Working Paper No. 2012/89

Effects of Food Price Shocks on Child Malnutrition: The Mozambican Experience 2008/09

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October 2012

Abstract

A propitiously timed household survey carried out in Mozambique over the period 2008-09 permits us to evaluate the short-to-medium run relationship between sudden shocks to food prices and child nutrition status. We link local price inflation with child malnutrition status. We find that the prevalence of underweight amongst children rises in response to a higher inflation rate for basic food products. Stunting and wasting malnutrition measures are mostly insensitive to the inflation rate. The very high food inflation during 2008/09 was responsible for an extra 39,000 moderately underweight and 24,000 severely underweight children.

Keywords: food prices, inflation, child malnutrition, Mozambique, short to medium-run relationship
JEL classification: C51, D12, I32, O12.

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This study has been prepared within the UNU-WIDER project 'Reconciling Africa's Growth, Poverty and Inequality Trends', directed by James Thurlow and Finn Tarp.

UNU-WIDER gratefully acknowledges the financial contributions to the research programme from the governments of Denmark, Finland, Sweden, and the United Kingdom

ISSN 1798-7237 ISBN 978-92-9230-553-6

Acknowledgements

We thank Olivier Ecker, Jörgen Levin and Vincenzo Salvucci for insightful comments and suggestions. The usual disclaimers apply.

Tables and figures appear at the end of the paper.

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1 Introduction

In 2008, countries around the globe experienced a dramatic food and oil price shock. From January 2007 to June 2008 deflated world food prices[1] increased by more than 60 per cent (cf. FAO 2012) while the world price of oil increased by about 125 per cent over the same period. The full implications of the 2008 food and fuel price crisis are yet to be understood and remain an important topic of research (e.g. Ortiz et al. 2011; Abbott and de Battisti 2011; Headey 2011; Headey et al. 2012; Verpoorten et al. 2012). The nutritional consequences, in particular amongst children, are a primary concern (e.g. Lock et al. 2009; Keats and Wiggins 2010; Tiwari and Zaman 2010; Ruel et al. 2010; Christian 2010; Brinkman et al. 2010).

This paper relates to the rate of inflation in basic food products consumed by poor households in Mozambique to changes in the nutritional status of children. We are able to conduct this analysis due to a household budget survey which contained an anthropometrics module that, coincidentally, took place over the period September 2008 to August 2009. This period follows hot on the heels of the peak of the world price spike for food and fuel which occurred in June 2008. The data from the household survey is supplemented by regularly collected price data from the ministry of agriculture. Combining these data sets allow us to assess annual price inflation from month to month. Consistent with normal seasonal patterns, the prices of basic food products in Mozambique actually peaked in February 2009 (around seven months after the world food price index). Due to high world food prices, combined with a production shortfall from the principal harvest in May/June, the seasonal price peak attained was much higher than usual.

The unfolding nutritional consequences of price shocks, in particular in the short to medium run, remain largely under-investigated due, in significant measure, to lack of data (Torlesse et al. 2003). A number of papers have examined the impact of regional or national food price crises on child nutritional status in the affected areas, for example due to drought or general economic turndown (see the next section for further references). However, most of this work has relied on yearly observations of child nutritional status over a certain period and other low-frequency data, or has compared the nutritional outcomes before and under (or after) some crisis for representative samples or cohorts.

From logit regression analysis, we find that the prevalence of underweight among children aged 0-4 is significantly higher the higher is the inflation rate, measured from the corresponding month of the previous year, of basic food products. Stunting and wasting malnutrition measures are almost entirely insensitive to the inflation rate during the investigated twelve month period. We use the estimated parameters to simulate the total effect of the very high food inflation during 2008/09 on underweight. We conclude that it may be responsible for an extra 39,000 moderately underweight and 24,000 severely underweight children.

The remainder of this paper is structured as follows. Section 2 reviews literature. Section 3 describes the data employed for the analysis. Section 4 provides descriptive statistics. Section 5 presents the approach employed and the results. Section 6 concludes that strong price

[1] FAO Food Price Index.

increases appear to have negatively impacted the nutritional status of children in Mozambique.

2 Literature

Studies examining the impact of a crisis on some type of child nutritional outcomes are plentiful, although somewhat dispersed, in the literature. With respect to prices, Torlesse et al. (2003) use yearly data collected in the period 1992-2002 to examine how changes in rice prices affect child underweight in Bangladesh. They find that rice expenditure/prices are strongly correlated with underweight (corr. coef. = 0.91, $p = 0.001$), although they consider only aggregated data. A number of other contributions study the impact of a crisis using micro data. For example, Block et al. (2004) assesses the nutritional impact of Indonesia's drought and financial crisis of 1997/98, Yamano et al. (2005) examines the effect of a shock (drought) and food aid on child growth in Ethiopia for the period 1995-96, and Hoddinott and Kinsey (2001) investigate the impact of drought on child growth in Zimbabwe, using panel data for the period 1993-97.

More recently, Stillman and Thomas (2008) examine the impact of the decline in economic activity in Russia between 1996 and 1998 on six dimensions of nutritional status. Miller and Urdinola (2010) investigate how child mortality in Columbia responds to fluctuations in world Arabica coffee prices (where a countercyclical relationship can be expected) and document starkly pro-cyclical child deaths. As in Stillman and Thomas (2008), the analysis is based on yearly data, hence focusing on medium to long run effects. Also, Hartwig and Grimm (2012) analyze the food crisis in 2002 in Malawi relying on representative data collected before and after the crisis.

