The Impact of Rising Food Prices on Child Nutrition in Zambia

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Abstract This article uses micro-econometrics to assess the impact of a price increase in various food commodities on the height-for-age z-scores of under-five children in Zambia. Using data from the Living Conditions Monitoring Survey (LCMS), the article finds that while the rise in prices of some food commodities has a negative effect on children's health outcomes, others have a positive effect. Specifically, the estimated results show that child height-for-age z-scores are negatively affected by an increase in cereal prices and other commodities such as chicken, beans and eggs, which are rich in proteins and energy. The article suggests that the positive health outcomes associated with the rise in prices of commodities such as beef in urban areas may be as a result of substitution to other products such as chicken, which has comparatively higher values for some nutrients.

1 Introduction

What is the effect of rising food prices on nutrition outcomes of children below the age of five? This question is asked in the wake of the global food price crisis in 2007–08, which saw Zambian food prices soar by about 60 per cent.[1] The price of less refined maize flour (locally referred to as roller meal) increased by 40.6 per cent. This experience is not unique to Zambia as other African countries also experienced soaring prices. For example, Wodon and Zaman (2009) reported that during the first quarter of 2008 alone, there was a 20 per cent increase in rice prices in Burkina Faso and a 41 per cent increase in maize prices in Kenya.

The question posed in this article is even more important as the levels of child stunting in Zambia before the 2007–08 food crisis were very high. The 2007 Zambia Demographic and Health Survey (ZDHS) found that 45 per cent of Zambian children were stunted or short for their age (GRZ 2009: 156). Stunting is a manifestation of long-run inadequate intake of nutrient-dense foods such as animal-source foods (meat, poultry, eggs, fish, milk), fruits and vegetables. Animal-source foods are recognised as having high energy density and as being good sources of high-quality protein, iron and zinc, among others (FAO 2013). All these nutrients enhance children's physical and cognitive development.

Considering poorer households spend over half of their incomes on food (Deaton 1989; Skoufias, Tiwari and Zaman 2012), a major concern arising from high prices of food commodities is that households may be induced to substitute away from foods that are high in required nutrients. Brinkman *et al.* (2010: 158) postulate that the decreased purchase of more expensive foods typically equates to consumption of fewer nutrient-dense foods. Other researchers such as Torlesse, Kiess and Bloem (2003) found that households spend more on non-rice foods when rice prices decrease while Campbell *et al.* (2010: 192) found that households with higher expenditure on rice in Bangladesh have an increased incidence of child stunting in comparison with households with higher non-rice expenditure.

There is a significant amount of literature on the importance of nutrition in early childhood. For example, using longitudinal data from rural Zimbabwe, Alderman *et al*. (2006) showed that improved pre-schooler nutritional status, as measured by height-for-age, is associated with increased height as a young adult, higher level of grades attained and an earlier age at which the child starts school. Behrman and Hoddinott (2005: 548) and Brinkman *et al.* (2010: 153) argue that physical growth lost in early years as a consequence of malnutrition is, at best, only partially regained during childhood and adolescence, particularly when children remain in poor environments. Similarly, the FAO (2013) suggests that stunting causes permanent impairment to cognitive and physical development that can lower educational attainment and reduce adult income.

On the other hand, the potential for catching up during adolescence for previously stunted children has been studied by some researchers. For example, using longitudinal data from Tanzania, Hirvonen (2014) found considerable catch-up growth for individuals who were stunted in childhood. Despite these findings, questions remain on the lasting effect of deficits in cognitive development among children. Grantham-McGregor *et al.* (2007) argue that early childhood undernutrition is associated with long-term deficiencies in cognition and educational outcomes.

Meanwhile, Thomas and Strauss (1992) have investigated the effect of prices on child heights in Brazil. Focusing on food groups which are likely to have an impact on the health of children, they found among others that higher prices for dairy products and sugar are associated with shorter children and that this effect is greater for urban children. They also found that a rise in the price of cereals has positive effects on rural children. In urban areas, a rise in the price of beans was associated with taller children at the bottom of the expenditure distribution. Similarly, a

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study by Christiaensen and Alderman (2004) in Ethiopia found that higher teff (Ethiopia's main staple) prices are associated with shorter children while higher maize, sorghum, beef and milk prices are associated with taller children. Ensuing from these studies is that the effects of rising prices on nutrition outcomes of children are dependent on the commodity and other factors such as the area of residence and age.

One starting point for assessing the individual price effects of a commodity is through household food budget shares. Appendix 1 shows the evolution of household food budget shares in Zambia between 2006 and 2010, disaggregated by region. The table shows that there is a displacement of some items in 2010. In urban areas, of the items that claimed 4 per cent or more of the food budget share, the much preferred and refined maize flour (locally known as breakfast mealie meal) was displaced by the less refined and cheaper roller meal. In rural areas, maize grain retained the highest share and households increased the budget share of vegetables from only 3 per cent in 2006 to 13 per cent in 2010. Reductions are observed in budget shares for protein products in both regions. For example, in rural areas, the share of the budget spent on fish reduced from 8 per cent to 4 per cent, while in urban areas the budget share for beef and fish reduced from 6 per cent to 4 per cent each.

Using cross-sectional data from the 2006 and 2010 Living Conditions Monitoring Surveys (LCMSs) and district price data from the government's monthly retail price survey, this article compares the nutritional outcomes of children under five years old before and after the 2007–08 price rise in Zambia. It does this by pooling the two rounds of cross-sectional data. With the inclusion of district fixed effects and province-by-year interaction terms (further explained in the empirical strategy section), the idea is to compare two cohorts of children originating from the same district at two points in time (2006 and 2010). These cohorts are exposed to very different prices as 2006 was before the 2007/08 price crisis and 2010 after.

