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Effects of Food Price Shocks on Nutrition Outcomes Among Farm Households in Nigeria: Implications for Food-Price-Related Policies

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Abstract

The starting point towards advancing nutrition-sensitive food price policies in Nigeria is a nationally representative empirical study on the effects of food price shocks on children's nutrition outcomes. This study uses data from the Nigeria Living Standard Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) of the years 2013 and 2016. A correlated random probit and a pooled panel data probit regression were employed in the analysis. The data description shows a notable concentration of wasting and stunting in Northern Nigeria, and in households characterized by low income, low education level, and not using insecticide-treated bednets. Shocks in the prices of rice and vegetables can substantially enhance the risks of child stunting, while wasting prevalence in children is positively associated with fish and dairy price shocks. Thus, this study lends support to nutrition-sensitive food price policies that are geared towards calming a surge in food prices, especially the prices of rice, vegetables, fish and dairy.

Key Words: *Food price shocks, Food policy, Undernutrition, Agricultural households, Africa*

1. Introduction

Substantial progress has been achieved at the global level towards reducing children malnutrition over the past few decades, however, the proportion of malnourished children are still unacceptably high in Africa. About 34% of under-five children still suffer from stunting, and approximately 10% suffer from wasting (Covic and Hendriks, 2016). Malnutrition affects the performance of children in school, can lead to a poor education system worldwide and poor economic productivity later in life (Belachew et al., 2011). Nigeria is among the five developing countries with more than 50% stunted children and is second highest in the acute malnutrition (wasting) burden in the world (IFPRI, 2015). An improvement in children's nutritional outcomes in Nigeria will significantly contribute to undernutrition reduction in Africa.

Most households in Nigeria live in poverty and are often trapped in hunger and suffer from undernutrition, especially when aggravated by unfavourable economic conditions such as financial crises, including shocks in food prices (FMARD, 2017). Available statistics suggest that the average price of food items in Nigeria has been on the increase over the years. The consumer food price index increased sharply and progressively from 71.9 in 2007 to 109.9 in 2010, to 134.9 in 2012, then to 186.2 in 2015, and it stood at 278.2 in June 2018 (CBN, 2012, 2016, 2018). The observed rise in the price index has been linked to increases in the prices of some groups of food items such as bread and cereals, fruits and vegetables, fish and meats, potatoes, yam, and other tubers (National Bureau of Statistics, NBS, and United Nations Children's Fund, UNICEF, 2017). It is unclear whether these increases translate to nutrition gains or losses among farm households.

The welfare effects of food price increases may be ambiguous (Brinkman et al., 2010; Shittu et al., 2015). The extent of the influence would, for example, depend on the type of household and how the labour and commodity markets within and outside agriculture respond to price changes (Dawe 2011; Shittu et al., 2015). Despite that, agricultural policies and the interplay of market forces are critical for food security and nutrition; their impacts on child nutrition outcomes can be limited without inputs from the health or other relevant sectors of the economy. As noted by the World Bank (2018), the provision of preventive and curative health services is indispensable for achieving better nutrition outcomes. Hence, empirical knowledge on how health-related programmes and interventions complement efforts on agriculture and the agricultural commodity market to deliver on child nutrition outcomes is imperative.

The overarching objective of this study is to examine the effects of food commodity price policy on nutrition outcomes in Nigeria. We intend to achieve this by assessing the prevalence of child wasting and stunting among farm households, disaggregating that by household characteristics, then examining the potential effects of shocks in food prices on the probability of child stunting and wasting. A limited number of studies have attempted to investigate the objective of this study in Nigeria, but with limitations in scope and indicators used to measure nutrition outcomes. The present study builds on previous work by considering more directly the indicators of nutrition outcomes in households, and by using a nation-wide panel dataset. This provides an opportunity to robustly investigate the potential effects of food price shocks on nutrition outcomes and offers suggestions on how food commodity pricing policy and market-related interventions can be sensitively guided for improved nutrition in Nigeria.