At the time of the global food and fuel price crisis, various efforts were made to consider the implications of the crisis for the welfare of countries, regions, and households. For example, Ivanic and Martin (2008) examined the implications of the food price crisis for ten countries. They found highly heterogeneous effects driven principally by the net buyer or net seller position of the household. Overall, they found that, across the ten countries considered, 'the adverse welfare impact on net buyers outweighs the benefits to net sellers resulting in an increase in the number of poor and in the depth of poverty' (p. 1). Similarly, Arndt et al. (2008) focus on Mozambique and find negative implications for poverty using an economy-wide simulation model linked to a poverty module. This result was driven principally by fuel price increases although higher food prices also contributed to increases in poverty, particularly in urban areas.

With the passage of time, attention has shifted from simulating the impacts of the food and fuel price crisis on living standards in poor countries, to analyzing the implications of the crisis in retrospective. Unfortunately, relatively few data sets are well suited to the task. For El Salvador, de Brauw (2011) finds a decrease in height for age of children under three which he attributes to the rise in food prices of 2008. He also finds that children in families with access to remittances or international migrants experienced lower declines in height for age. Arndt et al. (2012) consider the implications of the food and fuel price crisis for consumption poverty rates. They use a dynamic economy-wide model, linked to a poverty module, to track macroeconomic aggregates and world prices over the period 2003-09. With this approach, they are able to track measured poverty rates from 2008/09. They find that stagnation in consumption poverty rates in Mozambique were principally due to the near continuous increases in fuel prices over 2003-09 and to the combination of slow agricultural productivity growth particularly for food crops, a negative weather shock affecting the harvest in May/June 2008, and high world prices for food.

As noted by Ivanic and Martin (2008), the net buyer/seller position of the household determines the first order impact of food price changes on household welfare. In macroeconomic terms, Mozambique is a net food importer. Arndt et al. (2008) investigated the net buyer/seller position of households using detailed data available for 2003. This analysis showed that about 26 per cent of rural households and 76 per cent of urban households are net food buyers even after a good harvest. In addition, for most rural households, the net sale is very small; and rural households typically rely on own production for the large majority of their food consumption. As indicated, 2008 was not a good harvest with calorie availability from food production dropping by more than six per cent per rural inhabitant nationwide (GoM 2010) compared with 2002. Further, while prices for food generally rose alongside international prices, Arndt et al. (2012) show that prices at the local level also reflect local supply and demand conditions with relatively high prices reflecting particularly tight supply conditions. The present paper considers whether the combination of a negative supply shock and world price shock increased malnutrition rates, with a particular focus on local food price inflation.

3 Data for Mozambique

Malnutrition information from the latest household budget survey IOF 2008/09 (INE, 2012) and agricultural food prices from the Agricultural Markets Information System (SIMA) are applied. The IOF survey contains detailed information on expenditure and consumption of food items for a stratified random sample of 10,832 households. It also contains anthropometric information for 6,510 children under five from these households. The IOF sample is representative for the whole of Mozambique as well as for the rural and urban zones and each of the ten provinces plus Maputo City. It is also representative through time. The survey began in September 2008 and ended in August 2009. The sample is representative for each of the four quarters of the IOF survey. SIMA price information is collected continuously by the Ministry of Agriculture, with a focus on important food products, in 25 urban markets in towns and cities in all provinces of Mozambique, except Maputo Province.

3.1 Food price inflation

Based on the SIMA prices, we develop a price index with food item shares equal to the budget shares of the poor in 2002/03 and 2008/09 (average budget shares of the poor for the two surveys). A detailed description of the procedure is presented in GoM (2010: Appendix 10.4). In the following, we develop a monthly price index of each province's towns and cities. Based on this, we can calculate inflation rates by month and by province. We calculate the annual inflation rate (price index ratios) from month *m* in year *t-1* to month *m* in year *t* as:

$\pi^A_{m,t} = \frac{P_{m,t}}{P_{m,t-1}}$, where $P_{m,t}$ is the price index in month m year t.

(We also calculate the inflation rate from one month to the next: $\pi^M_{m,t} = \frac{P_{m,t}}{P_{m-1,t}}$

based on actual price indices as well as on seasonally adjusted price indices, but only refer to it in the sensitivity analysis).

There are some gaps in the price time series for some provinces for the time period in question. Those gaps are filled by using inflation from predicted price indices from regressions of provincial price indices against regional price indices, the regions being the North, Centre and the South. City inflation rates are missing for eight months in Sofala and seven months in Inhambane. Town inflation rates are missing for five months in Cabo Delgado and 12 months in Manica. As indicated, there are no recorded food prices for Maputo Province and this province is therefore excluded from the analysis. In total, 14 per cent of the inflation rates are initially missing. The final set of applied inflation rates are the actual ones plus, for the remaining missing inflation rates, we use the predicted inflation rates. Further details on imputation of inflation rates can be found in the Appendix.

Annual inflation using quarterly price information will be the main applied inflation measure throughout. It is defined as the geometric average $\pi_{m,t}^{Q}$, of the inflation rate in the present month, $\pi_{m,t}^{A}$, and the two preceding months, $\pi_{m,t-1}^{A}$ and $\pi_{m,t-2}^{A}$.[2]

These measures have the advantage of being relative to the prices that occurred during the preceding year, which was not strongly marked by special events and thus forms a reasonable anchor for price expectations of households. The choice of the quarterly measure has the advantage of using a fairly large sample of prices in order to develop the inflation index, and of being consistent with the survey design for four quarters.

3.2 Child nutritional status

We assess the nutritional status of children by combining their age, weight and height to calculate the following standard ratios: weight/age (underweight), height/age (stunting) and weight/height (wasting). These ratios are compared to the WHO's reference population that represents the expected distribution of the growth of children aged 0-4 (WHO 2006a, 2006b; WHO and UNICEF 2009). The degree of malnutrition is measured by the so-called Z score, defined as the ratio minus the reference ratio divided by the standard deviation of the reference ratio. Values of the Z score which are less than or equal to minus two indicate that a child is suffering from malnutrition. Similarly, severe malnutrition exists when the Z score is less than minus three. Moderate and severe malnutrition are standard concepts in the anthropometrics literature.