The article contributes to the literature in four ways: (i) unlike previous studies, this study analyses the effect of 17 different food commodities on child nutrition outcomes. Previous studies analysed a limited number of food products or food groups; (ii) as the impact of rising food prices is likely to vary across age groups, the article categorises age into three groups: six months and below; between six months and two years and between two and five years; (iii) the author utilises data sets that coincide with the period of the crisis; and (iv) to the best of the author's knowledge, this is the first article on Zambia that focuses on the direct link between the change in prices of particular food commodities and their effect on child health outcomes. A number of articles on the effect of food prices on households have been written on Zambia but none of them focus on this stunting link. See for example, a simulation of the impact of food prices on poverty (Ivanic, Martin and Zaman 2012), the impact of the food, fuel and financial crisis on Zambian households (McCulloch and Grover 2010) and Hossain, King and Kelbert (2013) who use mainly qualitative approaches to understand the effects of the food price crisis on everyday lives of selected households in a number of countries, including Zambia.

The following hypotheses are posed in this article: first, a rise in food prices is important for determining height-for-age z-scores (HAZ). Second, the level of importance varies across regions (rural/urban), gender and age groups.

Given the budget shares (see Appendix 1) and price observations (see second part of Table 3), the expectation is that a rise in the price of vegetables, *kapenta,*[2] beans and cooking oil would have the biggest impact on stunting in the country. In addition, as maize is a staple crop, maize products are expected to have an effect on stunting levels in both rural and urban areas. It is important, however, to note that the direction of the effect is unclear as it would depend on the availability of substitute products, as well as the net production position of a household. The net food selling households would theoretically benefit from higher food prices while net food buyers would suffer a welfare loss, which would subsequently affect children's health outcomes.

Using the Net Benefit Ratio (NBR) analysis[3] developed by Deaton (1989), the author finds that about 76 per cent of urban households are net buyers of cereal products[4] in comparison to only 32 per cent in rural areas. Therefore, these households are likely to lose from a rise in cereal prices. An NBR estimation of individual crops and also of all food commodities still shows that a higher proportion of urban households are likely to suffer a welfare loss in comparison to rural households.

In the analysis, height-for-age is converted into the standardised z-scores using US data as an international reference standard (see Kuczmarski *et al.* 2000). The z-scores are derived after subtracting the age- and gender-specific means from the reference data and after dividing by the corresponding standard deviation (Haddad *et al.* 2003). The growth of children with a z-score of minus two standard deviations (-2 SD) is considered unhealthy growth (GRZ 2009: 155).

The choice of using child height, conditional on age and gender, instead of low weight-for-age z-scores as a measure of child nutrition outcomes has been made in this article as it is a good predictor of long-run cognitive and other human capital deficits when children are below -2 SD in the first two years of life (Barrera 1990; Thomas, Strauss and Henriques 1990; GRZ 2009).

2 Empirical strategy

As the nutrition status of children is not only influenced by inadequate long-term dietary intake, the econometric strategy applied in this article employs district-level fixed effects while controlling for idiosyncratic (e.g. age and gender) and covariate factors such as household and community characteristics. As suggested by Christiaensen and Alderman (2004), household access to (and distribution of) food, availability and utilisation of health services and care provided to children influence children's nutrition status.

Since growth faltering varies with age (e.g. see Shrimpton *et al.* 2001), the article categorises age into three groups:

six months and below; between six months and two years and between two and five years. This will facilitate a more precise analysis on food price effects on HAZ for children with the first two categories corresponding to the crucial 1,000 days from conception to a child's second birthday. This categorisation also fits into the notion that child health outcomes generally exhibit a U-shaped pattern of deterioration and subsequent improvement where children face a decline from six months of age through the second year of life, followed by a slight improvement thereafter (Barrera 1990: 70).

In the reduced form specification formulae, the height-for-age z-score (*HAZ*) for child *i* from district *d* at time *t* is further modelled as a function of household characteristics (H′) that affect child height. These variables include the mother's characteristics (e.g. education and age) and binary variables on the following: ownership of a flush toilet and a radio and access to tap water. All these characteristics are meant to enhance a child's nutrition and health outcome. The rationale is that children of better educated mothers are healthier, while access to media information could enhance child nutrition, and access to clean water and sewerage significantly affect child height. Community level characteristics (E′) include variables such as logged distance to a health centre. The model also incorporates a vector of 41 district-level[5] food prices P′ of primary food commodities consumed by the household for the corresponding months when the LCMS was conducted, that is December 2006 and December 2010. The estimated model is formulated as:

$$(1)\ HAZ_{idt} = X_{idt}\beta_1 + H'_{idt}\beta_2 + E'_{idt}\beta_3 + P'_{dt}\beta_4 + \delta_d + (\theta_p{*}r_t) + \varepsilon_{idt}$$

where ε_{idt} represents the error term.

