *natural disasters* (mainly droughts and floods), using them as proxies for income reduction to identify failures in consumption-smoothing in response to the identified natural hazards. For example, del Ninno and Lundberg (2005) show Bangladeshi children who experienced the big 1998 flood could not recover during their survey period although, at the household level, there seemed to be successful consumption-smoothing. Similarly, Hoddinott and Kinsey (2001) and Yamano et al. (2005) show a decrease in child growth for the children who experienced drought in Zimbabwe and Ethiopia while Baez and Santos (2007) found higher child vulnerability in the aftermath of hurricane Mitch.[3]

To make the economic magnitude of natural shocks more explicit, Bengtsson (2010) conducted a two-step estimation that used rainfall variations as an instrument for income in the assessment of child weight responses to transitory income fluctuations. Furthermore, Bengtsson (2010) and Skoufias and Vinha (2012) suggest additional negative effects on child outcomes from biological/health events such as malaria or communicable

[3] Interestingly, Yamauchi et al. (2009) and del Ninno and Lundberg (2005) show *ex-ante* human capital production and government programmes for building resilience were able to partially mitigate the adverse effects of natural disasters on child health, allowing for a better recovery as compared with the case of *ex-post* coping measures.

disease spreading, but fall short of explicitly accounting for these events. Hence, we attempt to consider also these aspects.

Work on *health shocks* tends to focus on the effects of illnesses and mortality on income, consumption and child schooling. After a review of the literature, Grimm (2010) argues households cope fairly well with illness shocks while the evidence in the case of mortality is not clear. For Indonesia, Grimm finds mortality does not significantly affect household welfare, but this depends on the age and gender of the dead member. When a child or old member dies, death costs are compensated for by the increase in available resources in the household; adult mortality triggers more costs and the need to resort to coping strategies.

The literature on mortality and child schooling is quite prolific but constrained by data availability to cross-sectional studies (Ainsworth and Filmer, 2002; Case et al., 2004). A notable exception is Senne (2013), who provides difference-in-difference panel evidence that, in both the short and the long run, adult mortality negatively affects child education. Studies on the relationship between mortality shocks and child health are fewer and focus on long-term effects, showing negative effects of parental mortality on child mortality and height-for-age (Ainsworth and Semali, 2010; Kadiyala et al., 2009). We also add to this literature focusing on short-term effects and stressing the links between shocks, food security and child health. Focusing on the short term is useful because it allows for highlighting the main channels through which shocks affect household and child welfare while also testing the effectiveness of prevention and mitigation strategies already put in place in the context analysed.

3. Background and data

3.1 Country background

Senegal is a Sahelian country in West Africa classified by the World Bank as a low-income nation. Per capita gross domestic product (GDP) has increased over the years, from $662 in the early 1990s to $796 in the period 2010-2012, but real GDP growth has slowed since 2006 (World Bank, 2013). Senegal ranks 155th out of 187 countries on the Human Development Index, with a poverty headcount ratio at 2$ per day of 46.7%. Poverty differs considerably between rural and urban households: the poverty headcount ratio is more than 20% higher for rural households (57 against 33%) and the poverty gap index[4] suggests poverty is more pronounced in rural areas. Similarly, food insecurity is a major concern: 20% of the population is undernourished while almost 30% does not have adequate access to food (FAO, 2013).

Starting from 2002, the government of Senegal has been running the large-scale Nutrition Enhancement Programme (PRN) to tackle the problem of child malnutrition. The programme has multi-sectoral interventions towards nutrition improvement and the World Bank has renewed its funding until 2014. The first phase was between 2002 and 2006, mainly in urban areas, not covered by the survey used for the analysis. The second phase took place between 2007 and 2011, extending interventions to rural areas where malnutrition was particularly high (Natalicchio, 2011). The 2011 assessment of the programme states that in 2006 it covered 12% of children in rural areas whereas in 2011 coverage surpassed 50% (Mulder-Sibanda, 2011).

Senegal is particularly prone to natural shocks. Rough estimates of its disaster profile are drawn from the Emergency Events Database (EM-DAT) (2012) and show droughts have been the most disruptive disaster in terms of people affected (i.e. 850.000 affected in 2011).[5] Table 1 reports country statistics on precipitation (long-term mean (LTM) and yearly seasonal rainfall millimetres), on the evolution of the international food and cereal price index and on agricultural production and prices of relevant crops in 2008-2012. In the period considered, at the aggregate level, Senegal benefited from abundant precipitation, especially in 2009 and 2010 relative to the 1971-2000 long term, boosting production of primary cash and food crops. A notable exception is the March-May season of 2011, with rainfall 38% lower than the long-term mean.

Besides, the government of Senegal has been adopting several measures to improve rural households' food security since the 2008 price increases, so as to reduce household vulnerability to shocks. After setting up price controls, subsidies and rice (the major staple) redistribution in April-May 2008, the government started the Grand Agricultural Offensive for Food and Abundance (GOANA) to foster agricultural production and productivity.

[4] The poverty gap index considers how far the poor are on average from the poverty line.

[5] Estimated economic damages for droughts are not reported for Senegal but this does not imply droughts do not economically affect the country. Indeed, EM-DAT collects data on disaster direct impacts (costs of disaster at the moment of the event) rather than indirect impacts (post-disaster effects on flows of goods, services and business revenues that will not be generated owing to destruction and/or business interruptions) (Lazzaroni and Bergeijk, 2014). Since droughts do not take place as one-shot events, the estimation of their direct economic impacts is very difficult. EM-DAT also reports high negative effects from floods, but in our analysis we do not specifically address this shock since floods in Senegal usually take place during the rainy season, while the sampling period covers only the dry season. Therefore, in the dataset, only a negligible fraction of households reported having experienced a flood in the period considered, rendering any short-term econometric analysis of the effects of floods on child health meaningless.

Table 1: Country aggregate statistics for the period 2008-2012

			2008	2009	2010	2011	2012
Precipitation	DJF (mm)	LTM (1971-2000)=1	0	0	0	0	0
	MAM (mm)	LTM (1971-2000)=11.9	18.2	13.1	15.3	7.4	23.1
	JJA (mm)	LTM (1971-2000)=416.7	534.9	547.6	535.4	460.6	465.4
	SON (mm)	LTM (1971-2000)=213.8	240.6	244.3	368.3	188	310.1
International food prices	FAO Food Price Index, deflated		157	134	152	171	160
	FAO Cereal Price Index, deflated		181	142	145	179	178
Agricultural production in Senegal	Peanut	Quantity (tonnes)	836,843	1,059,093	1,195,573	865,770	708,986
	Peanut	Price (producer, index)	110	110	110	116.67	110.27
	Rice	Quantity (tonnes)	125,329	139,388	147,208	109,177	135,129
	Rice	Price (producer, index)	167.62	145.71	137.14	151.43	143.12
	Fruit+vegetables	Quantity (tonnes)	18,711	19,843	17,148	16,338	18,500
	Fruit+vegetables	Price (producer, index)	114.83	111.755	116.235	122.945	116.2
	Maize	Quantity (tonnes)	216,517	211,585	121,235	109,517	150,240
	Maize	Price (producer, index)	159.94	144.79	136.28	146.69	138.64
	Millet	Quantity (tonnes)	883,619	1,051,668	1,033,157	779,803	835,771
	Millet	Price (producer, index)	164.85	156.66	155.63	158.7	150

Note: For all price indexed, the base year is 2004-2006.

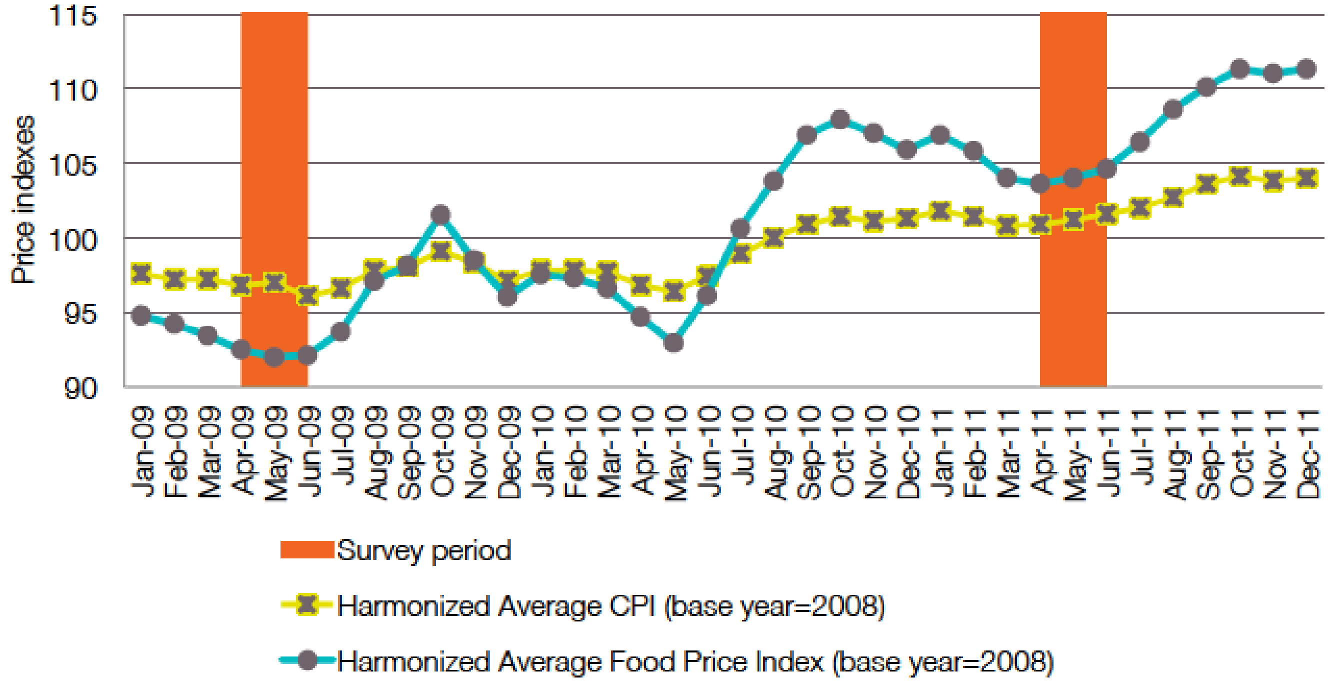
Source: FAO (2015); Harris et al. (2013).

Food security was further challenged in the year 2011 with a surge in the price of domestic and international food products. The government promptly responded by setting ceilings for the price of certain food products such as produced and imported rice, sugar and milk (FAO, 2013). Figure 1 shows the evolution of consumer prices between the survey years. The increase in the domestic and international food prices in 2008 constituted a major shock to Senegalese households, but good 2008/09 harvests helped reduce household vulnerability by reducing the share of imported food (République du Sénégal, 2010).

After the peak in June 2008, food prices rapidly declined, reaching pre-crisis levels when the first survey round was taking place in 2009. Accordingly, in Figure 1, the Harmonised Average Food Price Index (HAFPI) is below the Harmonised Average Consumer Price Index (HACPI).

However, starting from June 2009, food prices began again to increase, peaking at the end of 2010/beginning of 2011. Again, the government intervened, putting ceilings on the prices of the main staple food and sensitive commodities, stabilising food prices at a new high level throughout the first half of 2011 (the HAFPI now dominating the HACPI). Given these evolutions between 2009 and 2011, we expect households consuming a high share of imported food items to report having experienced this shock and to be more food-insecure as a result of it. Similarly, children living in households that reported occurrence of the 2011 increasing price shock are expected to have worse health conditions. Moreover, we expect households that experienced both price and drought shocks to be more affected than households that did not experience them.

Figure 1: Monthly HACPI and HAFPI in Senegal, 2009-2011



Source: AGNSD (2013) and authors' elaborations.