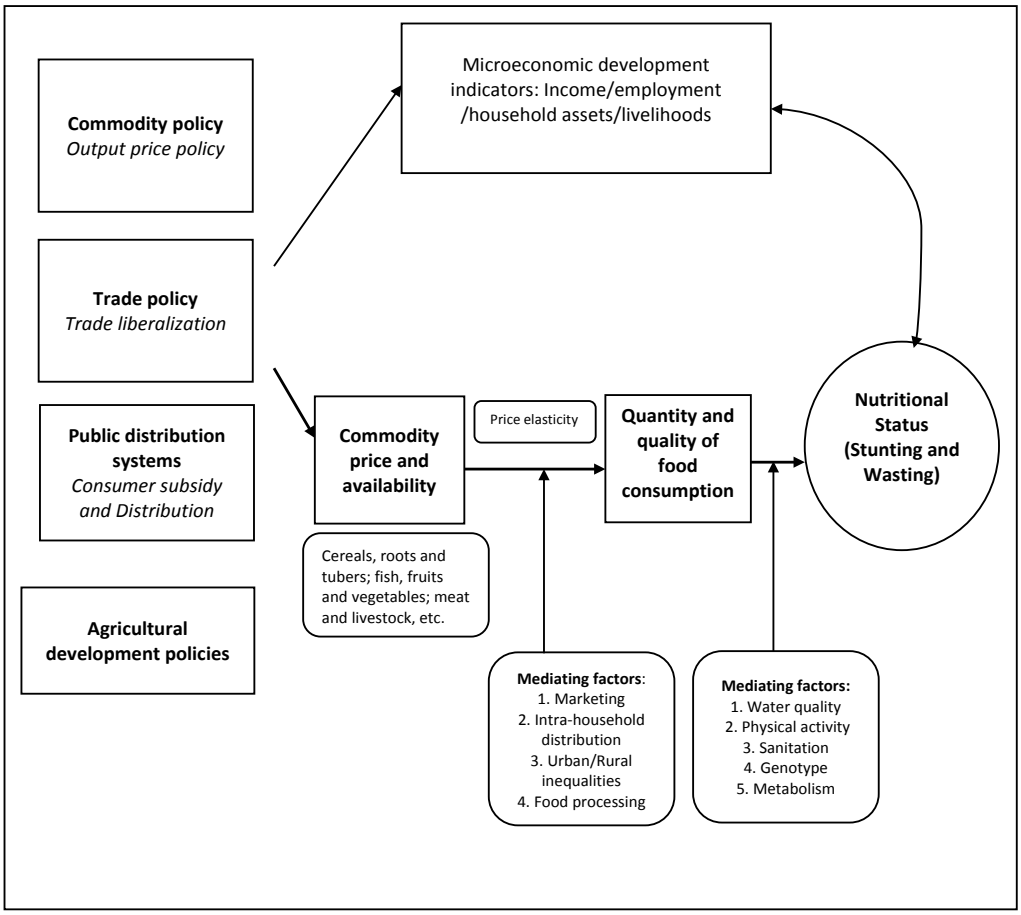
Some relevant literature is worthy to note. For example, Obayelu (2010) examined the effect of food price increases on household nutritional status in Nigeria. The results showed that households reduce their daily food consumption in terms of number and size of meals as a coping strategy and reduce their expenditures on non-staple foods. However, the limited scope of the data (two states in Nigeria) means that policy implications cannot be drawn for the whole country based on the study. Secondly, the study used food consumption as a proxy for nutrition, which is not an adequate measurement of nutrition. Olomola (2013) examined the impact of the 2008 global food price crises on a range of welfare indicators in Nigeria. The study revealed that the deficit between recommended and actual minimum per capita daily protein and calorie intake widened in the period between 2007 and 2008, compared to previous years. Though it provides crucial information related to food consumption responses and nutrient availability of households during this period, it did not investigate the relationship between food price increases and nutrition outcomes in the country. Shittu et al. (2018) went further to investigate the effects of food spikes on household welfare in Nigeria using a nationally representative dataset. They found that spikes in the price of cereals generally have negative consequences for food quantity consumption in terms of calorie and real value of food consumed. Nonetheless, the connection with nutrition outcomes were uncovered.

2. Conceptual framework linking food-price-related agricultural policies with nutrition outcomes

The conceptual framework adopted here draws from the work of Dangour et al. (2013) on the linkage between food-price-related agricultural policies and nutritional status. Although there are several reinforcing or complementing policy and intervention pathways that connect to nutrition outcomes. The key policy interests in this study relates to the food-price-related pathway (highlighted in bold, Figure 1). Food price policies influence nutrition through two major pathways: direct effects on food consumption via food prices or indirectly through income generation. In the first instance (food prices), the relative prices of various food items can influence food expenditure (purchasing power).