3.3 Combining IOF and SIMA

The child malnutrition and food price inflation information is matched via the combination of province, town/cities and month of IOF interview. Town inflation rates are linked to children living in rural areas and city inflation rates are linked to children living in urban areas. Although the SIMA prices are from urban markets, earlier analysis using unit values from the consumption modules of IOF illustrate that town price levels and trends are strongly correlated with rural observations from IOF (Arndt et al. 2012; GoM 2010). The use of SIMA

2 Thus, $\pi_{m,t}^{Q} = \sqrt[3]{\pi_{m,t}^{A} * \pi_{m,t-1}^{A} * \pi_{m,t-2}^{A}}$

data has the advantage of providing price observations for periods prior to September 2008, when IOF went into the field.

4 Descriptive Information

4.1 Malnutrition

Based on IOF 2008/09, 19 per cent, 48 per cent and seven per cent of 0-4 years old children are respectively suffering from moderate underweight, stunting and wasting (Table 1). No province is in the top or in the bottom regarding malnutrition when considering all three measures. But Cabo Delgado (underweight), Manica (stunting) and Sofala (wasting) are among the provinces with the most malnourished children. Maputo City performs best regarding both underweight and stunting. There is some variation in malnutrition during the IOF year. Based on quarterly measurements we see that the three types of malnutrition show peaks in the second or third quarter, before falling in the fourth quarter, which corresponds with the 2009 harvest season.

4.2 Inflation and malnutrition

Inflation rates ($\pi_{m,t}^{Q}$ defined above and presented in Table A3) and malnutrition rates (Table 1) peak during the IOF year. Within the IOF period, inflation peaked before malnutrition. This could indicate some lagged correlation between inflation and malnutrition. Although the IOF survey is not representative at the monthly level, we nevertheless present inflation and malnutrition rates in Figure 1 to illustrate the correlation in a bit more detail. First of all we see that stunting and wasting do not vary much over the year. It is perhaps surprising that wasting shows less variation than underweight (see below), but, in fact, this is consistent with recent findings from other crises, cf. e.g. de Brauw (2011), and Hartwig and Grimm (2012) (see also sections 5.1 and 6 for further discussion).

Underweight status shows much more variation. We also see that there seems to be a correlation between the movements in inflation and underweight. The correlation between the two using the simple aggregate numbers in the figure is 0.54. The aggregate numbers thus indicate some correlation between food price inflation and child malnutrition in terms of underweight. From this same simple correlation, we can see that a one percentage point increase in inflation increases underweight prevalence with 0.21 percentage points (insignificant). Figure 2 is based on another aggregation, where children are simultaneously classified by: (i) north, centre and south, (ii) city and town, and (iii) survey quarter. The figure shows that there seems to be some correlation between inflation and malnutrition—the effect is 0.22 percentage points (significant) when inflation increases one percentage point.

These aggregate relationships indicate some correlation between malnutrition and inflation, but with varying degrees of significance, although the inflation effect is stable at a little above 0.20. Also, we have not taken other factors, which might also influence malnutrition, such as geography and demographics, into account. These issues will be dealt with in the next section where we use micro data to investigate the relationship between inflation and malnutrition at the individual child level.

5 Approach and Results

5.1 Regressions

For the malnutrition regressions, we use the combined price data from SIMA and anthropometric data calculated from the household budget survey, IOF, alongside a series of likely covariates. The response variable is one of the three binary anthropometric measures. These measures are further divided into whether the malnutrition was moderate or severe. In total, this means that we have six different response variables.

The principal explanatory variable is the inflation rate $\pi_{m,t}^{Q}$ (defined above) and its squared value (divided by 100). We initially present results using only these two variables. For sensitivity analysis, other inflation rates are also used. In addition, both seasonally adjusted and unadjusted inflation rates are investigated. Here, we focus on $\pi_{m,t}^{Q}$ since this is the inflation measure showing greatest correlation with malnutrition, and also the inflation measure that shows least correlation with regional dummies. Moreover, it requires no adjustment for seasonal variation in prices and to some degree captures the lag and delay in the effect of prices on underweight status that one would anticipate. We only present results for this inflation measure, but comment on other inflation measures where appropriate—regressions using other inflation measures than $\pi_{m,t}^{Q}$ are available from the authors upon request.

In addition to inflation, a separate set of regressions employ other explanatory variables characterizing the household as well as the individual child. The individual child-related variables are gender, age, and variations over birth order. The household level variables include household head demographics, education, employment, housing quality, and own food production. We also include information on per capita expenditure as well as poverty status. Inflation is interacted with the poverty status of the household and also interacted with the share of own produced consumption.

Logit estimations are applied since we want to model the binary malnutrition indicator where a child does or does not suffer from malnutrition. We have two different malnutrition measures for each of the three types of malnutrition, underweight, stunting and wasting. In order to have interpretable numbers, we also present the marginal effect of the inflation rate on child malnutrition (measured in percentage points). As a robustness check, we apply Tobit analysis to continuous malnutrition measures censored at mild (Z score below minus 1), moderate (Z score below minus 2) and severe malnutrition (Z score below minus 3).

In the Appendix, we present tables with logit malnutrition regressions using the three malnutrition measures (underweight, stunting, and wasting); two malnutrition levels (moderate and severe); with and without other covariates aside from inflation. Covariates with insignificant parameters ($p>0.05$) have been successively eliminated.

Underweight

Both the moderate and severe underweight regressions without other covariates show that inflation ($p<0.01$) and inflation squared ($p<0.05$) significantly affect children's probability of being underweight (Tables A4 and A5). Also, we have the expected signs for these two parameters implying that higher probabilities of underweight are associated with higher inflation rates, and with the effect of inflation decreasing the greater the inflation rate. Higher polynomials than the square of inflation were also tried, and these regressions give much the same results up until around 60 per cent inflation. Given that 95 per cent of the children in the sample live in areas with inflation levels below 60 per cent, we elect to employ an order two polynomial approximation. Additionally, discrete inflation levels were also tried, but with generally many insignificant parameters representing different inflation levels.