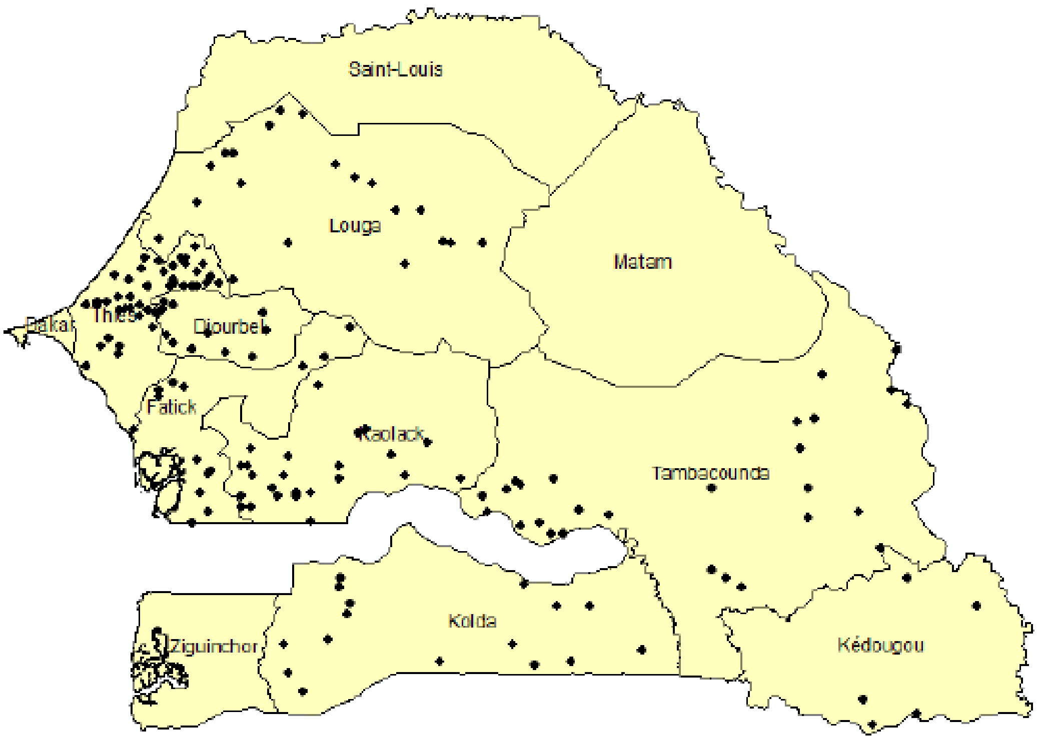
3.2 Data

Child health information was provided by a household survey carried out in eight regions of Senegal.[6] Originally, the purpose of data collection was the evaluation of a United Nations Development Programme (UNDP) intervention providing multifunctional platforms (Programme National Plateforme Multifonctionelle or PN-PTFM), namely generators for off-grid village electrification. Two rounds of data were collected: the baseline survey was conducted between May and June 2009 and the follow-up survey between April and May 2011, after the international food price peak recorded in February 2011. Randomisation of the households occurred at village level based on lack of access to energy. Hence, the sample is representative for rural Senegal in eight of 14 regions, in which income is most prevalently generated from subsistence agriculture (see Figure 2). The analysis is restricted to children who were between 12 and 60 months and for whom anthropometric data were available. After excluding cases with Z-scores beyond the [-6, +6] range, a total of 1,694 and 2,116 children were measured in 2009 and 2011, respectively. As the primary sampling units were households, we observe attrition at the individual child level. But no systematic difference is found when comparing the characteristics of the children with and without anthropometric data.[7]

[6] The regions are Diourbel, Fatick, Kaolack, Kedougou, Kolda, Louga, Tambacounda and Thies, according to the 2009 regional subdivision.

[7] Children without anthropometric data and/or with anthropometric data out of range numbered 1,515 in 2009 and 1,179 in 2011. Means tests on observables do not suggest systematic differences between children with and without z-scores. Detailed tables with group comparison on observables are available in the Appendix. Children with repeated observations numbered only 661, with some loss of representativeness; hence we preferred to use pooled cross-sections.

Figure 2: Map of Senegal with surveyed villages



Note: The sample consists of 165 villages in 8 regions according to the 2009 regional subdivision, as defined in the 2009 survey. • indicates the location of a survey village.

Source: CERDI et al. (2009).

3.2.1 Shock module and relevant timing of activities

Respondents were asked whether the household had experienced a shock within a list of possible adverse events and the year in which this event occurred for the last time.[8] We set up a dummy variable that takes value 1 if the household experienced the shocks *in the survey years* and 0 if the shock was either not experienced or experienced in non-survey years. Thus we are considering shocks that occurred in the period January-mid-June 2009 and January-May 2011. The choice to constrain shock variables to this period was made for two reasons.

First, we wanted to prevent recall bias in reported shocks incidence. Second, our analysis focuses on the short term (child-weight-for-age being the short-term indicator of child health and our primary outcome variable of interest); therefore we need short-term shock measures. Table 2 illustrates the survey and shock calendar. We also report the crop calendar for groups of crops cultivated in the country in order to better understand the timing of shocks with respect to the main activity of households (85% of households cultivate some crops), and we recall that:

'Millet, rice, corn and sorghum are the primary food crops grown in Senegal. Peanuts, sugar cane, gum arabic and cotton are the primary cash crops. A wide variety of fruits and vegetables are grown for the local and export markets [i.e. green beans, cherry tomato, mango and melons to Europe]' (Ndiaye, 2007).

By and large, primary crops are planted in the period May-July and harvested in the period September-November, whereas fruit and vegetables, roots and tubers and other secondary crops are cultivated throughout the whole year. Garden vegetables are planted especially during the dry season to contribute to dry season income and food security (Linares, 2009).

Table 3 presents the relevant shocks considered in the shock module with the number of children living in households that reported having experienced an adverse event in the year of the survey. In line with the analysis in the previous sections, an increase in purchase prices is the adverse event that has mostly affected rural households in Senegal: 41% (76%) of households reported having experienced price increases in 2009 (2011). Droughts were reported by 3-6% of households in both rounds.

[8] In the shock module, households were asked these questions: 1) does the household recall having been affected by one of the following events (followed by a list of events)? 2) in which year did this event take place for the last time? 3) on a scale from zero to 10, what was the intensity of the event for the household? 4) how did the household cope with this situation? 5) on a scale from one to 10, how do you estimate the frequency of this event?

Table 2: Survey and crop calendar in rural Senegal

		Jan	Feb	March	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Survey calendar	Survey period				Interviews								
	Shocks	Reference period for reported shocks											
Crop calendar	Cereals					Planting				Harvesting			
	Peanut, sesame					Planting				Harvesting			
	Leguminous					Planting				Harvesting			
	Root/tuber	Planting/harvesting											
	Vegetables, fruit	Planting/harvesting											
	Other crops	Planting/harvesting											

Source: Authors and FAO (2015).

Table 3: Shocks in the survey area in the period 2009-2011

Shocks	2009		2011		Difference
	Mean	St.Dev	Mean	St.Dev.	
Economic shocks					
• Increase in purchase prices	0.41	0.49	0.76	0.43	-0.34***
• Decline in sales prices	0.09	0.28	0.00	0.00	0.09
• Loss of employment	0.01	0.10	0.07	0.25	-0.06***
Natural hazard					
• Drought	0.03	0.16	0.06	0.23	-0.03***
• Cold wave	0.04	0.20	0.01	0.09	0.03
Biological hazard					
• Crop pest/insect invasion	0.04	0.20	0.04	0.20	0.00
Health shocks					
• Death of a member	0.04	0.20	0.05	0.23	-0.01***
Number of observations	1,694		2,116		

Note: *** P-value<0.01. Difference in shock incidence is in bold when incidence is significantly higher in 2011.

Source: Authors' elaborations.

As mentioned in the introduction, the weak prevalence of drought in the dataset depends largely on the fact that the reference period for shocks is not the drought key period for Senegal: at the time of interview, the planting, growing and harvesting of primary cash and food crops had already taken place and households were relying mainly on food from the previous wet season for intake and trade. However, dry season droughts may also have negative effects in terms of lower agricultural production and amplification of food scarcity (Maccini and Yang, 2008). We argue that our drought shock variable captures precisely this effect.[9]

Across shock categories, we observe that significantly more adverse events were reported in 2011.[10] We attribute the more sensitive perception of negative events in 2011 to the overall hazardous climate induced by high food prices. In particular, in light of the discussion above, at the aggregate level the increasing purchasing price shock variable is bound to capture three effects:

1. The seasonal increase in domestic primary crop prices;
2. The possible increase in secondary food prices in the case of drought-induced lower quantities available for exchange on the market;
3. The exogenous increase in international food prices in 2011. If households are net food-sellers, this event will have positive effects through the sales of primary and secondary cash crops and negative effects in terms of the imported food items. We argue that, in our sample, the former effect prevails in 2011.

The exogeneity of the drought and increasing price shock variables is crucial for the identification of the following econometric analysis. According to Hoddinott and Quisumbing (2003), two major issues stand out.

First, self-reported shocks may account for household attribution of causality rather than occurrence of the adverse event, depending on class, cast, gender and age (Tesliuc and Lindert, 2002). In the case of droughts, controlling for household-specific characteristics and using objective drought indexes may then rule out potential endogeneity. Since the households were geo-referenced, we perform robustness checks exploiting the household-specific objective shock variable based on the Standardised Precipitation Index – SPI (McKee et al., 1993). In the case of increasing prices, potential endogeneity may be driven by seasonality and/or crop production. However, in our case, seasonality should be accounted for in the econometric analysis by the fact that households were interviewed in the same season. Possible trends are captured by the time fixed effect. Moreover, as primary cash and food crops production occurs before the period covered by our shock measures and the 2010 primary crop harvest was exceptionally good, self-reported increasing purchase prices for rural households should be driven mainly by secondary food prices and international food price spikes.

Tables 4 and 5 present the extent of interdependencies between different shock categories for the two survey years.

Notably, in 2009, droughts are positively and significantly correlated with the occurrence of crop pests, loss of employment and price variations. Similarly, extreme cold events are correlated with price increases. Increasing purchase prices are also positively correlated with crop pests. Pairwise correlations differ slightly in 2011. Except for extreme cold, natural shocks are not significantly correlated with increases in purchase prices in 2011, while loss of employment is positively and significantly correlated with the occurrence of all other shocks. The differences in the pairwise correlations already hint at possible differences in the perception of shocks over time. Consequently, a possible reason for concern in the econometric model stems from the dynamic nature of individual perceptions. Yet the two shocks we focus on (reported drought and increasing prices) are not significantly correlated in 2011 when the second surge of food prices took place.[11]

Second, Hoddinott and Quisumbing (2003) point out that attribution of causality from the analyst has to be carefully based on theory and reflected in the model specification and estimation to avoid misinterpretations of the results. We therefore explore our results to test different pathways of effects.

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[9] Note that, for every household, occurrence of a drought does not necessarily imply a complete failure of harvest, depending on several factors such as drought intensity, differential incidence of the shock across parcels in different locations, crop diversification, etc.

[10] The external validity of the survey shock data is confirmed by similar data collected by the World Food Programme (WFP) in 2010 (République du Sénégal, 2010). Note that 88% (78%) of households that reported having experienced a drought also reported the occurrence of higher purchasing prices in 2009 (2011).

[11] Additionally, we investigated the determinants of the reported increasing purchase price shock. We estimate a probit model with the price shock dummy as dependent variable and several explanatory variables. Reported drought does not seem to be a significant determinant of an increase in purchase price.

Table 4: Correlation between different shocks for the 2009 survey period

Shock type			(1)	(2)	(3)	(4)	(5)	(6)	(7)
Natural	(1)	Drought	1						
	(2)	Extreme cold	0.040	1					
Biological	(3)	Crop pest	0.131*	0.102*	1				
Health	(4)	Death of a member	-0.015	0.180*	0.016	1			
Economic	(5)	Loss of employment	0.095*	0.038	-0.021	0.009	1		
	(6)	Decline in sales prices	0.068*	-0.023	0.060*	-0.064*	0.095*	1	
	(7)	Increase in purchase prices	0.157*	0.142*	0.114*	0.088*	0.072*	0.295*	1

Note: * Level of significance greater or equal to 0.05.

Source: Authors' elaborations.