The magnitude of the income that can be realized from sales of farm products, and the types and quantities of foods purchased in the markets, can also be substantially influenced by changes (shocks) in food prices. This could affect the quality of household diets and the income of net food sellers. In the second pathway (income generation), having consumed foods from own production, households can sell the remaining farm outputs (surplus) in the market to earn income. The earnings realized from sales of the farm outputs coupled with incomes from other sources can then be used to buy more diverse foods in the market (Gillepsie et al., 2012; Dangour et al., 2013).

Figure 1: Conceptual framework linking food-price-related agricultural policies to nutritional status



Source: Adapted from Dangour et al. (2013).

3. Data and empirical strategies

Data

This study uses the Nigeria Living Standard Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) of 2012/13 and 2015/16. The survey is representative at the geopolitical zone and national levels. Data were collected from households across all 36 states of Nigeria by the World Bank in conjunction with the National Bureau of Statistics (NBS) and cover various aspects of household livelihoods. Relevant to this study are information on household socioeconomic characteristics, values of food consumed, non-food expenditures, childcares variables such as child immunization and use of insecticide-treated bednets for children, and access to safe water sources. Data on food prices, consumer food price index and non-food price index collected by the NBS for the years, months and locations corresponding to the LSMS-ISA survey data were also used. We used the WHO Anthro V3.2.2 software to compute child anthropometric measures. A subset of the data containing agricultural households that have at least one child with valid anthropometric measures was selected for this study. A total of 1,077 farm households in post-harvest wave 2 (2013) and a total of 1,056 in wave 3 (2016) were included. The attrition rate was very small (1.95%) and unlikely to introduce bias in the econometric model estimation.

Empirical strategies

Conceptually, it is believed that the household is the basic unit of decision making and that most of the policy instruments will work through households to have an impact on either farm production or nutrition outcomes. Hence, household as unit of analysis will be maintained and all outcome variables are defined with the household as focus.

We assess the prevalence of child nutrition outcomes (wasting and stunting, respectively) among farm households and their disaggregation by household characteristics. In doing this, we constructed the measures of child nutritional outcomes (weight-for-height z-scores for wasting and height-for-age z-scores for stunting) for each child of the households. This is done to capture the acute and the chronic dimensions of malnutrition among children. A household that had at least one stunted child is considered to experience child stunting (chronic malnutrition), while a household with at least one wasted child is considered to

experience child wasting (acute malnutrition). Descriptive statistics were then used to summarize the prevalence of wasting and stunting according to some household characteristics.

Using a panel probit (correlated random effect probit) regression (Wooldridge, 2013), we examine the effects of shocks in food prices on child nutrition outcomes (wasting and stunting). The analysis was performed to determine the influence of food price shocks on the probability of child wasting and stunting among farm households. Two regression models were estimated. One for the probability of a household experiencing child wasting, and the other for child stunting. The panel probit regression model is specified for each of the dimensions of child nutrition outcomes as follows:

$$N^*_{it} = \emptyset X_{it} + c_i + e_{it} \text{ ,t} = 1, 2, \ldots, \text{T} \quad (1)$$

$$N_{it} = 1(N^*_{it} > 0)$$

N^*_{it} is the latent variable that determines whether a household *i* is classified as having a stunted or wasted child at time *t*. N_{it} is a dummy variable equalling one if at least one child in farm household *i* in time t suffered wasting, and zero if otherwise. The same operationalization is done with respect to stunting. Classification of children according to wasted or stunted is based on the child anthropometric z-scores, $e_{it}|(X_{it}, v_i) \sim N(0,1)$. .

e_{it} represents the idiosyncratic shocks assumed to be serially uncorrelated, c_i is the unobserved household specific heterogeneity assumed to be uncorrelated with the time-varying components of X_i. The correlated random effects probit framework permits c_i to depend on the time average of X_i as follows:

$$c_i = \delta + \vartheta \bar{X}_i + v_i, v_i|X_i \sim N(0, {\sigma_v}^2) \quad (2)$$

X is a matrix of explanatory variables that could be time-varying or time-constant. Combining Equations 2 and 3, the correlated random effects probit regression model can be specified as:

$$N^*_{it} = \emptyset X_{it} + \delta + \vartheta \bar{X}_i + v_i + e_{it} \quad (3)$$