The effect of inflation on moderate underweight is robust to inclusion of other explanatory variables and both of the inflation interaction terms are insignificant (Appendix Table A4). Possession of durable goods (TV, radio, and bed) is associated with a reduction in moderate underweight risk. Being the eldest infant also reduces risk while being youngest increases the risk, which is as expected.

For severe underweight (Appendix Table A5), inflation significance is unaffected, but the magnitude of the inflation effect is higher when including other explanatory variables. Interestingly, we see that inflation's interaction with poverty (h_ent_m_inf) is significantly negative, which means that the probability of being underweight is somewhat less sensitive to inflation in poor households. This effect occurs while simultaneously controlling for real consumption (cr2) and its square. Real consumption determines poverty status. Higher consumption reduces the risk of severe underweight at a decreasing rate.

Stunting and wasting

In contrast to underweight, there is less of a connection between inflation and the other two malnutrition measures, stunting and wasting. Inflation and inflation squared are insignificant for both moderate and severe wasting. Inflation and inflation squared are significant for severe stunting, when excluding other explanatory variables, and inflation squared is significant in the case of both moderate and severe stunting when including other explanatory variables. In the case of moderate wasting, the interaction of inflation with the share of own consumption is significant and negative as expected.

These results are largely expected for stunting, which is a relatively long-term measure. The result with respect to wasting is more surprising. It indicates that many households are able to sustain the level of calorie intake during the price crisis (preventing acute wasting), but cannot afford food which has the same quality, variation and nutritional value (causing underweight in short to medium run). Also, wasting afflicts a rather small share of the population (about 7 per cent for moderate wasting) and may primarily reflect household-specific shocks.

5.2 Estimated marginal effects

In Table 2, we present estimated marginal effects of a one percentage point increase in inflation on malnutrition prevalence. We will concentrate here on malnutrition measured by underweight since this was the malnutrition measure which showed significant sensitivity to inflation. When only inflation is included in the regressions, a one percentage point increase in inflation increases moderate underweight by 0.087 percentage points. Severe underweight increases 0.038 per cent points. As shown in Tables A4 and A5, separate regressions were made in which we included many other explanatory variables together with inflation (and inflation squared). For moderate underweight, the inflation effect is reduced to 0.072 percentage points; and, for severe underweight, the effect is reduced to 0.033 per cent when we include other variables than inflation. But, the change in inflation parameters when including other explanatory variables is not significant.

Note that the effects of inflation on underweight are much lower here (0.072 per cent and 0.087 per cent) than the effects mentioned in the preceding paragraph based on aggregated data (0.21 per cent and 0.22 per cent). Estimations based on the aggregate data thus produces amplified inflation effects (more than double the effects using micro data). Also, the effects here, while smaller, are much more precisely estimated in terms of statistical significance.

Moderate and severe stunting and moderate wasting marginal effects change sign when including other explanatory variables. Severe wasting marginal effects are negative. So, apart from insignificant inflation effects, the inflation effects on stunting and wasting are not robust or in the expected direction.

5.3 Simulations

We can use the estimated parameters to simulate the total effect of high inflation on underweight during the IOF survey conducted from September 2008 until August 2009. We focus this simulation on underweight because the inflation parameters from these malnutrition measure regressions are statistically significant. We make a set of simulations by estimating underweight prevalence under the assumption that inflation is equal to the average monthly provincial rural/urban level during the four years from September 2003 to August 2006. The national inflation average in this period was nearly 15 per cent, while it is nearly 32 per cent during the IOF year. We end this period in August 2006, which is two years before the start of the IOF, since global food prices had already begun their upward trend.

The simulations are based on the two national regressions representing moderate and severe underweight presented in Appendix Tables A4 and A5. Although the models are based on national regressions, the malnutrition predictions from the models are generally good for the three regions (‘Actual’ compared with ‘Simulated Actual’ in Table 3). Had the inflation rate been around 15 per cent rather than the observed around 32 per cent during the IOF year, the moderate underweight prevalence would have been 1.3 percentage points lower than the actual rate of 19.5 per cent. This represents a seven per cent reduction in moderate underweight, meaning 39,000 fewer infants suffering from moderate underweight. The high food price inflation affected different parts of the country differently. The counterfactual moderate underweight decrease is around 7.5 per cent in the north and the south, and a little less in the centre (6.2 per cent).

Similarly, severe underweight would be 0.8 percentage points lower if we assume a lower inflation rate (average inflation 15 per cent instead of the observed 32 per cent). This means there would be about 24,000 fewer children who are severely underweight. The relative reduction in the number of severely underweight is more than double as for moderately underweight (-16 per cent) due to a smaller base.

5.4 Tobit regressions

A full set of Tobit regressions was also carried out with z scores censored at minus 1, 2 and 3 respectively. As before, the explanatory variables included inflation only and inflation together with other explanatory variables. The results from this exercise (together with the logit parameters from earlier) are presented in Table 4. In short, qualitatively there is not much difference between the Tobit and logit regressions. Therefore, we do not pursue this approach much further, but instead briefly comment on the parameters.

For underweight, it is also the case in the Tobit regressions that the inflation parameters are significant and with the expected signs and the signs do not change much when including other explanatory variables. Similarly, stunting and wasting are still virtually unaffected by inflation. An exception, compared to the logit regressions, is stunting censored at minus 3: the inflation parameters are significant with the expected signs and the parameters are rather robust to including other explanatory variables.