Table 5: Correlation between different shocks for the 2011 survey period

Shock type			(1)	(2)	(3)	(4)	(5)	(6)	(7)
Natural	(1)	Drought	1						
	(2)	Extreme cold	0.115*	1					
Biological	(3)	Crop pest	0.168*	0.104*	1				
Health	(4)	Death of a member	0.076*	0.181*	0.053*	1			
Economic	(5)	Loss of employment	0.240*	0.350*	0.355*	0.182*	1		
	(6)	Decline in sales prices	.	.	.	.	.	.	
	(7)	Increase in purchase prices	0.011	0.058*	0.082*	0.005	0.127*	.	1

Note: * Level of significance greater or equal to 0.05.

Source: Authors' elaborations.

3.2.2 Sample descriptive statistics

Table 6 presents the descriptive statistics of the children in the dataset for whom anthropometric data are available. The sample is fairly gender-balanced. In 2009, the children are 30 months old on average. As outcomes, we employ the weight- and height-for-age Z-scores (WAZ and HAZ). We use the WHO 2006 growth standards for attained weight and height (WHO and UNICEF, 2009). The indicators of child health are standardised measures relative to an international reference population and are expressed in terms of standard deviations (Z-scores). As the metric for Z-scores is standard deviations, they can easily be interpreted. A child with a Z-score of zero has no deviation in its health status with respect to the reference population. Yet, with an average WAZ (HAZ) of -1.45 (-1.20), the children in the sample are underweight (stunted). Moreover, we observe that both weight-for-age and height-for-age improve over time in the sample at hand. As aforementioned, we attribute this to exceptional harvests in the periods considered and to nationwide programmes implemented in response to the food price shock. Moreover, some changes occurring between the survey rounds hint at a gradual structural change in household socioeconomic conditions, as outlined below. The households the children are living in had on average 14-15 members; in both rounds, about 25% of members were children below five years. In 2011, fewer children lived in households without their mothers; similarly, maternal literacy increased between rounds. Presence of the mother is likely to increase attention towards the health needs of the child at both the individual child and the household level, while maternal literacy and education account for higher abilities in processing health and nutrition information (Christiaensen and Alderman, 2004; Glewwe, 1999). Wealth and connectedness also improved in the sample households: on average, households own more poultry, mobile phones and radios. The combined effect of increasing maternal education and connectedness would also have positive effects on child health by increasing access to available nutrition information (Glewwe, 1999; Thomas et al., 1991) and facilitating risk management information in the event of shocks.

The last row of Table 6 reports a household food insecurity indicator for the households in which the children resided: food insecurity is measured as the number of weeks of food scarcity (stocks of cereals are exhausted) at the time of interview. In 2009 the children in the sample were reported as living in a household where the stock of cereals (and/or rice) had been exhausted on average for seven weeks, whereas in 2011 the average weeks of food scarcity decreased by one third. Thus, households appear to have been less food-insecure in 2011. This finding may be influenced by both the exceptional 2010 harvest and the national programmes implemented by the government of Senegal. Note that seasonal effects are minimised since both the surveys were conducted during the same agricultural season.

Table 6: Descriptive statistics of selected control variables for rural households in Senegal

Variable	2009		2011		Difference
	Mean	St.Dev	Mean	St.Dev	
Weight-for-age (WAZ) [a]	-1.447	1.805	-0.576	1.937	-0.871***
Height-for-age (HAZ) [a, b]	-1.196	2.234	-0.936	1.919	-0.260***
Sex (1=female)	0.453	0.498	0.495	0.500	-0.042***
Age (months)	30	12.873	34	14.816	-4.089***
Missing date of birth (=1)	0.787	0.409	0.798	0.402	0.011
Age of head of household	52	14.602	54	15.280	-1.467***
Sex of head of household[a] (female=1)	0.023	0.150	0.024	0.153	-0.001
Mother is out of household (=1)	0.053	0.223	0.035	0.185	0.018***
Age mother	29	7.536	30	7.381	-0.747***
Mother can read and write (=1)	0.148	0.355	0.176	0.381	-0.028**
Mother is head of household (=1)	0.005	0.073	0.004	0.065	0.001
Mother is wife of head of household (=1)	0.523	0.500	0.478	0.500	0.045***
Mother is daughter of head of household (=1)	0.035	0.185	0.042	0.201	-0.007
Mother is not a relative	0.025	0.155	0.015	0.122	0.010**
Household size	14	6.345	15	7.139	-1.524***
Share of children <5 in household	0.253	0.105	0.241	0.100	0.012***
Poultry	0.570	0.495	0.675	0.469	-0.105***
Livestock	0.943	0.231	0.953	0.212	-0.010
Water					
• (1) own tap	0.209	0.407	0.234	0.423	-0.025*
• (2) public tap	0.275	0.447	0.247	0.431	0.028*
• (3) protected well	0.088	0.283	0.040	0.195	0.048***
• (4) neighbour's tap	0.012	0.108	0.012	0.110	-0.000
• (5) non-protected well	0.299	0.458	0.330	0.470	-0.031**
• (6) hole	0.073	0.260	0.121	0.327	-0.048***
• (7) other	0.045	0.207	0.015	0.122	0.030***

Variable	2009		2011		Difference
	Mean	St.Dev	Mean	St.Dev	
Toilet					
• (1) none or external	0.207	0.405	0.164	0.370	0.043***
• (2) water sewer	0.010	0.100	0.003	0.057	0.007***
• (3) septic tank	0.032	0.175	0.089	0.285	-0.057***
• (4) covered latrine	0.381	0.486	0.292	0.455	0.089***
• (5) uncovered latrine	0.284	0.451	0.243	0.429	0.041**
• (6) other	0.087	0.283	0.208	0.406	-0.121***
Own mobile (=1)	0.668	0.470	0.882	0.322	-0.214***
Own radio (=1)	0.739	0.439	0.820	0.384	-0.081***
No. parcels cultivated	3.032	1.667	3.068	1.462	-0.036
Size of land cultivated (ha)	6.729	6.001	5.723	4.807	1.006***
Food (in)security (weeks of food scarcity)	6.510	6.102	3.988	4.796	2.522***
Number of observations	1,694		2,116		

Note: */**/*** P-value < 0.10/< 0.05/< 0.01, respectively. aThe pooled standard deviation for child weight-for-age and height-for-age is 1.931 and 2.062, respectively. bFor HAZ, the number of observations is 1,503 and 2,022 in 2009 and 2011, respectively.

Source: Author's elaborations.

The next section introduces the econometric model employed in the multivariate analysis. Here, we already present non-parametric estimates for the 2009 and 2011 cross-sections of children with available weight- and height-for-age and food insecurity data; we focus on price increases and drought shocks (Table 7). Children living in households that experienced price (drought) shocks in 2009 have higher (lower) weight-for-age than the non-price (drought) shock children, while in general household food security is lower for children experiencing the two shocks singly. Child weight-for-age in 2011 is lower for children living in households that experienced an increase in purchase prices or a drought, and the simple interaction term also supports the overall negative effect on child weight-for-age. The drought interaction term is most significant and accounts for 42% of the pooled weight-for-age standard deviation. Height-for-age is not affected by increases in purchase price, as the interaction term is insignificant. Yet drought shocks explain 54% of the pooled standard deviation in height-for-age. The deterioration of child health owing to shocks is also reflected in our measure of food security.

Both increasing purchase prices and drought shocks worsened food security in 2009 by increasing the number of weeks since the household had exhausted its cereal stocks. In 2011, food security seems rather unaffected by price and drought shocks and the non-parametric estimation confirms the prevalence of a structural improvement in food security between rounds. However, these results do not account for other determinants of child health – namely, biological and child-specific characteristics; SES and household-specific characteristics; and environmental quality, cultural factors and other community characteristics. The last set of characteristics is also crucial in determining food security, since this variable tends to be related to space and time dimensions (Hoddinott, 1999). In the multivariate analysis that follows, we include these determinants as well.

Table 7: Non parametric estimates

	2009		2011		interaction
	Price shock	No price shock	Price shock	No price shock	
Weight-for-age (WAZ)	-1.367	-1.503	-0.632	-0.402	-0.365***
Height-for-age (HAZ)	-1.013	-1.325	-0.881	-1.099	-0.094
Food insecurity (weeks of food scarcity)	7.104	6.091	3.984	4.000	-1.029***
	2009		2011		interaction
	Drought shock	No drought	Drought shock	No drought	
Weight-for-age (WAZ)	-1.511	-1.445	-1.407	-0.526	-0.815***
Height-for-age (HAZ)	-0.681	-1.210	-1.478	-0.901	-1.105***
Food insecurity (weeks of food scarcity)	9.532	6.429	4.550	3.954	-2.507***

Note: */**/*** P-value < 0.10/< 0.05/< 0.01, respectively.

Source: Authors' elaborations.

4. Economic model

We set up a fixed-effects model with two periods to analyse the impact of adverse events on child anthropometrics. The dependent variables are WAZ and HAZ as short- and long-term indicators of child health. The main effect we are interested in is the impact of drought and price shocks in concomitance with other types of shocks from the natural, biological and health sphere. For Ordinary Least Squares (OLS) to be unbiased, the error term has to be uncorrelated with the explanatory variables. The exogeneity of shocks allows us to obtain credible estimates of the impact of adverse events on child health. The estimation procedure follows three steps.

4.1 Basic model: partial and multi-shock analysis

Considering that child, household and community characteristics could be correlated with child health, we initially estimate a simple child health model including observable child, mother and household characteristics to avoid omitted variables bias. The basic estimation equation can then be written as:

$$Health_{ihvt} = \alpha + \beta\, CC_{ihvt} + \gamma HH_{hvt} + \delta_1 NAT_{hvt} + \delta_2 BIO_{hvt} + \delta_3 ECN_{hvt} + \delta_4 HLT_{hvt} + \lambda_{vt} + \varepsilon_{ihvt} \qquad (1)$$

where $Health_{ihvt}$ is the WAZ or HAZ pertaining to child *i* in household *h* and village *v* in year *t*. CC_{ihvt} is the vector of child and maternal characteristics. HH_{hvt} contains the household characteristics and asset wealth. The occurrence of shocks is observed at the household level; NAT_{hvt} is the vector of natural hazards experienced by the household in the survey year, BIO_{hvt} represents biological hazards and economic shocks are collected in ECN_{hvt} and health-related shocks in HLT_{hvt}. Structural change at the village level is captured by the village-year fixed effects λ_{vt} and ε_{ihvt} is the idiosyncratic error term.[12] Exogeneity of shocks with respect to observable child, household and community characteristics allows unbiased OLS estimates of the average impact of shocks on child health.

[12] Both the national nutrition and agricultural programmes were implemented at the village level.

4.2 Price (drought) shock and structural change interaction

Descriptive statistics already indicate structural improvements in 2011 but also the increased incidence of droughts and the increase in purchase prices. Therefore, we also analyse the wellbeing of children living in households that experienced the price (drought) shock before and after the structural change. Hence we estimate an augmented interaction model:

$$Health_{ihvt} = \alpha + \beta\, XCC_{ihvt} + \gamma HH_{hvt} + \delta_1 NAT_{hvt} + \delta_2 BIO_{hvt} + \delta_3 ECN_{hvt} + \delta_4 HLT_{hvt} + \sigma\ PricesIncrease_{2011} + \lambda_{vt} + \varepsilon_{ihvt} \qquad (2)$$

where the additional term $PricesIncrease_{2011}$ interacts the shock associated with an increase in the purchase price with the dummy variable for the year 2011. Other variables are defined as above. A similar model is also estimated to compare a drought shock before and after the structural change, introducing the additional term $Drought_{2011}$ (interacting the drought shock dummy variable with the dummy for the year 2011) in place of $PricesIncrease_{2011}$.

4.3 Misfortunes never come singly: increasing prices in times of drought

As a final step, we consider the effects of concomitantly increasing prices and experiencing drought shocks across children and rounds:

$$Health_{ihvt} = \alpha + \beta\, CC_{ihvt} + \gamma HH_{hvt} + \delta_1 NAT_{hvt} + \delta_2 BIO_{hvt} + \delta_3 ECN_{hvt} + \delta_4 HLT_{hvt} + \rho_t + \sigma_1 PricesDrought_{hvt} + \sigma_2 PricesIncrease_{2011} + \sigma_3 Drought_{2011} + \sigma_4 PricesDrought_{2011} + \lambda_{vt} + \varepsilon_{ihvt} \quad (3)$$

where $PricesDrought_{hvt}$ interacts the increase in purchase prices with the occurrence of a drought (shocks concomitance effect independent of the year), $PricesIncrease_{2011}$ interacts the purchase price shock with the dummy for the year 2011 and $Drought_{2011}$ interacts the drought shock with the dummy for the year 2011. The variable of interest is $PricesDrought_{2011}$ interacting both the purchase price and drought shock dummies with the dummy for the year 2011. Hence σ_4 will account for shock concomitance while considering the structural change. Other variables are defined as above.