Contained in explanatory variable X are: set of dummy variables capturing sources of drinking water for household; household income (proxy by per capita total expenditure); child received immunization; child slept under treated mosquito nets, household is located in urban sector, household head is married; household head completed secondary school education; a set of dummies depicting the particular geopolitical zone where a household belongs; and age of the household head, quantity weighted shocks in the prices of some food items or groups of foods and non-food items. Adapting the Stone price index formulation and following Tadesse

et al. (2016), the price shock for a particular food item or food group is specified for a given household as:

$$U_{gmt} = \sum_{k}^{g} W_{kgmt} \cdot \ln\left(\frac{P_{kmt}}{P_{kmt-1}}\right) \quad (4)$$

where $\boldsymbol{U_{gmt}}$ is the quantity weighted food price shock for a particularly food item or food group in month *m* of year *t* in a given state of the country. $\boldsymbol{P_{kmt}}$ is the actual or average (representative) price of food k in the m*th* month in the same state in year *t*. $\boldsymbol{W_{kgmt}} = \frac{\boldsymbol{q_{kmt}}}{\boldsymbol{Q_{gmt}}}$ is the share of food *k* in total quantity of food group g consumed by each household at time *t*. The weighted food price shock better reflects the variation in price shocks due to differences in the patterns of household food consumption. The specific food or group of foods are: rice, millet, sorghum, meat, fish, egg, roots and tubers, beans and pulses, fruits, vegetables, dairy proteins, fat and oils, and sugar and sweeteners.

4. Results and discussion

Descriptive Results of Food Price Shocks, Use of Insecticide-treated Bednets and Drinking Water Sources

The results in Table 1 show that the highest mean price shocks recorded is for rice. This suggests that shocks in the price of rice may have grave consequence for the nutritional wellbeing of the farm households, especially if the household is a net consumer of rice. Shocks in the prices of beans and pulses, and fat and oils are also recorded. Further shocks in the prices of these food items may threaten the nutritional wellbeing of the households where the foods are necessary goods and there is limited opportunity for substitutes. The magnitudes of the mean price shocks of fruits, vegetables and fish appear similar over the two time periods, whereas those of rice, sorghum, millet, meat, beans and pulses, roots and tubers, egg, and fats and oils seem higher. Similarly, greater shocks in the prices of these foods over time may limit access to these food items in terms of quantity and quality. The mean price shocks for meat and fish are also different, suggesting a different experience of short-term price upsurges for these food commodities.

Table 1: Summary statistics of food price shocks

Variables	Post-harvest 2013				Post-harvest 2016			
	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
Commodity price shocks								
Rice	0.051	0.137	-0.48	0.416	0.043	0.136	-0.479	0.450
Sorghum	0.002	0.146	-0.70	0.718	-0.007	0.145	-0.703	0.718
Millet	0.021	0.093	-0.41	0.392	0.009	0.106	-0.413	0.392
Meat	0.004	0.211	-0.81	0.739	-0.006	0.209	-0.811	0.739
Fish	0.002	0.070	-0.36	0.516	0.003	0.069	-0.362	0.516
Eggs	0.012	0.058	-0.25	0.334	0.016	0.058	-0.232	0.334
Roots & tubers	0.010	0.183	-1.36	0.673	0.025	0.201	-1.357	0.842
Pulses	0.032	0.191	-0.53	0.870	0.027	0.209	-0.622	0.870

continued next page

Table 1 Continued

Variables	Post-harvest 2013				Post-harvest 2016			
	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
Commodity price shocks								
Fat & oil	0.033	0.156	-0.57	0.659	0.028	0.128	-0.565	0.659
Fruit	0.003	0.004	0.001	0.014	0.004	0.005	0.000	0.014
Vegetables	0.009	0.004	-0.011	0.014	0.010	0.003	0.000	0.014
Milk & dairy	-0.001	0.056	-0.393	0.655	0.001	0.036	-0.393	0.394
Sugar	-0.006	0.106	-0.416	0.417	0.001	0.102	-0.416	0.417
Non-food	0.014	0.008	-0.001	0.041	0.013	0.008	-0.001	0.027

Distribution of prevalence of stunting and wasting among farm households' characteristics