Modelling the impact of price changes is difficult due to various endogeneity concerns related to omitted variables that are not controlled for. For example, prices are likely to be correlated with time-invariant characteristics, such as local governance efficacy and geography. To address these concerns, the author includes district-level fixed effects (δ_d) capturing all observed and unobserved time-invariant characteristics of the districts. But, unobserved time-varying factors may lead to similar omitted variable bias resulting in a biased estimate of β_4. For example, it is plausible that positive macro-economic shocks (e.g. new discovery of mineral resources) increase economic activity in the area leading to higher prices. β_4 would not only capture the effect of the price change but also the effect of the improvement in the general macro-economic situation. In an attempt to alleviate these concerns, the author adds province-by-year interaction terms ($\theta_p{*}r_t$) to the model.[6] These interaction terms capture all observed and unobserved changes between the two years at the province level. Now, in the presence of district fixed effects and province-by-year interaction terms, the impact of the price changes on child health is identified from district specific changes in prices after controlling for macro-shocks common to all districts in a given province. This strategy yields an unbiased estimate of β_4 if the unobserved time-variant characteristics that influence both district level prices and child health do not vary across districts within a province. While these strategies remove a large amount of the potential bias in the price estimates, some correlation between P'_{dt} and ε_{idt} may remain. The price estimates that follow should therefore be interpreted with some caution.

3 Data

The data analysed here are taken from two sources: the 2006 and 2010 Living Conditions Monitoring Survey (LCMS), a nationwide household survey, and the district retail price data collected on a monthly basis. Both of these surveys are conducted by the government's Central Statistical Office (CSO) in Zambia.

The two LCMSs are used to signify the pre-food crisis period and the period after the initial food crisis. Food prices in Zambia continued to rise and exhibited a volatile characteristic post the 2007/08 global food crisis period. Hence, the expectation is that households would have adapted to high prices by 2010 and the effects on child health outcomes would be observable by then, more so for the under twos.

District-level food prices are only available for 41 out of the 73 districts. In the absence of food price data at a household or community level, the procedure followed here is that suggested by Deaton (1997: 283) of merging regional price data with the household survey data. As such, each household has been associated with the prices for the district it is located in using the actual month the survey was conducted. In this article, 17 food commodities representing various nutrition groups are used.

Therefore, only the children from the districts with information on prices and also without missing information on relevant variables such as height and age are included. As such, a sub-sample of 11,338 children under five is used in this analysis. Of the total, 6,167 reside in urban areas while 5,171 reside in rural areas.

Furthermore, to simplify the interpretation of the results, the estimated units are converted to centimetres using data from the National Centre for Health Statistics/Centres for Disease Control and Prevention (NCHS/CDC).

4 Results and discussion

Contingent on the rise in commodity prices, this article assesses the health outcomes of children below five years old. Table 1 provides descriptive statistics for the variables used in the analysis. There is an equal representation of boys and girls. The highest level of education attained by the mother is relatively higher in urban areas (on average, mothers completed lower secondary education) than rural areas (mothers completed primary education on average). In relation to other household characteristics and as expected, a considerably higher proportion of households in urban areas have a flush toilet and they use a tap as the main source of their drinking water in comparison to rural areas. The table also provides information on food prices. In nominal terms, higher price changes are observed in cereals and proteins. The highest price increase was observed in rice (102.7 per cent) and *kapenta* (102.1 per cent). This could be an explanation for the reduction in shares between the two years in both regions (see Appendix 1), particularly for *kapenta*.

Table 1 **Means and standard deviations of determinants of height-for-age z-scores**

	National		Rural		Urban	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Child characteristics						
Height-for-age z-scores	-1.41	1.93	-1.54	1.90	-1.31	1.94
Sex (1=male)	0.50	0.50	0.49	0.50	0.50	0.50
Child age (months)	28	15.4	27.2	15.2	28.6	15.5
Household and community characteristics						
Household size	6.7	2.98	6.9	3.3	6.6	2.7
Mother's education (years)	8.5	3.5	7.0	3.1	9.8	3.2
Log of household expenditure on food	10.6	0.86	10.2	0.84	10.9	0.77
Main source of drinking water is tap (1=yes)	0.24	0.43	0.06	0.23	0.40	0.49
Household uses flush toilet	0.20	0.40	0.02	0.14	0.34	0.47
Household owns radio	0.59	0.49	0.53	0.50	0.63	0.48
Mother's age (years)	28.2	6.2	28.3	6.4	28.1	6.0
District prices	**2006**		**2010**			
	Mean	**SD**	**Mean**	**SD**	**Price increase (%)**	
Breakfast mealie meal	37.12	4.52	54.30	4.99	46.3	
Roller meal	27.57	4.94	38.76	4.14	40.6	
Kapenta	29.56	7.35	59.74	18.64	102.1	
Fish	11.77	3.35	15.53	4.29	31.9	
Milk	2.47	1.07	3.78	0.76	53.2	
Eggs	5.61	0.56	8.64	0.86	53.9	
Rice	3.75	0.53	7.60	1.37	102.7	
Bread	2.86	0.52	4.31	0.61	50.8	
Groundnuts	5.53	2.62	7.41	2.95	33.9	
Cooking oil	17.66	1.71	28.73	1.57	62.7	
Onions	4.05	1.77	5.57	2.93	37.5	
Tomatoes	2.26	0.85	3.66	1.20	61.8	
Vegetables	1.68	0.62	2.77	1.28	64.7	
Chicken	12.85	2.49	17.75	3.61	38.2	
Beef	13.99	5.43	20.81	4.51	48.7	
Beans	5.75	2.68	9.45	4.19	64.6	
Sugar	8.59	0.49	12.64	0.60	47.2	

Source Author's calculations based on Living Conditions Monitoring Survey (LCMS) (2006 and 2010) raw data and Central Statistical Office district price data.

Table 2 provides the results based on Equation (1). The two columns present the results for rural areas and for the urban sample. First the article finds that, *ceteris paribus* and on average, male children are relatively worse off than their female counterparts. The coefficients on the age dummies confirm the declining trend in HAZ scores in these years as found in Shrimpton *et al.* (2001).