5. Results

Tables 8 and 9 present the results for the impact of adverse events on child anthropometrics. We account for household size and composition (share of children below five years in the household), parental characteristics, access to water and sanitation and wealth indicators (poultry, livestock and land ownership). Indicator variables for the ownership of a radio and/or mobile phone in the household are included as indicators of both wealth and connectedness. These devices allow the household to get access to news and information about health and shocks occurring within and outside the country. Following the approach of Cogneau and Jedwab (2012) and Senne (2013), we control for village-year fixed effects by including dummies for the village of residence interacted with the year dummy for 2011 to control for all unobserved village-specific characteristics and trends related to shocks and child health. This specification allows us to account for the structural change at the village level. Standard errors are clustered at the village level to account for within-village correlation of the error term. Finally, we include dummies accounting for economic, natural, biological and health shocks. Negative and significant coefficients associated with a shock variable indicate the occurrence of the respective shock affects child health negatively. Non-significance of the coefficient pertaining to a shock variable does not necessarily suggest the specific shock did not have any effects on child nutritional status or on other indicators of household welfare. It rather suggests that, on average, households have been able to mitigate the adverse effects of the shock thanks to (*ex-ante/ex-post*) coping strategies. Table 8 and 9 present the results of equations (1), (2) and (3) using as dependent variables child weight-for-age and height-for-age, respectively.

Even at a glance, we see that the sign and level of significance of the shocks considered remain stable across specifications. This indicates that we analyse coherent shock–health pathways across the different models. We expect households located in the same areas to have similar characteristics, risk and food security profiles. The inclusion of village-year fixed effects in the analysis implies we are controlling for unobservable characteristics for households in the same village. Our choice is motivated mainly by the fact that, generally, governmental and non-governmental programmes and risk-sharing mechanisms (and most likely market access) are village-specific in the context analysed. Thus, we are considering within-village variation between children that experience and did not experience shocks, between survey rounds.

We verified that the village-year fixed effects are relevant. They are jointly significant and support the occurrence of a structural trend as observed in the descriptive statistics. Furthermore, when including village and year fixed effects separately, we observe a positive and significant coefficient estimate associated with the year dummy, supporting the occurrence of a structural change between the survey rounds. In the robustness checks, we also provide estimates with household fixed effects to account for unobserved time-invariant intra-locality inequalities.

5.1 Results of the partial and multi-shock analysis

Results of the partial shock analysis (including shocks singly in the specification of the model) are reported in specifications (1) to (7); specification (8) considers the shocks together. Note that coefficient magnitudes vary slightly in the multi-shock specification. In particular, the coefficient associated with crop pests increases in magnitude in the multi-shock specification for weight-for-age. This increase in the coefficient size is associated with the correlation of crop pest shocks with droughts as suggested by Tables 4 and 5. For example, droughts weaken crop resistance and favour the development of pests and insects. Yet the respective coefficient estimates are non-significant throughout the different model specifications.

Throughout specifications, only two shocks impact underweight significantly: droughts and the death of a household member. Basing our interpretations on the multi-shock specification in column (8), we conclude that droughts aggravate underweight by accounting for 27% of the standard deviation in weight-for-age. The death of a household member, in turn, has positive consequences for the redistribution of food among the remaining household members and increases weight in the short term. We do not observe any impact of reductions in household size through death on child height-for-age.

As already indicated, the short- and long-term impacts of the shocks differ. Results for child height-for-age (Table 9) suggest a positive effect of increasing prices and loss of employment when considered singly and in the multi-shock specifications (1)-(8). While these results seem counterintuitive in first place, they can be understood in light of their incidence rate and the shock correlation matrix. Loss of employment is a rare event in 2009, occurring in only 1% of the cases; in 2011, employment loss happens to 7% of the households. At the same time, 41% of the households in 2009 and 76% of the households in 2011 experience an increase in purchase prices (Table 3). Moreover, both these shocks are positively and significantly correlated in the two survey rounds (Tables 4 and 5). As our sample consists of poor rural subsistence farmers, the positive price effect reflects an income effect for households that are net food-producers. Under these circumstances, loss of employment is not necessarily a negative event as it frees labour that can be used on the field or reallocated to childcare. Ultimately, this results in better child health as captured by increased height-for-age. In addition, we observe that, in the multi-shock specification (column 8), the negative effects of droughts and decreasing sales prices become significant in deteriorating long-term child health. This hints again at the merits of the multi-shock approach as hazardous events are clearly correlated and focusing on just one shock might result in misleading conclusions.

As the natural hazard drought and the economic shock pertaining to income have the most pronounced impact on child health, we further exploit their dynamics in light of the structural change occurring between the two survey rounds.

5.2 Structural change and price/drought in an interaction set-up

The first pair of results of our analysis concerns the average effect of increasing purchase prices and occurrence of droughts for the children who experienced these shocks in the sample. Specifications (9) and (10) of Tables 8 and 9 present interacted estimates of increased prices and the drought shock conditional on the usual child, household and village observables and the survey year to consider fundamental changes occurring between 2009 and 2011.

Conditional interaction terms (the year-shock interaction) suggest on average a *negative effect of both increased prices and droughts on child weight-for-age* despite the considerable overall improvements in 2011. These findings are in line with the non-parametric estimates for child weight-for-age in Table 7. They highlight the need to implement measures to protect child health from certain adverse events even during periods of overall growth and expansion.

Similarly, when turning to child height-for-age, the conditional interaction term for the occurrence of drought (Table 9, column 10) is in line with the negative and significant non-parametric estimates in Table 7. By contrast, the surge in purchase prices conditional on the structural change did not have a significant effect on child height beyond the direct, unconditional price effects. Note that this may depend on the long-term nature of the height-for-age Z-score in contradistinction with the short-term nature of our analysis.

5.3 Misfortunes never come singly? Competing effects

The second main result of our analysis concerns the effect of the concomitant increase in purchase prices and drought episodes after 2011, therefore this result *applies to the children living in households that reported having experienced both the shocks*. For these children, we find concomitance has a negative but insignificant effect on both weight- and height-for-age. This is an interesting finding given the improvements in child health observed in 2011 but the higher incidence of shocks during the same period. In the triple interaction term analysis for weight-for-age (Table 8, column 11), we observe both the price-year and drought-year interaction terms are negative and significant, mimicking the results in section 5.2 but showing higher magnitudes. More importantly, the effects of the concomitance of increased prices and drought shocks in 2009 and 2011 are captured by the price-drought interaction term and the triple interaction term, respectively. Both these terms are positive and insignificant. In economic terms, this suggests competing price and income effects. Analogous to the simple household model for net producers, we find higher prices for consumption of home-produced goods increase income; this is particularly the case in times of scarcity, such as a drought, but may be related to the timing of the survey, shocks and agricultural production. We explore this effect more in depth in the following section.

In Table 7, specification (11) shows insignificant intermediate (conditional) and final triple interaction effects. Again, note this may capture only short-term effects or, in the best case, that some structural change protected child height-for-age for children who experienced both drought and price shocks.

In a nutshell, on average droughts and higher prices are associated with negative effects on child health, but children who experienced both shocks did not present significantly worse health outcomes. In the next section, we attempt to consider possible differential effects and the relevant channels driving the main results.

Table 8: Econometric results for child weight-for-age; village-year fixed effects estimations clustered at the village level

Dependent variable: child weight-for-age	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Drought	-0.574***							-0.542***	-0.571***	0.094	-0.326
	(0.195)							(0.192)	(0.195)	(0.345)	(0.398)
Extreme cold		0.328						0.347	0.292	0.341	0.280
		(0.257)						(0.250)	(0.252)	(0.255)	(0.257)
Crop pest			0.026					0.102	0.090	0.089	0.0522
			(0.168)					(0.175)	(0.172)	(0.169)	(0.165)
Increase purchase prices				0.044				0.044	0.293**	0.033	0.277**
				(0.0879)				(0.091)	(0.126)	(0.092)	(0.126)
Decrease sales prices					0.002			0.0121	-0.101	-0.006	-0.124
					(0.187)			(0.198)	(0.194)	(0.196)	(0.194)
Loss of employment						-0.454		-0.442	-0.426	-0.415	-0.393
						(0.276)		(0.271)	(0.275)	(0.269)	(0.266)
Death of a household member							0.230*	0.253**	0.237*	0.260**	0.248*
							(0.126)	(0.127)	(0.129)	(0.128)	(0.131)
Year 2011 * Incr.Prices									-0.477**		-0.507**
									(0.200)		(0.202)
Year 2011 * Drought										-0.824**	-1.072**
										(0.374)	(0.536)
Incr.Prices * Drought											0.370
											(0.554)
Year 2011 * Incr.Prices * Drought											0.469
											(0.677)
Observations	3,810	3,810	3,810	3,810	3,810	3,810	3,810	3,810	3,810	3,810	3,810
R-squared	0.212	0.210	0.209	0.209	0.209	0.211	0.210	0.214	0.217	0.216	0.219
Number of clusters (villages)	165	165	165	165	165	165	165	165	165	165	165

Note: All shock variables are dummy variables. Additional control variables included are age and gender of child, head of household and mother's age and gender, if mother resides in household, mother's literacy, if mother is related to head of household, number and size of parcels of land cultivated, ownership of poultry, livestock, radio and mobile phone and dummy variables for water and toilet facilities. */ **/ *** stand for significance at 10, 5 and 1%, respectively.

Source: Authors' elaborations.

Table 9: Econometric results for child height-for-age; village-year fixed effects estimations clustered at the village level

Dependent variable: child height-for-age	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Drought	-0.267							-0.373**	-0.368**	0.430	-0.259
	(0.172)							(0.170)	(0.169)	(0.348)	(1.303)
Extreme cold		-0.150						-0.322	-0.315	-0.318	-0.308
		(0.260)						(0.258)	(0.259)	(0.257)	(0.257)
Crop pest			-0.0807					-0.146	-0.147	-0.150	-0.163
			(0.209)					(0.207)	(0.207)	(0.199)	(0.199)
Increase purchase prices				0.363***				0.410***	0.371***	0.398***	0.342**
				(0.0910)				(0.0907)	(0.142)	(0.0916)	(0.143)
Decrease sales prices					-0.348			-0.573**	-0.556**	-0.602**	-0.589**
					(0.273)			(0.266)	(0.274)	(0.268)	(0.280)
Loss of employment						0.456*		0.572**	0.570**	0.598***	0.598***
						(0.239)		(0.225)	(0.224)	(0.221)	(0.219)
Death of a household member							0.146	0.109	0.112	0.119	0.125
							(0.151)	(0.152)	(0.153)	(0.153)	(0.154)
Year 2011 * Incr.Prices									0.074		0.0940
									(0.175)		(0.176)
Year 2011 * Drought										-1.026**	-0.448
										(0.398)	(1.451)
Incr.Prices * Drought											0.841
											(1.360)
Year 2011 * Incr.Prices * Drought											-0.692
											(1.522)
Observations	3,603	3,603	3,603	3,603	3,603	3,603	3,603	3,603	3,603	3,603	3,603
R-squared	0.145	0.145	0.144	0.150	0.145	0.145	0.145	0.154	0.154	0.156	0.156
Number of clusters (villages)	165	165	165	165	165	165	165	165	165	165	165

Note: All shock variables are dummy variables. Additional control variables included are age and gender of child, head of household and mother's age and gender, if mother resides in household, mother's literacy, if mother is related to head of household, number and size of parcels of land cultivated, ownership of poultry, livestock, radio and mobile phone and dummy variables for water and toilet facilities. */ **/ *** stand for significance at 10, 5 and 1%, respectively.

Source: Authors' elaborations.