Overall, the results in Table 2 show that the prevalence of stunting increased from 33.24% in 2013 to 47.92% in 2016. Similarly, the rates of wasting increased from 14.02% in 2013 to 18.56% in 2016. This illustrates the rising burden of undernutrition in the country. A much more disaggregated analysis reveals that there is a high prevalence of stunting across the six geopolitical zones of Nigeria, as 5 out of the 6 zones experienced an increase in the prevalence of stunting among farm households from 2013 to 2016. The North-West has the highest prevalence of stunting in 2016 (63.59%), followed by the North-East (56.15%) and North-Central (39.33%). Conversely, the South-South experienced a decline in the prevalence of stunting from 29.13% in 2013 to 27.78% in 2016.

This agrees with the reports by the National Population Commission (NPC) Nigeria and ICF International (2014), UNICEF (2015) and USAID (2018), which consistently show that the prevalence of stunting was highest among children living in the North-West and North-East geopolitical zones of Nigeria. This may be related to the high rate of conflict and poor socioeconomic conditions of most households in these regions (Mercy Corps, 2015). Furthermore, the prevalence of wasting increased in 4 out of 6 geopolitical zones of the country between 2013 and 2016. In particular, the prevalence of wasting increased sharply from 16.31% in 2013 to 28.76% in 2016 in the North-West and almost doubled from 14.04% in 2013 to 24.53% in 2016 in the South-West. However, it increased slightly in the North-East (12.06% to 13.11%) and declined in North-Central (15.2% to 12.0%), South-East (10% to 9.84%), and South-South (13.59% to 11.11%) between 2013 and 2016. These results suggest that appropriate interventions to reverse the rapid increase of wasting in the North-West and South-West geopolitical zones are needed in order to significantly lower the prevalence of wasting in Nigeria.

Table 2: Prevalence of stunting and wasting by selected household characteristics

Variable	Stunting		Wasting	
Characteristics	**2013**	**2016**	**2013**	**2016**
Location				
Urban	22.48	44.44	11.63	20.37
Rural	34.70	50.32	14.35	18.35
Geopolitical zone				
North-Central	35.01	39.33	15.46	12.00
North-East	37.59	56.15	12.06	13.11
North-West	34.74	63.59	16.31	28.76
South-East	23.64	35.25	10.00	9.84
South-South	29.13	27.78	13.59	11.11
South-West	22.81	28.30	14.04	24.53
Education level				
Below secondary education	37.80	56.91	14.25	21.81
Above secondary education	29.97	45.74	13.84	16.76
Drinking water sources				
Tap/pipe-borne water	28.36	53.41	14.49	23.86
Borehole	33.33	44.37	11.34	17.88
Well	33.13	50.09	13.87	20.22
River/ lake	36.17	51.66	20.21	13.25
Rain/vendor/sachet/bottle/other	29.17	48.33	10.42	15.00
Sex of household head				
Female	31.88	51.33	14.49	17.26
Male	33.56	49.28	13.90	18.92
Poverty status (income classification)				
Poor (relatively low income)	36.01	55.85	15.43	21.15
Not poor (relatively high income)	30.96	44.46	12.86	16.34
Use of treated mosquito bednets for child				
Child slept under treated bednets	32.12	46.77	12.07	17.28
Child did not sleep under treated bednets	34.01	51.92	15.36	19.39
Marital status				
Married	31.41	46.73	13.14	17.70
Otherwise (single, divorced, widowed)	38.49	54.08	16.55	19.81
Overall	33.24	49.72	14.02	18.56

Although the prevalence of stunting increased in both urban and rural households between 2013 and 2016, rural households had a higher prevalence of stunting in 2013 and 2016 than urban households. Similarly, the prevalence of wasting was higher among rural households in 2013 relative to those in urban areas. These findings are consistent with those reported by NPC Nigeria and ICF International (2014), and USAID

(2018) which stated that rural children are more likely to be malnourished than urban children in Nigeria. However, the prevalence of wasting among urban households was slightly higher in 2016, and the rate of change in stunting and wasting across the two time periods suggest that the problem of malnutrition is hitting harder on the urban sector than the rural sector. This may be connected to high rate of urban population growth in Nigeria (UNICEF, 2014). Ruel et al. (2017) also connect this to challenging food environment and large dependence on food purchase in urban areas, rising poverty and poor safety nets for urban poor, and inadequate access to healthcare, safe water, and sanitation which often results in severe health challenge, particularly among urban poor in growing cities.