4.1 *Household and community characteristics by region*

The logarithm of food expenditure is used here to control for resource availability for food purchases at the household level and to provide a proxy for general welfare level of the household. Other things being equal and as expected, Table 2 shows that an increase in food expenditure improves child HAZ scores, on average, in urban areas. More specifically, a 10 per cent increase in expenditure increases the z-scores, on average and *ceteris paribus*, by 0.022 units in urban areas. The effect is not statistically different from zero in rural areas.

Many authors have found that maternal education positively affects child health outcomes as children of more educated mothers tend to be taller (Barrera 1990: 87) and healthier (Smith and Haddad 2001). The article finds that the better educated the mother is in urban areas, the taller the children are. However, the effect in rural areas is not

Table 2 **Impact of food prices on children's nutrition in Zambia (dependent variable HAZ)**

	(1) Rural	(2) Urban
Child characteristics		
Male child	-0.224*** (0.041)	-0.161*** (0.040)
≤ 6 months	1.033*** (0.109)	0.947*** (0.093)
>2–5 years	-0.522*** (0.065)	-0.578*** (0.101)
Household and community characteristics		
Log food expenditure per capita	0.059 (0.037)	0.218*** (0.041)
Household size	0.016 (0.011)	0.024 (0.015)
Mother's age	0.009** (0.004)	0.006 (0.004)
Mother's education (years)	0.007 (0.010)	0.016* (0.009)
Flush toilet	0.108 (0.192)	-0.051 (0.083)
Distance to health facility (logs)	-0.025 (0.038)	0.118** (0.055)
Tap water	0.021 (0.132)	0.043 (0.070)
Radio ownership	0.104*(0.061)	0.067 (0.048)
Food prices (in logs)		
Breakfast mealie meal	-3.591** (1.543)	-2.348* (1.327)
Roller meal	-0.705* (0.417)	-1.744*** (0.587)
Rice	-0.030 (0.339)	-0.096 (0.340)
Bread	0.435 (0.791)	-1.969*** (0.553)
Beef	0.746 (0.661)	1.820*** (0.517)
Chicken	-1.973** (0.884)	-1.706* (0.939)
Kapenta	0.356* (0.193)	0.018 (0.327)
Fish (bream)	0.612*** (0.172)	0.419** (0.192)
Beans	-1.033*** (0.279)	-0.402 (0.337)
Eggs	-1.562*** (0.575)	-1.378** (0.541)
Milk (fresh)	0.103 (0.363)	1.255* (0.719)
Cooking oil	1.415 (1.090)	1.615** (0.659)
Groundnuts	0.639*** (0.218)	0.533** (0.224)
Vegetables	-0.198 (0.216)	-0.294 (0.242)
Tomatoes	0.944***(0.235)	0.929***(0.144)
Onions	-0.577*** (0.115)	-0.481*** (0.123)
Sugar	3.545* (1.964)	4.266*** (1.172)
District fixed effects	Yes	Yes
Province-by-year terms	Yes	Yes
Number of observations	5,171	6,167
R-squared	0.076	0.074
Adjusted R-squared	0.069	0.068

Note Robust standard errors in parenthesis *** p<0.01, ** p<0.05, * p<0.1
Source Author's calculations based on LCMS (2006 and 2010) raw data and Central Statistical Office district price data.

Table 3 **Impact of food prices on children's nutrition in Zambia – gender effects (dependent variable HAZ)**

	(1) Rural boys	(2) Rural girls	(3) Urban boys	(4) Urban girls
Child characteristics				
≤ 6 months	1.382***	0.741***	1.143***	0.749***
	(0.158)	(0.192)	(0.147)	(0.132)
>2–5 years	-0.488***	-0.537***	-0.600***	-0.537***
	(0.084)	(0.080)	(0.120)	(0.110)
Household and community characteristics				
Log food expenditure per capita	0.094*	0.037	0.280***	0.173***
	(0.051)	(0.051)	(0.048)	(0.051)
Household size	0.025	0.007	0.007	0.044**
	(0.016)	(0.011)	(0.013)	(0.022)
Mother's age	0.018***	-0.001	0.015***	-0.003
	(0.007)	(0.006)	(0.006)	(0.005)
Mother's education (years)	0.007	0.004	-0.002	0.031***
	(0.014)	(0.014)	(0.010)	(0.012)
Flush toilet	0.208	0.024	-0.040	-0.046
	(0.329)	(0.230)	(0.121)	(0.096)
Distance to health facility (logs)	0.060	-0.107**	0.159**	0.078
	(0.044)	(0.048)	(0.069)	(0.055)
Tap water	-0.008	0.064	-0.004	0.081
	(0.153)	(0.191)	(0.099)	(0.103)
Radio ownership	-0.022	0.216***	0.107	0.003
	(0.084)	(0.070)	(0.073)	(0.063)
Food prices (in logs)				
Breakfast mealie meal	-2.925	-3.842**	-1.471	-2.897*
	(2.059)	(1.670)	(1.767)	(1.574)
Roller meal	0.910	-1.911***	-1.450*	-2.253***
	(0.576)	(0.584)	(0.799)	(0.617)
Rice	-0.692	0.605	-0.253	-0.008
	(0.533)	(0.495)	(0.463)	(0.281)
Bread	-0.846	1.075	-2.436***	-1.657***
	(1.149)	(0.818)	(0.753)	(0.503)
Beef	0.661	0.724	1.097	2.579***
	(0.827)	(0.871)	(0.675)	(0.460)
Chicken	-0.156	-3.614***	-1.744	-1.758***
	(0.947)	(1.381)	(1.258)	(0.605)
Kapenta	0.165	0.482*	-0.419	0.616**
	(0.279)	(0.248)	(0.422)	(0.281)
Fish (bream)	0.119	0.977***	0.251	0.756***
	(0.220)	(0.263)	(0.275)	(0.203)
Beans	-0.783**	-1.237***	-0.172	-0.536**
	(0.317)	(0.374)	(0.427)	(0.268)
Eggs	-1.171	-1.436*	-2.370***	-0.535
	(0.804)	(0.738)	(0.744)	(0.582)
Milk (fresh)	0.006	0.240	1.436	0.733
	(0.377)	(0.538)	(1.121)	(0.684)
Cooking oil	2.200	1.040	2.104*	0.802
	(1.665)	(1.073)	(1.126)	(0.732)
Groundnuts	0.537**	0.724**	0.035	0.872***
	(0.239)	(0.358)	(0.279)	(0.195)
Vegetables	-0.114	-0.399	-0.197	-0.262
	(0.265)	(0.277)	(0.290)	(0.205)
Tomatoes	0.892***	1.043***	0.928***	0.889***
	(0.244)	(0.310)	(0.240)	(0.132)
Onions	-0.600***	-0.549***	-0.422***	-0.577***
	(0.139)	(0.181)	(0.132)	(0.152)
Sugar	0.287	7.289***	2.921*	5.509***
	(2.494)	(2.283)	(1.647)	(0.848)
District fixed effects	Yes	Yes	Yes	Yes
Province-by-year terms	Yes	Yes	Yes	Yes
Number of observations	2,539	2,632	3,082	3,085
R-squared	0.092	0.072	0.090	0.067
Adjusted R-squared	0.078	0.059	0.079	0.056