6. Differential effects and possible pathways

We provide more insights on how the impact resulting from the identified multiple shocks differentially affects different groups or communities (Table 10) and discuss the possible channels through which the shocks work (Table 11 and 12). In Tables 10, 11 and 13, we first present the interaction and triple interaction main results for ease of comparison.

6.1 Differential effects

Shocks may affect boys and girls in different ways depending on gender (Hoddinott and Kinsey, 2001; Rose, 1999). Therefore, in Table 10, specifications (1) and (2), we estimate equations (2) and (3) for the male and female subsamples, respectively. Estimates for both weight-for-age and height-for-age suggest boys are significantly more affected than girls by increasing prices and drought shocks. Moreover, shock concomitance is associated with particularly negative effects for boys in terms of lower height-for-age. Although this result may seem in contrast with expectations of higher female vulnerability to shocks, the prevalence of negative effects on males has been found in several studies in Sub-Saharan Africa and may owe to differences in morbidity rates between boys and girls in the case of environmental stresses in early life (Wamani et al., 2007; Wells, 2000).

In Section 3.2.2, we also pointed out that maternal literacy and education may account for higher abilities in processing health and nutrition information (Christiaensen and Alderman, 2004; Glewwe, 1999). To test this argument, we split the sample according to maternal ability to read and write and present results in Table 10 – specifications (3) and (4). In line with our expectations, the results for the sample including children with non-educated mothers capture magnitude and level of significance of the main findings, emphasising the importance of maternal education in determining child health.

Finally, pastoral communities and agricultural households could be differentially affected. The only way we can trace pastoral household is through the 'Male activities questionnaire' in which the head of the household or another adult male member is asked about his main activity. About 75% of the children live in a household headed by a farmer, whereas only a very small fraction of the households can be considered pastoral. In Table 10, specifications (5) and (6), we estimate results for pastoral and non-pastoral households. None of the coefficients of interest is significant in the case of pastoral households, which may owe to low statistical power of the available subsample. On the other hand, on average, child health is negatively affected by droughts and higher purchase prices when we consider non-pastoral households. Moreover, shock concomitance is positively and significantly associated with child weight-for-age for non-pastoral households, fully supporting the importance of the agricultural production and income channel for children who experienced both shocks.

Table 10: Differential effects – econometric results for child health (WAZ, HAZ); village-year fixed effects estimations clustered at the village level[a]

			Price	Drought	Concomitance	Observ.
WAZ		Results from Table 8	-0.477**	-0.824**	-0.469	3,810
			(0.200)	(0.374)	(0.677)	
	(1)	Boys sample	-0.647**	-0.977**	-0.056	1,994
			(0.266)	(0.481)	(1.114)	
	(2)	Girls sample	-0.272	-0.873	1.759	1,816
			(0.247)	(0.889)	(1.182)	
	(3)	Educated mothers sample	-0.464	-0.266	0.186	622
			(0.464)	(0.792)	(0843)	
	(4)	Non-educated mothers sample	-0.493**	-0.914**	0.191	3188
			(0.213)	(0.404)	(0.716)	
	(5)	Pastoral households	2.835	-2.445	-4.850	106
			(1.848)	(2.584)	(7.198)	
	(6)	Non-pastoral households	-0.501**	-0.760*	0.704**	3,704
			(0.197)	(0.437)	(0.332)	
HAZ		Results from Table 9	0.074	-1.026**	-0.692	3,603
			(0.175)	(0.398)	(1.522)	
	(1)	Boys sample	0.006	-1.051*	-2.679*	1,850
			(0.272)	(0.614)	(1.424)	
	(2)	Girls sample	0.202	-0.636	-0.157	1,753
			(0.256)	(1.028)	(1.288)	
	(3)	Educated mothers sample	-0.470	-1.403	-1.015	588
			(0.538)	(1.113)	(1.155)	
	(4)	Non-educated mothers sample	0.157	-0.978**	-0.845	3,015
			(0.197)	(0.485)	(1.608)	
	(5)	Pastoral households	-1.709	1.790	-	105
			(1.852)	(1.960)		
	(6)	Non-pastoral households	0.038	-1.133***	-0.326	3,498
			(0.175)	(0.346)	(0.563)	

Note: All shock variables are dummy variables. Additional control variables included are age and gender of child, head of household and mother's age and gender, if mother resides in household, mother's literacy, if mother is related to head of household, number and size of parcels of land cultivated, ownership of poultry, livestock, radio and mobile phone and dummy variables for water and toilet facilities, region dummies. */ **/ *** stand for significance at 10, 5 and 1%, respectively. a Specification (6) is estimated with household fixed effects with standard errors clustered at the household level.

Source: Author's elaborations.

6.2 Other robustness checks

Following the approach of Maccini and Yang (2008), we estimate equations (2) and (3) including key control variables representing relevant channels of effects and comparing results with our main findings. If the inclusion of specific variables leads to a variation on the coefficient and level of significance of the interaction and triple interaction estimate, this would suggest the additional variables 'represent an important pathway [toward child health]' (Maccini and Yang, 2008: 15).[13]

6.2.1 Seasonal variations, shock intensities and objective drought measurement

Timing and intensity of shocks could influence the way adverse events impact on child health. For example, Ntab et al. (2007) analyse the prevalence of malnutrition and malaria transmission in 1,063 Senegalese preschool children and find seasonality in child health and consequent changes in malaria transmission. Similarly, Simondon et al. (2008) and Savy et al. (2006) that women's Body Mass Index varies strongly both between and within seasons depending on the month considered (beginning or end of season) in rural Senegal and Burkina Faso. Similarly in our case, although the two survey rounds take place in the same season (lean season of April-June), child health may be particularly sensitive to the month of survey, therefore in Table 9, specifications (1) and (2), we present results controlling for the months of interview. Results for both child weight-for-age and height-for-age are in line with the main findings. However, the drought interaction coefficient has a lower magnitude whereas the triple interaction coefficient (although insignificant) suggests positive rather then negative effects in the case of shocks concomitance. The dummy variables accounting for households interviewed in May and June (not reported) show positive and significant coefficients, suggesting that, on average, children living in household interviewed in these months were significantly healthier than households interviewed in April. These results are consistent with Figures 1 and 3, showing that the 2011 peak in the monthly HAFPI in Senegal occurred in January and the 2011 peak in the price of imported rice (the major staple) occurred in March. On the other hand, months of the survey variables are not significantly associated with child height-for-age, which we expected, since this indicator captures long-term variations in contradistinction to the rather short-term nature of our analysis.

Moreover, we explore the sensitivity of our results to reported shock intensities. The shock module of the survey included a question asking the respondents to evaluate on a scale from zero to 10 the intensity of the shock experienced by the household. In Table 9, specification (2), we estimate equations (2) and (3), including interaction terms between the shock dummies and the related reported shock intensities. Our results remain robust.

Finally, we explore results using an objective indicator of drought occurrence. In particular, we exploit data from the African Flood and Drought Monitor (AFDM, 2014) and compute geo-referenced drought indices for the households in the sample. In particular, the SPI (McKee et al., 1993) is considered one of the most reliable (Ntale and Gan, 2003) and it is also the index that closely reflects our household self-reported drought variable.[14] Results are robust except in the case of the drought interaction term that suggests insignificant effects of droughts when measured in objective terms, emphasising that household perceptions about droughts may depend on some factors that we are not addressing in our main analysis. Finally, note that the triple interaction estimator for children who experienced concomitant shocks is positive and significant. The following sections try to address these points, unfolding other channels driving results.

6.2.2 Local effects: institutions

Given that changes in institutions occur slowly over time (our survey covers only two years) and norms are hard to grasp, we argue that village fixed effects are the best candidate to capture institutional factors. Almost all the respondents (96%) to the 'Participation and solidarity' module of the survey indicated that social cohesion was very high in the village where they resided. This is also suggested by the considerable participation of household members in village organisations such as charity groups, traditional savings organisations (*tontines*), producer organisations, women's empowerment groups, groups for the management of multifunctional platforms and economic interests. In line with the literature on the developmental effects of village organisations (Bernard et al., 2008; Cassidy and Barnes, 2012), in Table 10, specification (4), we perform a robustness check of the main results of the paper controlling

[13] Note that, as stated by Maccini and Yang (2008: 15) '[w]ithout question, these regressions are open to potential concerns about omitted variables, data quality and reverse causality. The results should therefore only be taken as suggestive.'

[14] The SPI is expressed in terms of standard deviations of the observed precipitation from the long-term mean, for a normal distribution and fitted probability distribution for the actual recorded precipitation (McKee et al., 1993). We compute household-specific indices based on location and over different time periods. Finally, we construct the related shock variables taking the value 1 if the SPI is lower than -1.5, and 0 otherwise. The three-month index is the one that closely reflects household perceptions of drought in the survey.

for household participation in selected village organisations. Notably, results remain robust, while the participation of household members in organisations for economic interests, charity and development has a positive and significant effect on child health.

6.2.3 Local effects: social policies

Unfortunately, our dataset does not report household or village enrolment in specific social protection programmes. However, the main purpose of data collection was the evaluation of a UNDP programme providing PN-PTFM to selected rural villages. This intervention could be considered a special form of social protection programme through productive means. Thus, in Table 10, specification (5), we present estimates of the effects of shocks while controlling for village PN-PTFM availability. The main results hold, while we acknowledge that the dummy variable accounting for PN-PTFM availability is positively but non-significantly associated with both child weight-for-age and height-for-age.

Furthermore, we have already discussed the importance of the gradual implementation of the PRN in rural areas starting in the year 2006. The aim of the programme is to reduce child malnutrition through increased community nutrition activities such as growth monitoring, food supplements for underweight children and information, education and communication sessions for pregnant women (Natalicchio, 2011). Given that coverage of programme villages changed between rounds, we need to control for the programme. Using data from the Senegalese Unit against Malnutrition (CLM), we tracked villages in our dataset that were also sites of programme delivery. Moreover, since programme sites were bound to cover neighbouring villages up to 10 km away, we also tracked programme coverage within this radius. In Table 11, we present estimates of the effects of shocks on weight-for-age and height-for-age controlling for programme sites (specification 6) and the coverage radius (specification 7). As shown, our main results remain robust despite controlling for the PRN.[15]

The GOANA programme was also launched after the first round of the survey. This aims at making Senegalese households food self-sufficient by 2015 through increased land cultivation and fostering the production of rice. Indeed, rice is the major staple in Senegal, and it is largely imported (Dermont et al., 2013). The GOANA programme aimed at shifting from dependence on imported rice to reliance on own-produced rice to improve food security (Colen et al., 2013).[16] Unfortunately, we cannot conduct an impact evaluation of the programme because of lack of precise data on implementation, although we can identify rice-producers in the dataset. In Table 11, row (8), we estimate the drought and price shock models controlling for rice-producing households. Results are left unaffected, except for the triple interaction term, which is considerably reduced in magnitude. However, the dummy variable accounting for rice-producers (not reported) has a negative sign, suggesting rice production is not the main channel of insignificant effects for children experiencing both droughts and increasing prices.

[15] In its initial phase in 2002, the PRN was limited to the regions of Fatick, Kaolack and Kolda and randomised to allow for evaluation before scaling-up. It was delivered by selected non-governmental organisations (NGOs). Linnemayr and Alderman (2011) analysed the impact of the programme, detecting a low overall effect. Moreover they emphasised that coverage was not perfectly random but influenced by NGOs' perceived need for or probability of success and NGOs' localisation and ability to reach sites and neighbouring villages. Since we do not have data on implementing organisations, our estimations controlling for the programme have to be considered only tentative because listed programme sites may be only a subsample of the villages actually covered by the implementing NGOs.

[16] 'This program implements massive investments in the national rice sector, notably by irrigating and cultivating unused land in the [Senegal River Valley] and intensifying production of rice through double cropping. […] Additional components of the program include: (i) input subsidies; (ii) provision of certified seed; (iii) financing of production and post-harvest machinery; and (iv) creation of a private sector marketing agency responsible for collecting, processing and marketing local rice production' (Colen et al., 2013).