5.5 Rural and urban logit regressions

In addition to the Tobit regressions we also carried out logit regressions for rural and urban areas separately. Results are presented for moderate underweight in Table A6 in the Appendix. We do not show results for stunting and wasting since, like the national regressions, they are generally insignificant regarding inflation parameters. Rural inflation and inflation squared parameters are roughly equal to parameters in the national regressions and have the expected signs. The parameter estimates are robust to including other explanatory variables. For the urban areas we also have the expected signs for inflation and inflation squared and with magnitudes in the neighborhood of national estimates. But the inflation squared parameter is insignificant and also the inflation parameters are not robust to inclusion of other variables.

6 Summary and conclusion

We employ household survey data from Mozambique to consider the implications of food price inflation for the nutritional status of children aged 0-4 years. The data was collected from September 2008 to August 2009. As such, it comprehends the effects of the food and fuel price crisis. Anthropometric data from the household survey is complemented by price data for basic food products collected by the agriculture ministry.

We find that moderate and severe underweight prevalence is significantly related to food price inflation. On the other hand, stunting and wasting are generally not sensitive to the inflation rate. Given the high level of persistence in stunting measures, the lack of correlation between stunting and monthly inflation is not surprising. In principle, wasting should be more sensitive to shocks. At the same time, even though Mozambique is a very poor country, wasting is a fairly low probability condition with incidence of seven per cent and two per cent for moderate and severe respectively. Given the high prevalence of stunting, low weight for height represents a particularly severe circumstance in the Mozambican context. Wasting would appear to be the result of extreme shocks that overwhelm the coping capacity of the household. So, food price inflation is likely linked directly to underweight as households switch, in the aggregate, to reduced intake and to cheaper and less nutritious food in response to high prices. Food prices and wasting may be linked indirectly via the impact of high food prices on the probability of an extreme event that prevents the household from providing the minimum nutrition necessary to avoid wasting. This effect may be subtle and not well captured in the approach employed here.

For underweight prevalence, the estimated impact of inflation and inflation squared is essentially unaffected by the inclusion of other covariates. We find that the unusually high food price inflation rates over the period 2008/09 increased the number of moderately and severely underweight children by about 39,000 and 24,000 respectively. This corresponds to a proportional increase in prevalence of about 7 per cent and 16 per cent respectively. These results contribute to mounting evidence that the combination of slow agricultural productivity growth, a weather shock, high real food prices, and high real fuel prices that prevailed in 2008/09 had discernible and substantial negative impacts on the welfare of households.

Tables and figures

Table 1: Moderate malnutrition in provinces and over time (%)

	Underweight	Stunting	Wasting
Niassa	17	50	5
Cabo Delgado	26	54	6
Nampula	22	56	8
Zambezia	19	49	5
Tete	25	52	9
Manica	21	58	5
Sofala	20	36	12
Inhambane	10	38	3
Gaza	14	33	4
Maputo City	7	24	4
Survey quarters:			
Sep 08-Nov 08	17	45	6
Dec 08-Feb 09	24	49	8
Mar 09-May 09	23	51	7
Jun 09-Aug 09	13	47	6
National	19	48	7
National, severe	5	24	2

Source: authors' calculations.

Table 2: Marginal effects of inflation on moderate malnutrition (percentage points)

	Underweight		Stunting		Wasting	
	Inflation	Other Xs	Inflation	Other Xs	Inflation	Other Xs
Moderate malnutrition	0.0866	0.0718	0.0603	-0.0958	-0.0004	0.0108
Severe malnutrition	0.0379	0.0327	0.0511	-0.0447	-0.0199	-0.0200

Notes: Marginal effect (% points) on malnutrition prevalence of a one percentage point increase in inflation. 'Inflation' is defined in the main text. Significance (see tables A4 and A5 in the Appendix): Underweight: all estimates are significant. Stunting: all estimates are insignificant, except for inflation square (including other explanatory variables), inflation/inflation square (including no other explanatory variables), and inflation square (including other explanatory variables than inflation). Wasting: all estimates are insignificant.

Source: authors' calculations.

Table 3: Actual and counter factual (CF) simulation of underweight prevalence using long-term[1] inflation 2008/09 (percentage points)

	Prevalence	Prevalence, %			Change from Simulated Actual to CF		
	Actual, 1,000	Actual	Simulated Actual	Simulation, CF	% points	%	1,000
Moderate underweight:							
North	226	21.68	21.37	19.77	-1.60	-7.5	-17
Central	291	20.73	20.90	19.61	-1.29	-6.2	-18
South	50	10.70	10.88	10.05	-0.83	-7.6	-4
National (total)	*567*	*19.45*	*19.45*	*18.13*	*-1.33*	*-6.8*	*-39*
Severe underweight:							
North	55	5.29	5.26	4.38	-0.88	-16.7	-9
Central	81	5.77	5.72	4.86	-0.86	-15.0	-12
South	13	2.71	3.39	2.84	-0.54	-16.1	-3
National (total)	*149*	*5.11*	*5.18*	*4.36*	*-0.81*	*-15.7*	*-24*

Notes: 'Simulated Actual' based on present inflation rates during IOF 2008/09 (Sep 2008-Aug 2009). 'Simulation CF' based on average inflation rates that existed during September 2003 until August 2007. Inflation rates are specific for provinces, rural/urban and each month. The moderate and severe underweight regressions behind the simulations are the same as in tables A4 and A5. All 'Simulated Actual' underweight prevalence estimates are very well within the 95 per cent confidence intervals for the 'Actual' prevalence rates, including severe underweight in the south. 'Inflation' is defined in the main text.

Source: authors' calculations.