Note Robust standard errors in parenthesis *** p<0.01, ** p<0.05, * p<0.1
Source Author's calculations based on LCMS (2006 and 2010) raw data and Central Statistical Office district price data.

Table 4 **Impact of food prices on children's nutrition in urban Zambia: age effects (dependent variable HAZ)**

	(1) Rural (≤ 6)	(2) Rural (>6m ≤2y)	(3) Rural (>2– 5y)	(4) Urban (≤ 6)	(5) Urban (> 6m ≤2y)	(6) Urban (>2–5y)
Child characteristics						
Male child	0.163	-0.345***	-0.229***	0.176	-0.180**	-0.208***
	(0.284)	(0.074)	(0.056)	(0.189)	(0.085)	(0.052)
Household and community characteristics						
Log food expenditure per capita	0.188	-0.054	0.116**	0.434**	0.223***	0.181***
	(0.157)	(0.057)	(0.051)	(0.187)	(0.068)	(0.042)
Household size	0.060	0.024	0.000	-0.024	0.041	0.014
	(0.037)	(0.018)	(0.015)	(0.032)	(0.026)	(0.014)
Mother's age	0.022	-0.001	0.016***	0.011	-0.014**	0.015***
	(0.020)	(0.008)	(0.005)	(0.021)	(0.007)	(0.004)
Mother's education (years)	-0.060	0.019	0.014	-0.075**	0.009	0.036***
	(0.052)	(0.012)	(0.017)	(0.038)	(0.014)	(0.011)
Flush toilet	3.084***	-0.043	0.298	-0.035	-0.259***	0.021
	(0.552)	(0.286)	(0.228)	(0.338)	(0.093)	(0.112)
Distance to health facility (logs)	-0.047	-0.088	0.041	-0.328	0.325***	0.022
	(0.169)	(0.053)	(0.044)	(0.206)	(0.067)	(0.074)
Tap water	-0.769	0.232	-0.042	-0.236	0.049	0.039
	(0.468)	(0.221)	(0.140)	(0.382)	(0.065)	(0.100)
Radio ownership	-0.168	0.038	0.172***	0.075	-0.101	0.165**
	(0.277)	(0.109)	(0.065)	(0.201)	(0.074)	(0.071)
Food prices (in logs)						
Breakfast mealie meal	-1.849	-3.752**	-4.280**	2.111	-3.945	-1.638
	(3.613)	(1.732)	(2.066)	(11.253)	(2.616)	(1.793)
Roller meal	1.280	0.888	-2.216***	-5.722	-1.185	-1.416
	(1.496)	(0.609)	(0.740)	(4.182)	(0.930)	(0.864)
Rice	-1.627*	-0.699	-0.100	-3.489*	-0.106	0.158
	(0.928)	(0.540)	(0.702)	(2.085)	(0.547)	(0.484)
Bread	-7.238***	-1.124	2.396**	3.296	-1.751*	-3.208***
	(1.545)	(1.115)	(0.970)	(3.124)	(1.050)	(0.948)
Beef	8.799***	2.218***	-0.003	-2.557	2.408***	1.906***
	(2.255)	(0.735)	(0.924)	(2.798)	(0.885)	(0.581)
Chicken	-4.323*	-1.185	-3.327***	-5.597	-2.638**	-0.655
	(2.241)	(1.320)	(1.210)	(3.851)	(1.247)	(1.074)
Kapenta	-0.431	0.369	0.470	0.464	0.947*	-0.170
	(0.739)	(0.280)	(0.333)	(1.204)	(0.522)	(0.315)
Fish (bream)	1.424***	-0.135	0.919***	2.710*	0.884**	-0.049
	(0.428)	(0.288)	(0.285)	(1.570)	(0.365)	(0.371)
Beans	-1.947**	0.150	-1.622***	-2.773	-2.308***	1.185***
	(0.931)	(0.362)	(0.470)	(2.168)	(0.527)	(0.429)
Eggs	-10.396***	-0.382	-1.595	-7.455*	-1.958**	-0.744
	(1.606)	(0.909)	(0.997)	(4.333)	(0.945)	(0.884)
Milk (fresh)	-2.589***	-1.624**	1.295***	-3.109	3.336***	0.197
	(1.002)	(0.731)	(0.470)	(2.967)	(1.037)	(0.943)
Cooking oil	8.611***	1.196	0.810	0.614	1.386	2.071*
	(2.622)	(1.608)	(1.238)	(4.472)	(1.187)	(1.253)
Groundnuts	-0.226	0.083	0.860**	4.539***	-0.453	0.709**
	(0.836)	(0.302)	(0.382)	(1.101)	(0.361)	(0.316)
Vegetables	-3.274***	0.358	-0.280	-0.898	-0.571*	-0.008
	(0.558)	(0.294)	(0.327)	(0.993)	(0.324)	(0.283)
Tomatoes	5.554***	0.889***	0.442	1.859*	1.928***	0.085
	(1.017)	(0.283)	(0.417)	(1.018)	(0.236)	(0.331)
Onion	-3.155***	-0.166	-0.497**	-1.179	-0.804***	-0.129
	(0.638)	(0.181)	(0.229)	(1.220)	(0.277)	(0.143)
Sugar	29.350***	5.308**	0.710	-13.074	5.005***	4.327*
	(4.656)	(2.063)	(2.341)	(8.859)	(1.578)	(2.436)
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-by-year terms	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	432	1,987	2,752	450	2,259	3,458
R-squared	0.111	0.055	0.054	0.176	0.063	0.059
Adjusted R-squared	0.030	0.038	0.042	0.104	0.048	0.049