Table 11: Robustness – econometric results for child health (WAZ, HAZ); village-year fixed effects estimations clustered at the village level [a]

			Price	Drought	Concomitance	Obs.
WAZ		Results from Table 8	-0.477** (0.200)	-0.824** (0.374)	-0.469 (0.677)	3,810
	(1)	Controlling for month of survey	-0.420** (0.192)	-0.585* (0.345)	0.670 (0.680)	3,810
	(2)	Controlling for shock intensities	-0.501** (0.201)	-0.841** (0.332)	0.222 (0.530)	3,810
	(3)	Results using SPI3 drought index	-0.451** (0.202)	0.114 (0.255)	2.157*** (0.346)	3,810
	(4)	Controlling for major social groups	-0.489** (0.206)	-0.812** (0.388)	0.380 (0.671)	3,810
	(5)	Controlling for PN-PTFM villages	-0.477** (0.198)	-0.827** (0.374)	0.368 (0.554)	3,810
	(6)	Controlling for PRN sites	-0.482** (0.201)	-0.829** (0.374)	0.474 (0.673)	3,810
	(7)	Controlling for PRN village coverage	-0.485*** (0.200)	-0.862** (0.373)	0.450 (0.671)	3,810
	(8)	Controlling for rice producers	-0.398* (0.214)	-0.826** (0.379)	0.072 (0.661)	3,810
HAZ		Results from Table 9	0.074 (0.175)	-1.026** (0.398)	-0.692 (1.522)	3,603
	(1)	Controlling for month of survey	0.084 (0.177)	-1.084*** (0.408)	-0.667 (1.513)	3,603
	(2)	Controlling for shock intensities	0.065 (0.177)	-1.003** (0.385)	-0.565 (1.437)	3,603
	(3)	Results using SPI3 drought index	0.087 (0.176)	-0.668*** (0.215)	-0.006 (0.444)	3,603
	(4)	Controlling for major social groups	0.015 (0.184)	-1.032** (0.417)	-0.633 (1.531)	3,603
	(5)	Controlling for PN-PTFM villages	0.074 (0.176)	-1.031*** (0.397)	-0.690 (1.521)	3,603
	(6)	Controlling for PRN sites	0.157 (0.175)	-0.836** (0.391)	-0.224 (1.443)	3,603
	(7)	Controlling for PRN village coverage	0.156 (0.175)	-0.853** (0.394)	-0.228 (1.442)	3,603
	(8)	Controlling for rice producers	0.227 (0.181)	-0.789* (0.413)	-0.930 (1.397)	3,603

Note: All shock variables are dummy variables. Additional control variables included are age and gender of child, head of household and mother's age and gender, if mother resides in household, mother's literacy, if mother is related to head of household, number and size of parcels of land cultivated, ownership of poultry, livestock, radio and mobile phone and dummy variables for water and toilet facilities, region dummies. */ **/ *** stand for significance at 10, 5 and 1%, respectively. a Specification (6) is estimated with household fixed effects with standard errors clustered at the household level.

Source: Authors' elaborations.

6.2.4 Food security, agricultural production and income effects

Concomitant price increases and droughts could have been mitigated by a structural improvement in household food security between the two survey rounds: the descriptive statistics in Table 6 and the non-parametric estimates in Table 7 indicate this channel. In Table 12, we report a summary of the main cash and food crops cultivated by the households in the survey and explore the effects of cultivating these crops on child health.

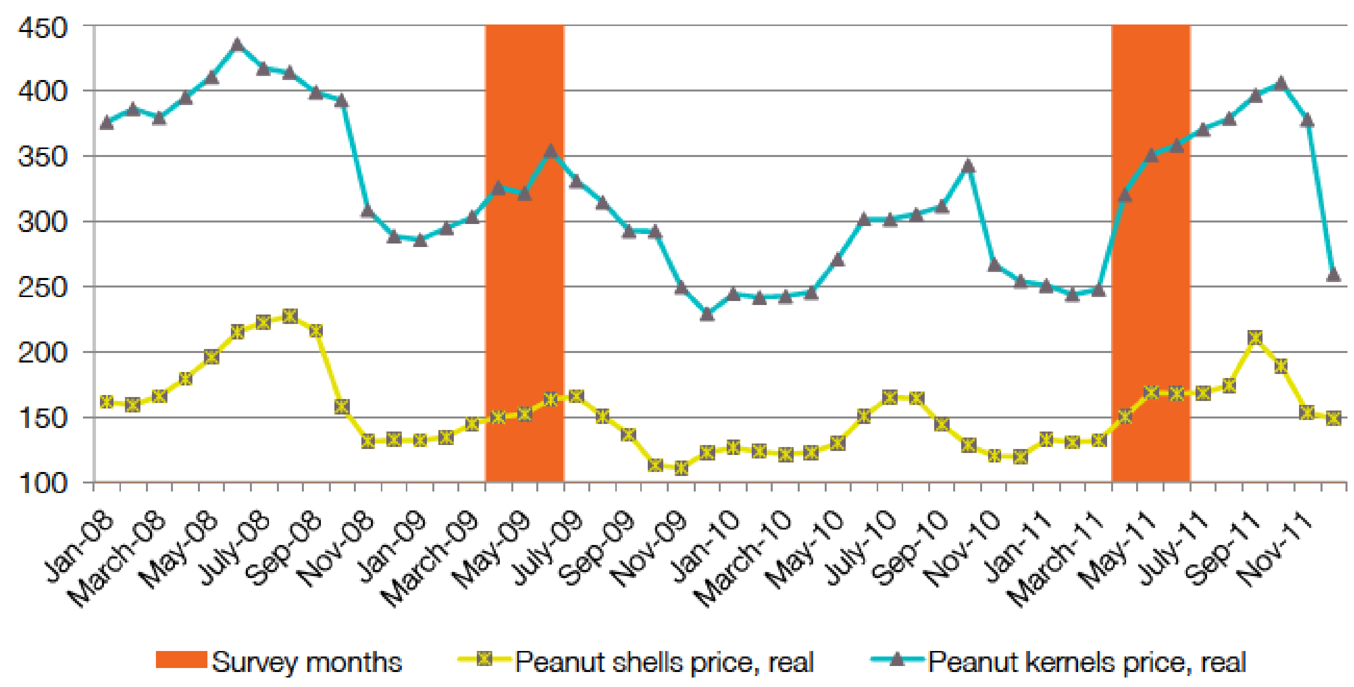
The main cash crop cultivated by surveyed households was peanut, whereas the share of households cultivating fruit and vegetables increased considerably between survey rounds following steadily increasing demand from the European market (Ndiaye, 2007). Some further observations follow. First, we recall that peanut cultivation and harvest took place in the year before the survey (during the period May-November 2008 and 2010) with very favourable rains, therefore household stocks for export should be high (which may cause a downward pressure on prices). Second, we report in Figure 3 the evolution of peanut prices for both shells and kernels: the figure clearly shows a sharp increase in the price of this particular cash crop, especially in the survey periods, which may account for increasing household income. Third, production of fruit and vegetables may instead have been affected by droughts in the survey period since their cultivation occurs throughout the whole year, therefore either households may have not been able to sell these goods on the market or these goods will be sold at a higher prices owing to the low supply.

Table 12: Selected crops cultivated by surveyed households

Crops cultivated	Full child-household sample		Households experiencing	
	2009	2011	2009	2011
Cash crops				
• Peanut	46.57%	89.10%	20.51%	96.25%
• Fruit+vegetables	1.75%	8.00%	0%	6.25%
Food crops				
• Mil	48.62%	85.96%	89.74%	95.00%
• Maize	14.25%	36.20%	0%	15.00%
• Rice	4.21%	4.38%	0%	0%

Source: Authors.

Figure 3: Monthly peanut prices in rural areas of Senegal for the period 2008-2011



Source: AGNSD (2013) and authors' elaborations.

In Table 13, specification (1), we control for peanut farmers. All the three relevant results report lower magnitudes whereas the dummy variable accounting for peanut farmers (not reported) is positive and significantly associated with child weight-for-age. Notably, although insignificant, the triple interaction term has positive sign, corroborating our argument that positive income effects from peanut cultivation may have prevailed for households that experienced concomitant drought and increasing price shocks.

In Table 13, specifications (2), (3) and (4), we control for fruit and vegetables farmers, maize and millet farmers, respectively. Our main results hold but the dummy variables for the cultivation of these crops are all insignificant (with negative sign for vegetables and fruit farmers and positive sign for maize and millet farmers).

Table 13: Robustness – econometric results for child health (WAZ, HAZ); village-year fixed effects estimations clustered at the village level [a]

			Price	Drought	Concomitanc	Obs.
WAZ		Results from Table 8	-0.477**	-0.824**	-0.469	3,810
			(0.200)	(0.374)	(0.677)	
	(1)	Controlling for peanut farmers	-0.394*	-0.818**	0.084	3,352
			(0.218)	(0.377)	(0.096)	
	(2)	Controlling for fruit+veg farmers	-0.422**	-0.587*	0.684	3,810
			(0.191)	(0.345)	(0.676)	
	(3)	Controlling for maize farmers	-0.367*	-0.796**	0.064	3,351
			(0.126)	(0.376)	(0.672)	
	(4)	Controlling for millet farmers	-0.396*	-0.818**	0.077	3,352
			(0.217)	(0.380)	(0.674)	
			(0.200)	(0.373)	(0.671)	
	(5)	Household fixed effects [a]	-0.532*	-0.870	0.130	3,810
			(0.283)	(0.554)	(1.254)	
HAZ		Results from Table 9	0.074	-1.026**	-0.692	3,603
			(0.175)	(0.398)	(1.522)	
	(1)	Controlling for peanut farmers	0.140	-1.041**	-1.463	3,161
			(0.184)	(0.439)	(1.513)	
	(2)	Controlling for fruit+veg farmers	0.153	-1.077**	-1.484	3,152
			(0.186)	(0.445)	(1.496)	
	(3)	Controlling for maize farmers	0.118	-1.070**	-1.462	3,160
			(0.184)	(0.440)	(1.511)	
	(4)	Controlling for millet farmers	0.131	-1.038**	-1.503	3,161
			(0.183)	(0.103)	(1.520)	
	(5)	Household fixed effects [a]	-0.034	-1.138	-1.556	3,603
			(0.363)	(0.766)	(1.898)	

Note: All shock variables are dummy variables. Additional control variables included are age and gender of child, head of household and mother's age and gender, if mother resides in household, mother's literacy, if mother is related to head of household, number and size of parcels of land cultivated, ownership of poultry, livestock, radio and mobile phone, dummy variables for water and toilet facilities and region dummies. */ **/ *** stand for significance at 10, 5 and 1%, respectively. a Specification (4) is estimated with household fixed effects with standard errors clustered at the household level.

Source: Authors' elaborations.