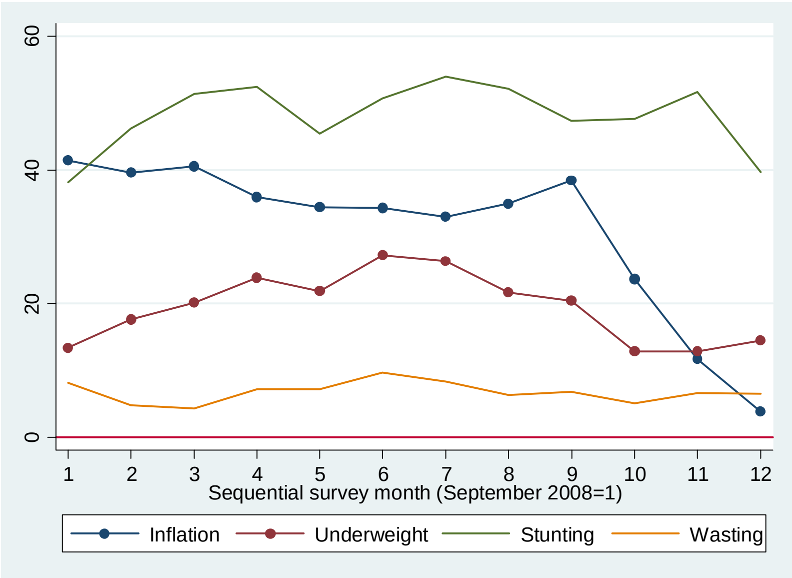
Table 4: Tobit regression parameters modeling censored malnutrition Z scores, 2008/09

	Parameter	Underweight		Stunting		Wasting	
		Inflation	Other *X*	Inflation	Other *X*	Inflation	Other *X*
Tobit regressions							
Z score censored at:							
Minus 1	Inflation	0.015**	0.016***	0.01	0.01	0.018	0.019
	Inflation sq.	-0.018*	-0.023***	-0.011	-0.024***	-0.026	0
Minus 2	Inflation	0.052***	0.059***	0.018*	0.017	0.032	0.021
	Inflation sq.	-0.060***	-0.072***	-0.023	-0.039**	-0.051	0.012
Minus 3	Inflation	0.132***	0.126***	0.054**	0.041*	-0.01	-0.055
	Inflation sq.	-0.155**	-0.153**	-0.071**	-0.075**	-0.041	0.046
Logit regressions							
Moderate (minus 2)	Inflation	0.023***	0.026***	0.007	0.008	0.012	0.008
	Inflation sq.	-0.026**	-0.032***	-0.007	-0.018*	-0.019	0.005
Severe (minus 3)	Inflation	0.038***	0.047***	0.016**	0.013	-0.003	-0.02
	Inflation sq.	-0.044**	-0.043**	-0.020*	-0.025**	-0.01	0.018

Notes: * *p*<.1; ** *p*<.05; *** *p*<.01. The Z scores measures distance from median (normal) anthropometric status. Low (negative) scores indicate deficiency and positive (high) scores indicates too much food consumption. In order to make signs on parameters comparable with logit regressions, the sign on the Z scores was reversed when running Tobit regressions. A positive parameter in the Tobit regression thus indicates that higher values of the variable are associated with higher malnutrition. Columns with 'Inflation' heading means that only inflation and inflation squared were included in the regression. Columns with 'Other X' heading means that apart from inflation and inflation squared a whole set of other explanatory variables were also included in the regression. Insignificant variables were successively excluded (significance level 0.05), except for inflation.

Source: authors' calculations.

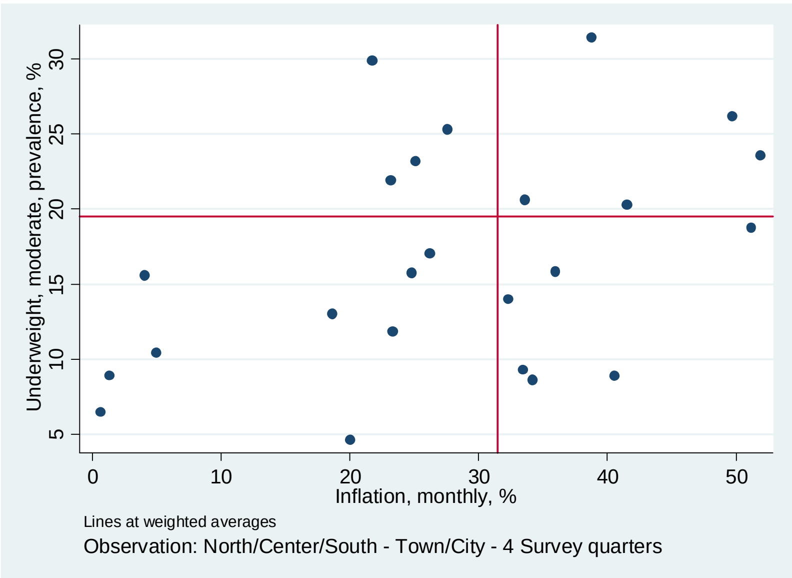
Figure 1: Inflation and malnutrition, September 2008-August 2009 (IOF year)



Note: Inflation is defined in the main text.

Source: authors' illustration.

Figure 2: Inflation and moderate underweight: towns/cities in north, centre and south in the four survey quarters, September 2008-August 2009 (IOF year)



Note: Inflation is defined in the main text.

Source: authors' illustrations.

Appendix 1: Inflation estimations

In the following, we explain how the inflation rates were estimated and also how they were imputed in some cases where price indices did not exist. Comparable numbers here and in the main text differs in some instances since we here employ unweighted price data, while the price information in the main text is weighted by population size (children aged 0-4 years).