Note Robust standard errors in parenthesis *** p<0.01, ** p<0.05, * p<0.1

Source Author's calculations based on LCMS (2006 and 2010) raw data and Central Statistical Office district price data.

significant from zero. This might be because rural mothers are generally less educated in comparison to mothers residing in urban areas, as observed in Table 1.

In rural areas, holding all other variables constant, the older the mother is, the better the child nutrition outcome. The most likely explanation here is that older mothers are better equipped to provide for their children. The effect in urban areas is not statistically significant.

Owning a radio is a positive determinant of children's nutrition outcomes in rural areas. The coefficients are not statistically significant for other household and community characteristics such as tap water, flush toilet and household size.

4.2 *Food price effects by region*

For the main variable of interest, food prices, the results show that the effect on children's height, holding all other variables constant, is dependent on the type of food commodity. The results in this article are only based on individual food commodities and are not aggregated into major nutrition groups such as cereals, proteins, and oil and fats. This is because, after running regressions on major nutrition groups, the results were largely statistically insignificant and the coefficients were too small to have any economic meaning. For this reason, the article focuses on individual food commodities only. This decision is also more informative for policymaking. Furthermore, the food prices are expressed in (natural) log terms, hence the coefficients are interpreted as semi-elasticities.

The results in Table 2 show that higher prices of maize products (refined and less refined maize flour) are associated with shorter children in both rural and urban areas. More specifically, a 10 per cent price increase of the more refined maize flour would reduce rural children's height-for-age z-scores by 0.36 units and by 0.23 units in urban areas. For an average child of 28 months old in the sample, these effects translate approximately into 1.29cm and 0.85cm reduction in height, respectively.[7] Assuming that the average child remains in this growth curve, this further translates into a reduction of 2.6cm and 1.7cm in adult heights.[8] In relation to the less refined maize flour, a price increase of 10 per cent is associated with a reduction in children's height-for-age z-scores of 0.07 units (0.25cm) and 0.17 units (0.63cm) in rural and urban areas, respectively.

The results for maize are somewhat surprising as the author would have expected that rural households would benefit from the rise in prices due to a higher proportion of rural households being net food sellers. An explanation for this finding could be that rural households sell some of the maize meant for consumption. Geier (1995) cited in Devereux (1996) made a similar discovery in Tanzania where the commoditisation of staple food crops undermined household food security and child nutrition. However, in the case of Zambia, it is also necessary to understand market interactions such as the presence of middle men who may be benefiting more from higher prices than the actual small-scale producers. Furthermore, the results for these two products show that households do not easily substitute from the staple crop, maize, to other starchy products such as cassava, once prices rise.

Considering that the household budget share of bread in urban areas is over double that of rural areas (Appendix 1), on average, it is not surprising that a rise in the price of bread only affects urban households. Specifically, a 10 per cent increase in the price of bread is associated with a 0.20 unit (0.71cm) reduction in children's height-for-age z-scores in urban areas. In rural areas, the effect is not significantly different from zero.

Regarding other nutrients, a 10 per cent increase in the price of eggs is associated with shorter children in both regions. Similarly, a rise in the price of beans is associated with a reduction in child health outcomes of up to 0.10 units (0.37cm) in rural areas. Though the coefficient is negative, the results are not statistically different from zero in urban areas. This result is also surprising as the author would have expected rural households to benefit from a rise in the price of beans due to their net selling capacity. However, this might also be an issue of food crop versus cash crop as suggested in the case of maize products.