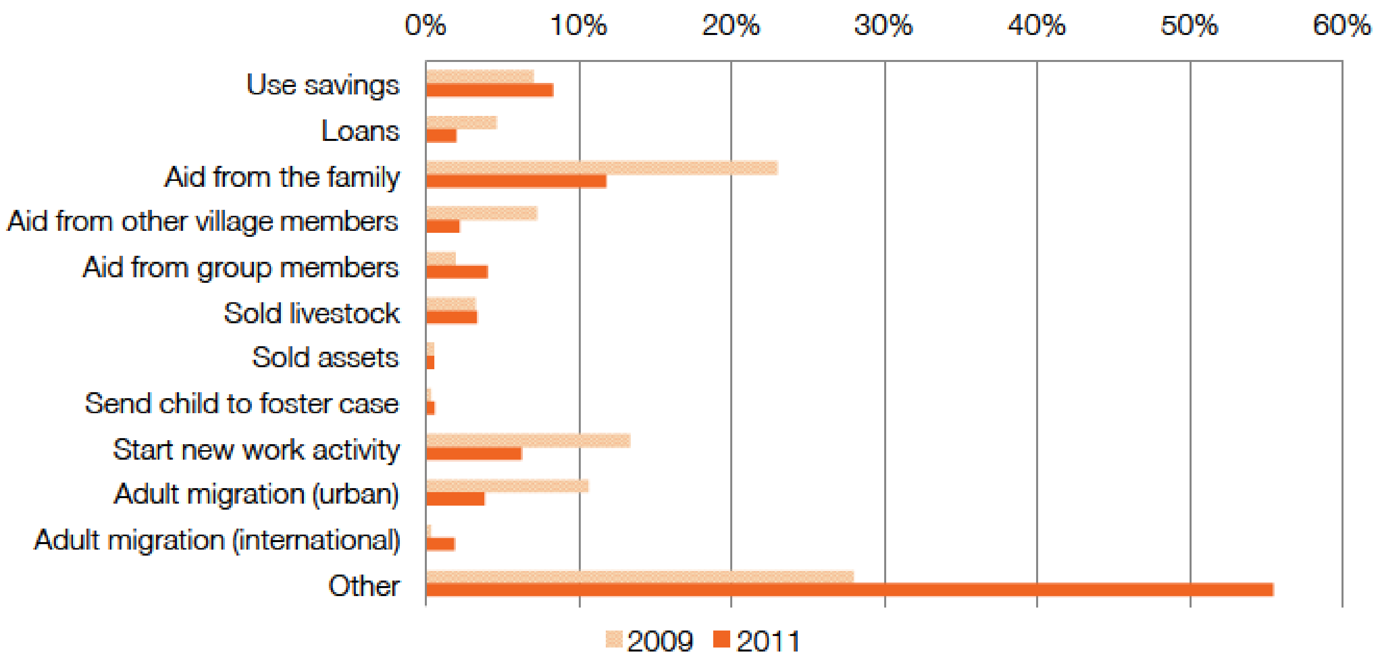
6.2.5 Intra-locality effects

Finally, households can be heterogeneous even in the context of poor rural households, therefore our assumption that households located in the same areas have similar characteristics, risks and food security profiles may be problematic. As a test for this assumption, we provide in Table 13, specification 5, household fixed effects estimations with standard errors clustered at the household level to precisely account for possible intra-locality inequalities, for example in terms of access to resources. Household fixed effects control for unobservable time-invariant household characteristics, potentially correlated with price and drought shocks that affect child health, while accounting for baseline household characteristics. Results show the 2011 increase in purchase prices is still associated with a significant decline in child weight-for-age and no significant effects on child height-for-age. On the other hand, the drought interaction estimates do no longer show significant effects on child health. Note also coping strategies can be different between households belonging to the same villages. All the more so, these coping mechanisms vary according to the fact that households have to deal with idiosyncratic or covariate shocks. In Figure 4, we explore reported household coping strategies in the sample at hand. We observe that households have mainly engaged in two strategies: 'assistance from the family' (23% and 12% in 2009 and 2011, respectively) and 'other' (28% and 55% in 2009 and 2011, respectively). This latter undefined category may account for additional household-specific unobserved heterogeneous responses to shocks and preferences for child health. Unfortunately, we could not trace what the 'other' category represents.[17]

Following Wagstaff and Lindelow (2013), the Appendix details a test of the level of 'idiosyncrasy' of the shocks considered. According to the authors, '"Idiosyncrasy" captures the degree to which the risk of the shock varies across households at the village level' and can be measured 'by the R^2 from a linear-probability regression of the shocks on a vector of village dummies' (Wagstaff and Lindelow, 2013: 709). Exploiting a cross-section of 600 households in Laos, the authors find about 40% of the inter-household variation in the reported incidence of declined selling prices and pest infestations depended on village fixed effects. On the other hand, only 5% of intra-household variation was explained by health and crime shocks, thus the authors conclude health shocks are more idiosyncratic than agricultural and economic shocks in the context analysed. We conducted the same test including the year dummy. The village fixed effects and year dummy explain up to 17% of the inter-household variation in drought experience, suggesting droughts were a relatively household-specific shock in the sample at hand. As aforementioned in the case of droughts, this may stem from the shock calendar considered in our analysis, which focuses on a period that is not the key drought period for primary cash and food crops in Senegal.

[17] We consulted local researchers and enumerators in charge of data collection but received no clear information.

Figure 4: Household coping strategies in the survey rounds



Source: Authors' elaborations.

7. Key policy messages

Interventions for strengthening the resilience of families and individuals will be more effective if informed by knowledge of the pathways through which shocks affect rural household welfare. This study suggests the following key policy messages:

First, children and especially boys are highly vulnerable to shocks and thus need special attention. Moreover, as the negative association between shocks and child health was significant only for children without educated mothers, investments to increase education of the mothers should be promoted.

Second, improved management of climate and global market risks will strengthen the success of social policy programmes for better child nutrition and higher household agricultural production, and large-scale programmes to reduce food import dependency. Policies for improving child health often overlook climate risks and, more generally, how nutrition interventions are vulnerable to, and confer resilience to, shocks. Data availability on programme design, implementation and evolutions is crucial for a thorough and reliable evaluation of impacts.

Third, stability of external demand for cash crops will be crucial for the sustainability of cash crop income as a strategy to offset adverse effects of shocks. For example, in the case of peanut production in Senegal for the export market, recent developments show a steadily increasing demand from China, Lebanon and other foreign buyers. This makes peanuts the new 'gold' for Senegal (Cissé, 2014; Rokhy, 2013). If external demand keeps increasing, the cultivation of peanuts may boost the economy of Senegal.

There have been many studies that show to what extent high food prices can indeed have positive effects for smallholders who sell their products on the market (but equally harm poor consumers). Cavero and Galián (2008) suggest an additional range of factors need to be in place for increasing prices to have positive effects:

- Access to markets: Often, small farmers have difficulties in accessing the markets owing to physical constraints (lack of infrastructure connecting villages to main domestic and global markets) and constraints on the availability of financial assets and services (high transaction costs).
- Access to inputs: If the price of critical farming inputs such as fertilisers and pesticides increases more than producer prices, the potentially positive effect of rising food prices may be offset.
- Size of landholdings: Generally, farming is conducted on a small scale, therefore it is difficult for farmers to access credit because of lack of collateral. This points to the need for secure access to land and for extension services.
- Government investments and interventions in the agriculture sector have to be appropriately directed to avoid potential unwanted effects (e.g. a reduction in taxes on staple food may sharply reduce fiscal revenues, preventing the government supporting structural investments).

Research questions or knowledge gaps that the PRISE consortium could consider may be:

- Strategic analysis of recent patterns of sustainable socioeconomic development in Senegal: how the income from cash crops sales has been allocated between consumption and saving/investment;
- Assessment of long-term effects of price dynamics on households welfare;
- What has been done and will be done to enhance Senegalese household resilience to climate short-term variability and long-term changes;

Based on data availability, the effects of the 2011 international food price spike and government food price controls on urban households.

8. Conclusions

The results of our multiple shock analysis for the case of rural Senegal suggest shocks from the natural, biological, economic and health sphere can considerably reduce the wellbeing of children. Moreover, the impact of adverse events on child health critically depends on the type and concurrence of the shocks. Therefore, multi-shock analyses are needed to better understand the effects of shocks, while several pathways of effects have to be explored to understand differential effects across households and individuals and elaborate more appropriate policy interventions.

We exploited interaction and triple interaction empirical estimation strategies to explore the effects of non-concomitant and concomitant increases in purchase prices and drought shocks. We show that, on average, increasing purchase prices and droughts were negatively associated with child weight-for-age (the interaction coefficients are negative and significant). Thus, the fundamental improvements in child health between survey rounds were not sufficient to ensure child health if the respective household experienced non-concomitant higher purchase prices or droughts. However, these negative effects seem to vanish for the particular set of households that experienced both shocks concomitantly, the net effect on child health being insignificant. Given that the bulk of the households experiencing both shocks concomitantly were mainly producing peanut as a cash crop and that retail peanut prices increased in the period considered, we argue that income effects from higher cash crop prices dominated concomitant drought and price shocks, thus ensuring shocks negatively affective neither short- nor long-term child health. Moreover, exploration of differential effects emphasises the higher vulnerability of boys and the importance of maternal education for child health preservation during hard times.

To conclude, children are the most vulnerable constituents of society while at the same time being the gateways for future household and community welfare. As our analysis shows, growing up in poor shock-prone environments does not necessarily preclude child opportunities to develop. At the same time, leaving non-concomitant/concomitant shock effects unmanaged could result in a variety of positive and negative effects. Indeed, although the analysis suggested positive income effects from concomitant price and drought shocks for children in households cultivating peanuts, long-term effects have still to be further explored, and nothing can be said about the effects of these shocks in urban areas, where mainly net consumers reside. Ultimately, the effects on urban children and households are expected to be very different. Hence, from the perspective of the policymaker, the various channels of effects have to be considered in short-term intervention decisions and long-term programmes aiming at structural change. This will minimise the vulnerability of households and individuals already before shocks occur, while maximising resilience *ex-post*.

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Appendix

Tables A1-A5

Appendix

Table A1: Test for differences in means for the sample of children (12-60 months) and the study sample (661 children with repeated observations), 2009

Variable	Full child dataset		Children sample		Difference
	Mean	St. Dev	Mean	St. Dev	
Weight-for-age°	-1.450	1.810	-1.030	1.663	-0.420***
Height-for-age°	-1.202	2.223	-1.142	2.409	-0.060
Sex	0.473	0.499	0.486	0.500	-0.013
Age (months)	37.012	16.989	23.002	9.703	14.010***
Age head of household	52.223	14.442	52.005	14.469	0.218
Sex head of household[a] (female=1)	0.026	0.161	0.026	0.158	0.000
Mother is out of household (=1)	0.060	0.238	0.033	0.180	0.027***
Age mother	29.318	7.692	28.458	7.166	0.860***
Mother can read and write (=1)	0.141	0.349	0.156	0.363	-0.015
Mother is head of household (=1)	0.006	0.079	0.005	0.067	0.001
Mother is wife of head of household (=1)	0.538	0.499	0.551	0.498	-0.013
Mother is daughter of head of household (=1)	0.032	0.175	0.042	0.202	-0.010
Mother is not a relative	0.027	0.162	0.014	0.116	0.013**
Household size	13.938	6.281	13.371	6.294	0.567**
Share of children <5 in household	0.252	0.106	0.252	0.102	0.000
Poultry	0.559	0.497	0.575	0.495	-0.016
Livestock	0.937	0.242	0.936	0.244	-0.001
Water					
• (1) own tap	0.211	0.408	0.160	0.367	0.051***
• (2) public tap	0.272	0.445	0.287	0.453	-0.015
• (3) protected well	0.084	0.278	0.076	0.265	0.008
• (4) neighbour's tap	0.011	0.105	0.008	0.087	0.003
• (5) non-protected well	0.299	0.458	0.346	0.476	-0.047**
• (6) hole	0.074	0.261	0.080	0.272	-0.006
• (7) other	0.049	0.216	0.042	0.202	0.007
Toilet					
• (1) none or external	0.203	0.402	0.210	0.408	-0.007
• (2) water sewer	0.008	0.090	0.005	0.067	0.003
• (3) septic tank	0.027	0.163	0.036	0.187	-0.009
• (4) covered latrine	0.391	0.488	0.337	0.473	0.054***
• (5) uncovered latrine	0.271	0.445	0.333	0.472	-0.062***
• (6) other	0.099	0.299	0.079	0.269	0.020

Variable	Full child dataset		Children sample		Difference
	Mean	St. Dev	Mean	St. Dev	
Own mobile (=1)	0.657	0.475	0.628	0.484	0.029
Own radio (=1)	0.725	0.447	0.722	0.449	0.003
No. parcels cultivated	3.004	1.647	3.010	1.655	-0.006
Size of land cultivated (ha)	6.879	5.916	6.767	5.886	0.112
Region 1 – Diourbel	0.107	0.309	0.106	0.308	0.001
Region 2 – Fatick	0.084	0.277	0.094	0.292	-0.010
Region 3 – Kaolack	0.176	0.381	0.177	0.382	-0.001
Region 4 – Kedougou	0.010	0.098	0.012	0.109	-0.002
Region 5 – Kolda	0.081	0.272	0.050	0.218	0.031***
Region 6 – Louga	0.094	0.292	0.070	0.255	0.024**
Region 7 – Tambacounda	0.200	0.400	0.268	0.443	-0.068***
Region 8 – Thies	0.248	0.432	0.224	0.417	0.024
Number of observations	3,209		661		

Note: ° For the full child dataset, the number of observations for WAZ and HAZ are 1,694 and 1,603, respectively. */**/*** stand for level of significance at 10, 5 and 1%, respectively.

Source: Authors' elaborations.