The prevalence of stunting was higher among households whose heads had an education below secondary school level, and wasting prevalence appears to increase with decreasing educational achievement. These findings are consistent with what has been reported in the literature (Benson et al., 2017; Fadare et al., 2019). Households headed by a female had higher stunting (31.88% in 2013 and 51.33% in 2016) and wasting prevalence (14.49% in 2013 and 17.26% in 2016). Although wasting prevalence was observed to be slightly higher among male-headed households (18.92%) in 2016. This is supported by Ayogu et al. (2018).

The burden of child undernutrition appears to be lower among household whose heads are married compared to the other household groups. With respect to the sources of drinking water for the households, the general pattern is that of an increased rate of wasting and stunting between 2013 and 2016. Households that sourced drinking water from river water had the highest prevalence of wasting across the time periods, compared to households that obtained drinking water from other sources. In addition, households that utilize insecticide-treated bednets for children had a lower prevalence of stunting and wasting relative to those who did not use the nets, across the years. Child stunting and wasting is consistently higher among poor farming households over the time periods covered by the analysis. The question whether the observed variation in the prevalence of child wasting and stunting across the different households is substantial from a statistical standpoint is examined in the econometrics analysis in the next section.

Results of the determinants of undernutrition among farm households in nigeria

The econometric results of the influence of price shocks, income and other factors on the likelihood of child undernutrition (stunting and wasting) among farm households are presented and discussed here. Two strands (models) of probit regression models were estimated for correlated random effects (CRE) and the pooled probit versions of the panel probit model for wasting and stunting. In the first strand (Model 1), the per capita household income (proxy by total expenditure) was included as one of the independent variables, and in the other (Model 2) the income variable was transformed

into a dummy variable that equals 1 for a household that is classified as relatively poor, and 0 for the relatively non-poor. The estimated log pseudo-likelihood value, the Wald chi-square value and the associated p-value (which is below 0.05) for each of the estimated models suggest overall significance of each estimated model. This implies that the estimated models could be relied upon to explain the relationships between the likelihood of child undernutrition and the identified influencers. In the CRE probit models, the estimated likelihood ratio (rho) value and the associated p-value (which is above 0.05) for each of the estimated CRE probit models indicate an absence of serial correlation in the idiosyncratic errors. Given that the assumption of conditional independence of the idiosyncratic errors cannot be rejected in the estimated CRE probit models, the discussion of results therefore focusses more on the pooled probit models.

Food price shocks effect on stunting among farm households in nigeria

The results of factors influencing the likelihood of child stunting among farm households in Nigeria are presented in Table 3. The coefficients of shocks in price of rice and vegetables are statistically significant while the coefficients of shocks in the prices of other food items are statistically insignificant. This suggests that higher shocks (extreme price rises) of rice and vegetables are stronger determinants of prevalence of child stunting among farm households in Nigeria. Thus, policy efforts and interventions that seek to curtail excessive rises in the prices of rice and vegetables are crucial for the reduction of child nutrition. These findings are in accordance with the work of Woldemichael et al. (2017), which indicates a positive relationship between higher prices of some cereals and the risk of child stunting in Ethiopia. Extreme rises in the price of vegetables may limit affordability and consumption of nutrient-dense vegetables (which are vital for improved nutrition outcomes), thereby increasing the risk of stunting. There are reports indicating a positive association between higher consumption of vegetables and lower susceptibility to stunting (Keatinge et al., 2011; Melaku et al., 2018). It can be inferred that for food price policy to be more nutrition sensitive and advance nutrition outcomes it must curtail extreme rises in the price of rice and vegetables.

The findings hold enormous implications for research on the domestic and international triggers and drivers of shocks in the prices of rice and vegetables, and how policy actions can be geared towards mitigating excessive rises in their prices. Some of the efforts could entail actions to prevent post-harvest losses, maintenance of strategic grain storage and buffer stock operations, ensuring more efficient market functioning, sensitively guided trade policies, and farm-level input subsidies to boost farm production through provision of improved seeds and agrochemicals and other technological measures. There are also implications for output expansion in rice and vegetables, through farm input subsidies.