Conversely, higher beef prices are associated with taller children in urban areas. This result could be explained by the substitution effect that may occur between chicken and beef. While the budget share (see Appendix 1) remained about the same for chicken between 2006 and 2010 (9 per cent and 8 per cent respectively), the budget share for beef reduced by three percentage points from 7 per cent to 4 per cent during the same period. A substitution of beef for chicken is beneficial for energy as each 100g of chicken[9] contains 247 kilocalories in comparison to only 165 kilocalories in beef.[10] Chicken also has higher fat and vitamin A content. However, with this substitution, children would lose out on higher traces of vitamin B6, vitamin B12 and zinc found in beef. Vitamin B6 is particularly important for boosting immunity as well as brain development during pregnancy and infancy. Due to this substitution link, it is a major concern that the coefficient of chicken in rural areas is negative and highly significant. Therefore, a 10 per cent increase in the price of chicken is associated with a reduction in children's health outcomes in both rural and urban areas by 0.20 units (0.71cm) and 0.17 units (0.61cm) respectively.

In their paper, Thomas and Strauss (1992) found that if the prices of dairy products rise by two standard deviations, then mean standardised height would decline by 2cm. Other food commodities that are associated with taller children when prices rise in Zambia include: fish, groundnuts, tomatoes and sugar in both regions and cooking oil in urban areas.

4.3 *Household and community characteristics by gender and age*

The rest of the results are based on a split sample by gender (Table 3) and by age (Table 4). In Table 3, the older the mother is, the better the health outcome for the male children in both regions. The results are insignificant for girls. In relation to maternal education, Table 3 shows that the education of the mother is positive and significant only for girls in urban areas. The results observed in Table 4 where the mother's education has a negative effect on children up to six months old in rural areas are surprising; perhaps this is influenced by mothers with low levels of education. As suggested by Thomas and Strauss

(1992) education has the biggest impact on the heights of children whose parents have some secondary education.

Furthermore, counter-intuitive results on flush toilets are observed in Table 4, which has a negative effect on the nutrition outcomes for children between six months and two years in urban areas. This result is unexpected but the coefficient could be influenced by other variables that are beyond the scope of this article. Table 3 also shows that the further away a health facility is, the worse off the nutrition outcomes are for girls. The coefficients are not statistically significant for the other groups.

4.4 *Food price effects by gender and age*

For some commodities, the nutrition effects once prices rise vary for boys and girls. In urban areas, Table 3 shows that a rise in the price of refined maize flour, chicken and beans is associated with shorter girls but the effect is not statistically different from zero for the boys. The opposite is true for eggs. A rise in the price of eggs is associated with shorter boys but the coefficient for girls in urban areas is not statistically significant. On the other hand, a rise in the price of bread is regressive for both boys and girls.

Results for the rural areas show that unlike boys, the rise in the price of refined maize flour, less refined maize flour and chicken is associated with shorter girls. However, an increase in the price of beans and onions negatively affects the health outcomes of both the girls and the boys. Table 4 disaggregates the results by age group. As expected, an increase in the price of milk decreases the height-for-age z-scores for children between six months and two years old in rural areas. The result is not surprising as this is the period children are weaned but are still dependent on milk for the relevant macro and micro nutrients. The same age group in urban areas, however, is positively affected by the rise in the price of milk. In rural areas, this age group is further affected by the rise in prices of breakfast mealie meal.

In urban areas an increase in the price of bread reduces the height-for-age z-scores for children between six months and five years. The effect is more precisely estimated for the older age group.

The nutritional outcomes of children below six months old in urban areas are negatively affected by an increase in the prices of rice and eggs. In rural areas on the other hand, a rise in the price of rice, bread, chicken, beans, eggs, milk, vegetables and onion negatively affects the health outcomes of infants who are under six months. These commodities are a reflection of the effect through maternal nutrition as children under six months would be too young to consume solid foods.

For the older age group (between two to five years old) in rural areas, their height-for-age z-scores lag behind the reference group if prices of commodities such as chicken, beans and both the refined and less refined maize flour increase.

5 Conclusions and policy implications

This article highlights the effects of an increase in various food prices on the height-for-age z-scores of children under five. The results confirm the hypothesis that a rise in prices of food is indeed an important determinant for height-for-age z-scores (HAZ). Furthermore, they suggest that the level of importance varies across rural and urban areas, gender and age of the child.

The results show that the rise in prices of some food commodities has a negative effect on children's heights while others have a positive effect. In general, the estimated results in this article show that child height-for-age z-scores are negatively affected by an increase in the price of nutrient-dense foods such as chicken, beans and eggs.

The article suggests that the positive health outcomes associated with the rise in the price of commodities such as beef in urban areas are as a result of substitution with other products such as chicken, which has comparatively higher values for some nutrients.

These results depart from the findings of Thomas and Strauss (1992) who found that the rise in price of cereals had positive effects on rural children and in urban areas that a rise in the price of beans was associated with taller children. Instead, this article finds that a rise in prices of maize products and beans is associated with shorter children in both rural and urban areas. This is despite rural areas having more net sellers than urban areas. Nevertheless, these findings are somewhat similar to Christiaensen and Alderman (2004) on Ethiopia who found that higher teff prices are associated with shorter children. Likewise, in their research on the likely impact on Ugandan households of rising global food prices, Benson and Mugarura (2008) suggested that the quality of diets may suffer as families shift part of the income that they were initially spending on animal-source foods to purchase energy-dense cereals or tubers.

Given the extent of the negative effects of the increase in prices of food products on children's health outcomes, it is imperative to insulate the most vulnerable groups through appropriate policies. Sabates-Wheeler and Devereux (2010) suggested several ways in which social transfer interventions could be redesigned so that they are more responsive to food price variability such as a switch out of cash transfers towards food transfers when cash is devalued by prices or a combination of cash and food transfers. In addition and for the case of Zambia, a more integrated agriculture market system where information flows are enhanced and markets to sell the produce are readily available may offer more sustained positive health outcomes for children, especially those in rural areas.