Table A2: Test for differences in means for the sample of children (12-60 months) and the children with anthropometric measures, 2009

Variable	Full child dataset		Children with WAZ		Difference
	Mean	St. Dev	Mean	St. Dev	
Sex	0.473	0.499	0.453	0.498	0.020
Age (months)	37.012	16.989	29.975	12.815	7.037***
Age head of household	52.223	14.442	52.426	14.603	-0.203
Sex head of household[a] (female=1)	0.026	0.161	0.023	0.150	0.003
Mother is out of household (=1)	0.060	0.238	0.053	0.223	0.007
Age Mother	29.318	7.692	28.894	7.536	0.424*
Mother can read and write (=1)	0.141	0.349	0.148	0.355	-0.007
Mother is head of household (=1)	0.006	0.079	0.005	0.073	0.001
Mother is wife of head of household (=1)	0.538	0.499	0.522	0.500	0.016
Mother is daughter of head of household (=1)	0.032	0.175	0.035	0.185	-0.003
Mother is not a relative	0.027	0.162	0.025	0.156	0.002
Household size	13.938	6.281	13.957	6.345	-0.019
Share of children <5 in household	0.252	0.106	0.253	0.105	-0.001
Poultry	0.559	0.497	0.570	0.495	-0.011
Livestock	0.937	0.242	0.943	0.231	-0.006
Water					
• (1) own tap	0.211	0.408	0.209	0.407	0.002
• (2) public tap	0.272	0.445	0.275	0.447	-0.003
• (3) protected well	0.084	0.278	0.088	0.283	-0.004
• (4) neighbour's tap	0.011	0.105	0.012	0.108	-0.001
• (5) non-protected well	0.299	0.458	0.299	0.458	0.000
• (6) hole	0.074	0.261	0.073	0.260	0.001
• (7) other	0.049	0.216	0.045	0.207	0.004
Toilet					
• (1) none or external	0.203	0.402	0.207	0.405	-0.004
• (2) water sewer	0.008	0.090	0.010	0.100	-0.002
• (3) septic tank	0.027	0.163	0.032	0.176	-0.005
• (4) covered latrine	0.391	0.488	0.381	0.486	0.010
• (5) uncovered latrine	0.271	0.445	0.283	0.450	-0.012
• (6) other	0.099	0.299	0.087	0.282	0.012
Own mobile (=1)	0.657	0.475	0.668	0.471	-0.011
Own radio (=1)	0.725	0.447	0.739	0.439	-0.014
No. parcels cultivated	3.004	1.647	3.032	1.667	-0.028
Size of land cultivated (ha)	6.879	5.916	6.729	5.958	0.150
Region 1 – Diourbel	0.107	0.309	0.112	0.316	-0.005
Region 2 – Fatick	0.084	0.277	0.096	0.295	-0.012

Variable	Full child dataset		Children with WAZ		Difference
	Mean	St. Dev	Mean	St. Dev	
Region 3 – Kaolack	0.176	0.381	0.164	0.370	0.012
Region 4 – Kedougou	0.010	0.098	0.011	0.103	-0.001
Region 5 – Kolda	0.081	0.272	0.073	0.260	0.008
Region 6 – Louga	0.094	0.292	0.074	0.262	0.020**
Region 7 – Tambacounda	0.200	0.400	0.217	0.412	-0.017
Region 8 – Thies	0.248	0.432	0.254	0.436	-0.006
Number of observations	3,209		1,694		

Note: *, **, *** Level of significance at 10, 5 and 1%, respectively.

Source: Authors' elaborations.

Table A3: Probit results for the determinants of reported increasing price shock, st.err. clustered at the village level

	Dependent variable: increasing purchase price shock binary variable							
	(1)		(2)		(3)		(4)	
Age head of HH	0.000	(0.002)	-0.001	0.002	-0.002	(0.002)	-0.001	(0.003)
Sex head of HH[a] (female=1)	-0.013	(0.137)	0.150	0.140	-0.022	(0.214)	0.111	(0.260)
Household size	-0.007	(0.004)	-0.004	0.005	-0.001	(0.006)	0.000	(0.008)
Share of children <5 in HH	0.447**	(0.185)	0.304	0.198	0.554	(0.342)	0.566	(0.386)
Poultry	-0.064	(0.052)	-0.110*	0.057	-0.128*	(0.075)	-0.192**	(0.090)
Livestock	0.090	(0.112)	0.076	0.119	0.386***	(0.134)	0.384**	(0.161)
Water								
• (1) own tap	0.095	(0.152)	0.222	0.220	-0.071	(0.213)	0.243	(0.348)
• (2) public tap	0.007	(0.149)	0.060	0.213	-0.223	(0.192)	-0.150	(0.328)
• (3) protected well	0.321*	(0.186)	0.344	0.229	0.143	(0.241)	0.146	(0.376)
• (4) neighbour's tap	0.204	(0.228)	0.367	0.268	-0.037	(0.336)	0.346	(0.472)
• (5) non-protected well	0.204	(0.139)	0.173	0.198	-0.034	(0.192)	-0.083	(0.345)
• (6) hole	0.039	(0.172)	0.098	0.236	-0.387*	(0.235)	-0.334	(0.375)
Toilet								
• (1) none or external	0.010	(0.093)	0.043	0.105	0.037	(0.135)	0.119	(0.164)
• (2) water sewer	-0.026	(0.330)	0.021	0.379	-0.636	(0.362)	-0.670	(0.427)
• (3) septic tank	0.523***	(0.133)	0.440***	0.159	0.357*	(0.195)	0.280	(0.251)
• (4) covered latrine	0.268***	(0.089)	0.348***	0.104	0.274**	(0.129)	0.326**	(0.152)
• (5) uncovered latrine	0.029	(0.095)	0.066	0.110	0.138	(0.121)	0.044	(0.144)
Own mobile (=1)	0.080	(0.059)	0.013	0.065	0.023	(0.087)	-0.042	(0.099)
Own radio (=1)	0.026	(0.062)	0.013	0.070	0.003	(0.088)	-0.015	(0.104)
No. parcels cultivated	-0.043**	(0.021)	-0.072***	0.023	-0.094	(0.028)	-0.137***	(0.032)
Size of land cultivated (ha)	0.000	(0.005)	-0.002	0.005	0.004	(0.007)	0.003	(0.009)
yr2 (2011=1)	1.035***	(0.086)	1.218***	0.310	1.166***	(0.100)	1.449***	(0.348)
Drought	0.115	(0.181)	0.260	0.171	0.223	(0.232)	0.202	(0.245)
Frost	0.641***	(0.147)	0.590**	0.234	0.788***	(0.221)	0.699**	(0.358)
Crop pest	0.842***	(0.151)	0.693***	0.166	0.612**	(0.283)	0.647**	(0.317)
Decrease selling prices	1.532***	(0.143)	1.848***	0.175	1.653***	(0.256)	2.324***	(0.420)
Loss of employment	0.842***	(0.184)	0.544***	0.206	0.841***	(0.312)	0.490	(0.376)
Death of HH member	0.229*	(0.123)	0.279**	0.131	0.105	(0.170)	0.177	(0.197)

	Dependent variable: increasing purchase price shock binary variable			
	(1)	(2)	(3)	(4)
Region dummies	YES	YES	YES	YES
Village-year dummies	NO	YES	NO	YES
Sample	Household	Household	Child	Child
Observations	3,670	3,656	3,810	3,755
Number of clusters (villages)	165	164	165	159

Note: Standard errors in parenthesis. */ **/ *** stand for level of significance at 10, 5 and 1%, respectively.

Source: Authors' elaborations.

Table A4: Econometric results for child weight-for-age and height-for-age; village-year fixed effects estimations clustered at the village level

	WAZ – 8		HAZ – 8	
Sex (1=female)	0.181***	(0.060)	0.143*	(0.073)
Age (months)	-0.034***	(0.002)	-0.022***	(0.003)
No complete date	-0.095	(0.085)	0.066	(0.093)
Head of household age	0.004	(0.003)	-0.006**	(0.003)
Head of household sex	-0.485*	(0.283)	-0.119	(0.278)
Mother is out of household	-0.217	(0.161)	0.127	(0.199)
Age mother	0.007	(0.005)	0.008	(0.006)
Mother is able to read/write	0.188**	(0.094)	0.321***	(0.093)
Mother is head of household	0.313	(0.503)	0.167	(0.535)
Mother is wife of head of household	0.051	(0.075)	-0.066	(0.105)
Mother is daughter of head of household	0.014	(0.201)	0.165	(0.185)
Mother is not a relative head of household	0.313	(0.503)	0.324	(0.262)
No. household members	0.007	(0.007)	0.001	(0.007)
Share children <5 years	-0.511	(0.381)	1.090**	(0.433)
1.1.1.1.1.1.1.1 Household own poultry	0.101	(0.078)	0.046	(0.100)
1.1.1.1.1.1.1.2 Household own livestock	-0.154	(0.151)	0.218	(0.179)
Water: own tap (=1)	0.166	(0.264)	-0.201	(0.280)
Water: public tap (=1)	0.010	(0.278)	-0.376	(0.251)
Water: protected well (=1)	0.065	(0.262)	-0.343	(0.285)
Water: neighbour's tap (=1)	0.080	(0.439)	0.309	(0.516)
Water: non-protected well (=1)	-0.059	(0.268)	-0.289	(0.261)
Water: hole (=1)	-0.463*	(0.278)	-0.340	(0.267)
Toilet: none/external (=1)	0.307**	(0.140)	0.268*	(0.139)
Toilet: water sewer (=1)	-0.330	(0.360)	0.120	(0.554)
Toilet: septic tank (=1)	-0.375*	(0.211)	-0.014	(0.201)
Toilet: covered latrine (=1)	0.355***	(0.122)	0.196	(0.134)
Toilet: uncovered latrine (=1)	0.046	(0.124)	0.257*	(0.138)
1.1.1.1.1.1.1.3 Household own mobile	0.217**	(0.087)	-0.073	(0.109)
1.1.1.1.1.1.1.4 Household own radio	-0.045	(0.093)	0.153*	(0.090)
No. parcel of land	0.029	(0.032)	-0.042	(0.031)
Size of land cultivated	-0.008	(0.008)	0.003	(0.007)
Drought	-0.542***	(0.192)	-0.373**	(0.170)
Extreme cold	0.347	(0.250)	-0.322	(0.258)
Crop pest	0.102	(0.175)	-0.146	(0.207)
Increase purchase prices	0.044	(0.091)	0.410***	(0.091)
Decrease sales prices	0.012	(0.198)	-0.573**	(0.266)
Loss of employment	-0.442	(0.271)	0.572**	(0.225)

	WAZ – 8		HAZ – 8	
Death of a household member	0.253**	(0.127)	0.109	(0.152)
Constant	-0.738*	(0.399)	-0.694	(0.429)
Village-year dummies (not reported)		YES		YES
Observations		3,810		3,603
R-squared		0.214		0.154
Number of clusters (villages)		165		165

Note: All shock variables are dummy variables. Additional control variables included are age and gender of child, head of household and mother's age and gender, if mother resides in household, mother's literacy, if mother is related to head of the household, number and size of parcels of land cultivated, ownership of poultry, livestock, radio and mobile phone and dummy variables for water and toilet facilities. Standard errors in parenthesis. */ **/ *** stand for significance at 10, 5 and 1%, respectively. Full results for specification 8 in Tables 8 and 9.

Source: Authors' elaborations.

Table A5: Idiosyncrasy of shocks [a]

Shocks	Idiosyncrasy [a]
Economic shocks	
• Increase in purchase prices	0.215
• Decline in sales prices	0.174
• Loss of employment	0.153
Natural hazard	
• Drought	0.170
• Cold wave	0.135
Biological hazard	
• Crop pest/insects invasion	0.065
Health shocks	
• Death of a member	0.055
Observations (household)	3,670

Note: [a] Following Wagstaff and Lindelow (2013: 709), 'idiosyncrasy captures the degree to which the risk of the shock varies across household at the village level. It is measured here by the R^2 from a linear probability regression of the shock on a vector of village dummies. High values of the R^2 indicate that where the household lives explains a high fraction of the intrahousehold variation in the risk of the shock.' We also control for survey year and calculate robust standard errors.

Source: Authors' elaborations.

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