In Table A1 we present the population weighted observed price index levels as well as predicted price index levels in the IOF year which runs from September 2008 until August 2009, and the year before IOF as well. The price index predictions are from simple regressions of the provincial price index against the regional (North, Centre and South) price index, regional price index squared and time and time squared. Because of many missing observations for Inhambane cities, the explanatory variable in that regression only included the regional price index. The actual and predicted price index levels are close and the correlation between the two indices is high. Inflation rates simply calculated from the aggregate provincial price indices indicates an inflation of 28 per cent during the IOF survey year both for actual and predicted observations. This can be compared to a 16 per cent annual inflation over the entire period from the second household budget survey IAF in 2002/03 to the third survey IOF in 2008/09. From 2002/03 to the year before IOF the inflation is 14 per cent. This means that the inflation rate doubled during the IOF year 2008/09 compared to average inflation before the IOF year. This confirms other analyses highlighting the unusual surge in food prices in Mozambique during the last household budget survey conducted between September 2008 and August 2009—mainly caused by higher food prices globally as well as higher fuel prices.

Based on existing price indices we are able to calculate inflation rates. Here in the Appendix we define inflation as the relative increase in the price index from a given month in a year to the same month in the year after. Inflation based on existing price indices is called 'Actual' in Table A2. Inflation based on predicted price indices (from the regressions) is called 'Predicted'. When the actual inflation exists, we use that for a given region in a given month. If actual inflation does not exist in a region due to missing observations we instead use the predicted inflation rate. This fills any inflation gaps such that every province's rural and urban areas are 'given' an inflation rate depending on month of IOF 2008/09 interview and location of the household. This complete set of inflation rates is called 'Final'.

The actual, predicted and finally applied inflation rates (Table A2) are highly correlated among each other and also closely correlated with inflation rates calculated from the aggregated price indices in Table A1. Table A3 presents inflation evidence over time; quarterly observations are used since the IOF is representative over time for quarters only. Generally the actual and final inflation rates are highly correlated. The biggest difference is observed for Cabo Delgado in the first quarter of the IOF year, where the final inflation rate is 10 percentage points less than the actual (though incomplete) observed inflation rate in the first quarter. All in all, Table A2 indicates that the final set of inflation rates corresponds well with the observed inflation pattern.

Very high inflation is observed for Zambezia (nearly 50 per cent) and quite low inflation existed in Gaza (a little above 10 per cent) during the IOF survey (Table A2). Looking at each of the quarters of the year, the differences are even bigger (Table A3). Zambezia tops with 64 per cent inflation in the first quarter. Inflation remains high during the second and third quarters, but also shows a reduction during these quarters. In the last quarter inflation is reduced heavily, and for some provinces we even see falling prices compared to the year before.

Inflation is on top in the first quarter in six provinces, in the second quarter in another three provinces, and the third quarter in one province.

Table A1: Food price index and inflation: a year before IOF and during IOF, 2002/03=100

	Price index				Derived inflation	
	Actual		Predicted		Actual	Predicted
	2007/08	2008/09	2007/08	2008/09		
Niassa	143	181	144	178	27	24
Cabo Delgado	182	205	185	206	13	11
Nampula	197	235	194	236	19	22
Zambezia	235	342	234	342	46	46
Tete	180	240	185	244	33	32
Manica	219	279	225	283	27	26
Sofala	227	294	222	288	30	30
Inhambane	202	236	199	234	17	18
Gaza	191	213	191	216	12	13
Maputo City	181	215	181	214	19	18
National	201	257	201	257	28	28
Correlation with "Actual"	1	1	0.991	0.998	1	0.988

Notes: The index is set to 100 in the base year, which is IAF 2002/03, which runs from July 2002 until June 2003. The increase from 2002/03 to 2008/09 is a little higher here because we weight prices with (children 0-4 years) population weights. Maputo Province is not included since SIMA prices do not exist for this province. Entries are weighted averages with weights equal to population size of children aged 0-4 years. Observation size is 6,510 children. Predictions are from regressions where the actual provincial price index is regressed on the actual regional (respectively north, centre or south) price index.

Source: authors' calculations.

Table A2: Inflation rates (per cent)

	Actual	Predicted	Final
Niassa	27	25	27
Cabo Delgado	16	12	13
Nampula	20	23	20
Zambezia	47	48	47
Tete	34	32	34
Manica	28	26	28
Sofala	33	30	31
Inhambane	16	19	21
Gaza	12	13	12
Maputo City	20	20	20
National	29	28	28
Correlation with "Actual"	1	0.973	0.981
Corr with "Derived" in Table 1	0.992	0.998	

Notes: See Table A1.

Source: authors' calculations.

Table A3: Average of three months annual inflation rates (as defined in Table A2) (%)

	Actual				Final			
	Sep 08-Nov 08	Dec 08-Feb 09	Mar 09-May 09	Jun 09-Aug 09	Sep 08-Nov 08	Dec 08-Feb 09	Mar 09-May 09	Jun 09-Aug 09
Niassa	20	33	41	0	20	33	41	0
Cabo Delgado	39	14	8	0	29	14	14	-7
Nampula	32	26	24	-3	32	26	24	-3
Zambezia	64	57	53	18	64	57	53	18
Tete	51	52	30	10	51	52	30	10
Manica	31	36	28	16	31	36	28	16
Sofala	38	43	22	-2	38	42	24	3
Inhambane	36	28	15	-4	40	32	18	-4
Gaza	23	16	13	-1	23	16	13	-1
Maputo City	41	27	15	-4	41	27	15	-4
National	41	36	31	6	40	36	31	6

Notes: See Table A1. The correlation between actual and final inflation rates is 0.99. Actual: Inflation rates based on whatever price indices that is available. Final: Actual inflation rates are used. In case of missing inflation rates, an imputed inflation rate is used.

Source: authors' calculations.