Table 3: Effects of food price shocks on child stunting among farm households

Variables	Stunting model 1				Stunting model 2			
	Pooled probit model 1		Correlated random probit model 1		Pooled probit model 2		Correlated random probit model 2	
	Coeffi	Std Err	Coeffi	Std Err	Coeffi	Std Err	Coeffi	Std Err
Borehole	0.140	0.231	0.125	0.251	0.111	0.272	0.116	0.251
Well	-0.137	0.217	-0.165	0.241	-0.172	0.262	-0.158	0.241
River/lake	-0.277	0.237	-0.292	0.263	-0.290	0.276	-0.296	0.263
Rain/vendor/sachet/bottle/other	-0.006	0.168	-0.043	0.328	-0.052	0.351	-0.052	0.328
Ln(per capita income)	-0.065	0.041	-0.169	0.114	-	-	-	-
Income poverty	-	-	-	-	0.208	0.143	0.073	0.083
Treated bednets	-0.137**	0.057	-0.137**	0.058	-0.138**	0.057	-0.138**	0.058
Immunization	-0.120	0.125	-0.123	0.121	-0.118	0.125	-0.118	0.121
Household head age	0.002	0.004	0.002	0.004	0.002	0.004	0.002	0.004
North-East	0.313***	0.102	0.315***	0.103	0.314***	0.102	0.311***	0.103
North-West	0.340***	0.087	0.342***	0.089	0.340***	0.088	0.338***	0.089
South-East	0.015	0.134	0.010	0.138	0.005	0.134	0.013	0.138
South-South	-0.087	0.130	-0.092*	0.131	-0.100	0.129	-0.095	0.131
South-West	-0.294*	0.169	-0.299	0.166	-0.311*	0.168	-0.305*	0.166
Urban sector	0.261	0.332	0.358	1.337	0.353	0.361	0.253	1.334
Married household head	-0.458**	0.193	-0.454**	0.219	-0.462**	0.194	-0.463**	0.219
Male household head	-0.172	0.133	-0.172	0.134	-0.171	0.133	-0.172	0.134
Head had secondary education	-0.078	0.159	-0.082	0.156	-0.081	0.160	-0.078	0.156
Rice price shocks	1.040**	0.477	1.031**	0.472	1.061**	0.479	1.050**	0.472
Sorghum price shocks	0.480	0.617	0.494	0.615	0.528	0.625	0.487	0.616

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Table 3 Continued

Variables	Stunting model 1				Stunting model 2			
	Pooled probit model 1		Correlated random probit model 1		Pooled probit model 2		Correlated random probit model 2	
	Coeffi	Std Err	Coeffi	Std Err	Coeffi	Std Err	Coeffi	Std Err
Millet price shocks	0.686	0.639	0.671	0.718	0.664	0.639	0.682	0.717
Meat price shocks	0.327	0.307	0.329	0.287	0.319	0.307	0.319	0.287
Fish price shocks	1.043	0.838	1.016	0.877	1.053	0.841	1.053	0.877
Egg price shocks	-0.655	1.177	-0.709	1.132	-0.698	1.185	-0.653	1.130
Root &tuber price shocks	-0.434	0.299	-0.431	0.310	-0.427	0.301	-0.433	0.309
Pulses price shocks	0.320	0.359	0.334	0.351	0.334	0.363	0.322	0.350
Fat & oil price shocks	0.019	0.449	0.024	0.446	0.027	0.448	0.016	0.445
Fruit price shocks	-1.916	13.238	-0.404	12.527	-0.374	13.333	-1.974	12.460
Vegetable price shocks	45.260*	23.392	49.011**	24.332	42.797*	23.135	42.758*	23.933
Milk & dairy price shocks	0.426	1.042	0.381	1.147	0.401	1.027	0.434	1.146
Sugar price shocks	0.352	0.628	0.349	0.534	0.339	0.631	0.347	0.534
Non-food price shocks	3.561	18.200	4.803	19.303	3.699	18.218	2.965	19.194
Constant	-0.129	0.322	-0.245	0.358	-0.583	0.209	-0.524	0.478
Log pseudolikelihood	-1363.315		-1362.844		-1363.126		-1363.55	
Wald chi2	172.690		158.110		173.690		157.030	
Prob> chi2	0.000		0.000		0.000		0.000	
lnsig2u			-13.706	34.265			-13.712	34.347
sigma_u			0.001	0.018			0.001	0.018
Rho			1.12e-06	3.80e-05			1.11e-06	3.80e-05
LR test of rho=0: chibar2(01)			5.1e-05				5.1e-05	
Prob>= chibar2			0.497				0.497	