Furthermore, in order to make agriculture work for poor households, the government must ensure the majority of the beneficiaries for the Farmer Input Support Programme (FISP), formerly called Fertiliser Support Programme, are poor households. Burke, Jayne and Sitko (2012) found that despite being framed as a key component of the nation's poverty reduction strategy, the FISP excludes the poorest households who cannot afford to pay the mandatory membership costs.

More broadly, the results in this article suggest that household dietary choices may not always be the most

Appendix 1 Household food budget shares by region

2006 Rural		2010 Rural		2006 Urban		2010 Urban	
Maize grain	0.15	Maize grain	0.16	Breakfast mealie meal	0.09	Roller meal	0.08
Cooking oil	0.09	Vegetables	0.13	Chicken	0.08	Vegetables	0.08
Chicken	0.08	Cassava	0.08	Bread	0.07	Bread	0.08
Fish	0.08	Chicken	0.05	Cooking oil	0.07	Chicken	0.08
Sugar	0.07	Hammermill maize flour/pounded maize	0.04	Vegetables	0.06	Cooking oil	0.05
Cassava	0.06	Cooking oil	0.04	Beef	0.06	Maize grain	0.05
Kapenta	0.06	Sugar	0.04	Fish	0.06	Sugar	0.05
Salt	0.05	Fish	0.04	Sugar	0.06	Beef	0.04
Beans	0.04	Kapenta	0.03	Kapenta	0.05	Kapenta	0.04
Tomatoes	0.03	Bread	0.03	Tomatoes	0.05	Fish	0.04
Vegetables	0.03	Dried beans	0.03	Rice	0.04	Tomatoes	0.04
Bread	0.03	Fruits	0.03	Beans	0.03	Rice	0.04
Groundnuts	0.03	Tomatoes	0.03	Maize grain	0.03	Dried beans	0.03
Rice	0.03	Breakfast mealie meal	0.02	Roller meal	0.03	Fruits	0.03
Beef	0.03	Bream	0.02	Eggs	0.03	Bream	0.03
Goat meat	0.02	Roller meal	0.02	Onion	0.02	Eggs	0.03
Pork	0.02	Groundnuts	0.02	Fresh milk	0.02	Onion	0.02
Onion	0.01	Salt	0.02	Non-alcoholic drinks	0.02	Breakfast mealie meal	0.02
Game meat	0.01	Beef	0.02	Irish potatoes	0.02	Milk fresh	0.02
Fresh milk	0.01	Rice	0.02	Groundnuts	0.01	Cassava	0.01
Eggs	0.01	Non-alcoholic drinks	0.01	Salt	0.01	Potatoes	0.01
Millet	0.01	Onion	0.01	Tea/coffee	0.01	Groundnuts	0.01
Hammermill maize flour/pounded maize	0.01	Sweet potatoes	0.01	Butter	0.01	Wheat	0.01
Non-alcoholic drinks	0.01	Fresh beans	0.01	Hammermill maize flour/pounded maize	0.01	Hammermill maize flour/pounded maize	0.01
Sorghum	0.01	Goat meat	0.01	Fruits	0.01	Sweet potatoes	0.01
Breakfast mealie meal	0	Milk fresh	0.01	Pork	0.01	Salt	0.01
Irish potatoes	0	Eggs	0.01	Cassava	0.01	Butter	0.01
Tea/coffee	0	Millet	0.01	Goat meat	0.01	Pork	0.01
Roller meal	0	Game meat	0.01	Game meat	0.01	Tea	0.01
Honey	0	Pork	0.01	Powdered milk	0	Goat meat	0.01
Sweet potatoes	0	Wheat and wheat products	0.01	Sweet potatoes	0	Game meat	0.01
Fruits	0	Potatoes	0	Other poultry	0	Fresh beans	0.01
Total shares	**0.99**		**0.98**		**1**		**0.98**

Source Author's calculations based on LCMS (2006 and 2010) raw data.

nutritious, given the price effect. Therefore, low-cost interventions such as regular community-based nutrition education, which could be integrated within the Ministry of Health, should be implemented. For maximum benefits, this type of education should be tailor-made for districts by taking into account the locally available food commodities and providing information on the precise nutrition contents based on the nutrition tables from Zambia's National Food and Nutrition Commission.

Finally, the article argues for more investment in regular household surveys to enhance evidence-based policymaking and more importantly, ensure timely targeted responses when households face covariate shocks.

Notes

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1 Calculated by author using monthly retail price data collected by the Zambian government's Central Statistical Office (CSO).

2 Sardine-like small fish.

3 Deaton (1989) defines NBR as the value of net sales of a commodity as a proportion of income.

4 The cereal products used to calculate the NBR estimates are maize, rice, cassava, millet and sorghum.

5 Each district has an average of 190 households. More information about the rationale for selecting these districts is in the data section.

6 The 39 districts are representatives of all nine provinces.

7 One standard deviation in the CDC distribution at this age corresponds approximately to 3.6cm.

8 One standard deviation in the CDC distribution at the age of 20 is 7.2cm for boys and 6.5cm for girls.

9 The nutrition contents are based on a fresh boiled chicken containing a neck, meat and skin; and boiled lean beef.

10 A substitution of beef for chicken could be beneficial for poor households who may mostly consume lean rather than high fat beef. In comparison to lean beef with only 165 kilocalories, energy levels in each 100g of chicken is higher (247 kilocalories). Chicken also has higher vitamin A and calcium content (NFNC 2007).

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