Table A4: Logit regression parameters of moderate malnutrition: inflation only and inflation together with other explanatory variables, 2008/09

		Underweight		Stunting		Wasting	
		Inflation	Other *X*	Inflation	Other *X*	Inflation	Other *X*
Inflation	Inflation	0.023***	0.026***	0.007	0.008	0.012	0.008
	Inflation square	-0.026**	-0.032***	-0.007	-0.018*	-0.019	0.005
	Infla. interac. own food share						-0.015***
Child	Girl		-0.201**		-0.163**		-0.404***
	Age 6-11 months		-0.308**				
	Age 12-23 months				1.038***		-0.490***
	Age 24-35 months				1.344***		-0.777***
	Age 36-47 months				1.121***		-1.360***
	Age 48-59 months				1.162***		-1.513***
	Youngest child		0.286***		0.218***		
	Oldest child		-0.220**				
Househ' demograh.	Male adults (no)						0.233**
Consumption	Food diversity index						-1.682***
Human capital	Years of education				-0.053***		
	Primary education (frac)				-0.365**		
	Technical education (frac)		3.033**				
	No education (fraction)		0.754***				
	Salaried worker						-2.317***
Economic sector	Agriculture				0.325**		
	Public service						2.583**
Agricultural assets	Fruits						0.477***
Durable goods	Bed		-0.276**		-0.314***		
	Bicycle						-0.305**
	Motorbike						-1.088**
	Radio		-0.305***				
	TV		-0.492***				
Province	Cabo Delgado		0.558***				
	Gaza				-0.719***		
	Nampula						0.461**
	Tete						0.582***
	Sofala				-0.727***		0.929***
	Inhambane		-0.740***		-0.507***		-0.932***
	Maputo City		-0.676***		-0.688***		
Constant		-1.800***	-1.902***	-0.203**	-0.654**	-2.766***	-1.805***
Chi-square		12.1	170.3	2.0	329.2	1.2	197.5
Pseudo R-sq		0.003	0.038	0.000	0.065	0.001	0.077
Sample size, N=		6510	6510	6510	6510	6510	6510

Notes: * *p*<.1; ** *p*<.05; *** *p*<.01. Columns with 'Inflation' heading means that only inflation and inflation squared were included in the regression. Columns with 'Other *X*' heading means that apart from inflation and inflation squared a whole set of other explanatory variables were also included in the regression. Insignificant variables were successively excluded (significance level 0.05), except for inflation.

Source: authors' calculations.

Table A5: Logit regression parameters of severe malnutrition: inflation only and inflation together with other explanatory variables, 2008/09

		Underweight		Stunting		Wasting	
		Inflation	Other *X*	Inflation	Other *X*	Inflation	Other *X*
Inflation	Inflation	0.038***	0.047***	0.016**	0.013	-0.003	-0.02
	Inflation square	-0.044**	-0.043**	-0.020*	-0.025**	-0.01	0.018
	Inflation interac. poverty		-0.016**				
Child	Girl		-0.351**		-0.186**		-0.604***
	Age 6-11 months		-0.640**				-1.190***
	Age 12-23 months				1.031***		-0.899***
	Age 24-35 months				1.229***		-0.931**
	Age 36-47 months				0.998***		-1.491***
	Age 48-59 months				1.162***		-2.075***
	Lone child				0.384***		
	Youngest child		0.943***				0.831***
	Oldest child				-0.278**		
	Sibling age diff<15 months		0.594***				
Household head	Female headed HH						-0.932***
	Age		-0.018***				
Househ' demograh.	Male adults (no)				-0.136**		
Consumption	Spat. defla. consumption		-0.050***		-0.010***		
	Spat. defla. consumption, sq.		0.006***		0.001**		
Human capital	Primary education (frac)						3.911**
	Student (frac)		-1.124**				
	Mother's years educ., sq.		-0.010**				
	No education (fraction)				0.857***		4.423***
Economic sector	Agriculture				0.457***		0.871**
	Public service						4.968***
Agricultural assets	Vegetables						-0.511**
	Fish						-1.200**
Habitation	Sanitation, safe acces						0.730***
	Concrete roof		-1.012***		-0.337***		
Durable goods	Bicycle						-0.444**
	Fridge						0.979**
	Iron		1.764***				
	TV						-0.716**
Province	Gaza				-0.656***		
	Manica				0.479***		
	Sofala				-0.752***		1.070***
	Inhambane				-0.753***		
	Maputo City				-0.544**		
Constant		-3.563***	-2.072***	-1.398***	-2.463***	-3.582***	-6.977***
Chi-square		7.0	92.4	4.7	260.2	2.5	124.4
Pseudo R-sq		0.005	0.09	0.001	0.071	0.003	0.116
Sample size, N=		6510	6510	6510	6510	6510	6510

Note: * *p*<.1; ** *p*<.05; *** *p*<.01

Source: authors' calculations.

Table A6: Logit regression parameters of severe malnutrition: inflation only and inflation together with other explanatory variables: separately for rural and urban areas, 2008/09

Rural			***Urban***		
	Inflation	Other *X*		Inflation	Other *X*
Inflation	0.022***	0.022***	Inflation	0.027**	0.031**
Inflation square	-0.028**	-0.030**	Inflation square	-0.025	-0.035*
Girl		-0.208**	Widow		0.617***
Oldest child		-0.361***	Dependents 0-15 years		0.001**
Technical education (frac)		10.498***	Dependency rate (%)		-0.061***
No education (fraction)		0.766***	No females - no males		-0.082***
Economically active		1.028**	Food diversity index		-2.212***
Concrete roof		-0.534***	Literate		-1.026***
Radio		-0.348***	Child dependency rate (%)		0.050**
			Electricity access		-1.185**
Constant	-1.666***	-1.927***	Constant	-2.312***	-0.885**
Chi-square	8.1	77.1	Chi-square	7.8	74.8
Pseudo R-sq	0.003	0.027	Pseudo R-sq	0.006	0.042
Sample size, N=	3860	3860	Sample size, N=	2650	2650

Note: * *p*<.1; ** *p*<.05; *** *p*<.01

Source: authors' calculations.

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