Significance: * p < 0.10, ** p < 0.05, *** p < 0.01

The results further suggest a statistically significant relationship between income and the likelihood of child stunting. This implies that increased income is unlikely to lead to a substantial reduction in child stunting among farm households in the country and, as such, economic growth is unlikely to automatically lead to reductions in child stunting. This agrees with Vollmer et al. (2014) who found a very small to null quantitative relationship between gross domestic product growth and stunting in low- and middle-income countries. Nonetheless, Biadgilign et al. (2016) found that income growth has a strong reduction effect on child stunting in Ethiopia. Likewise, a re-analysis based on classification of the income variable into income poverty status also indicates a statistically insignificant coefficient of the income poverty dummy. There can be several reasons for this. First, stunting is characterized by a longer lead time and may be difficult to reverse (once it is experienced), even with a substantial improvement in the economic condition of the household. Second, if income increases, households may not necessarily spend the additional income on items that enhance the nutritional status of children. This raises concerns about household consumption (and resource allocation) patterns especially as it relates to spending on items (food and non-food) that have more direct impacts on nutrition, and the intra-distribution of food distribution patterns.

Furthermore, the coefficient of insecticide-treated bednets is negative and statistically significant. This implies that using insecticide-treated bednets for children to sleep (which reduces the incidence of Malaria and associated illnesses) can substantially reduce the probability of stunting among farm households. Some recent studies (Gari et al., 2018; Oldenburg et al., 2018) showed that Malaria infection was a risk factor that significantly increased a child's chances of being stunted. The results also indicate that the marital status of the household head, as well as the specific geopolitical zone of the households, have an influence on the likelihood of child stunting. Specifically, households in the North-East and North-West zones have a higher probability of experiencing child stunting compared to those in the Southern region. This may be related to some cultural issues and a higher prevalence of poverty and violent conflicts in parts of the region. The coefficient of each of the sources of drinking water is statistically insignificant, indicating that the source of drinking water may hold little significance for child stunting among the households.

Food price shocks effect on wasting among farm households in Nigeria

The results of factors influencing the likelihood of child wasting among farm households in Nigeria are presented in Table 4. The coefficients of shocks in the price of fish and dairy proteins are positive and statistically significant. This suggests higher shocks in the price of these food items can substantially enhance the risks of child wasting in households. A sharp rise in the price of a food item would normally result in lower consumption of the food, which may result in compromised nutrition outcomes. Ali et al. (2017) found a statistically significant relationship between low consumption of animal source foods (including fish) and lower weight-for-height z-scores (i.e., wasting) among

Table 4: Effects of food price shocks on child wasting among farm households

Variables	Wasting model 1				Wasting Model 2			
	Pooled probit model 1		Correlated random probit model 1		Pooled probit model 2		Correlated random probit model 2	
	Coeffi	Std Err	Coeffi	Std Err	Coeffi	Std Err	Coeffi	Std Err
Borehole	-0.271	0.316	-0.281	0.307	-0.291	0.314	-0.285	0.306
Well	-0.143	0.303	-0.156	0.293	-0.178	0.301	-0.138	0.292
River/lake	0.048	0.335	0.058	0.320	0.060	0.331	0.047	0.320
Rain/vendor/sachet/bottle/other	-0.177	0.392	-0.176	0.410	-0.173	0.392	-0.187	0.409
Ln(per capita income)	-0.080	0.101	-0.157	0.138	-	-	-	-
Income poverty	-	-	-	-	0.311*	0.169	-0.021	0.105
Treated bednets	-0.118	0.072	-0.128*	0.075	-0.121*	0.072	-0.127*	0.075
Immunization	-0.108	0.131	-0.118	0.152	-0.100	0.131	-0.112	0.151
Household head age	-0.001	0.004	-0.001	0.005	-0.001	0.004	-0.001	0.005
North-East	-0.070	0.124	-0.079	0.134	-0.067	0.123	-0.078	0.134
North-West	0.360***	0.105	0.373***	0.114	0.354***	0.104	0.373***	0.114
South-East	-0.059	0.181	-0.086	0.182	-0.119	0.178	-0.085	0.181
South-South	0.022	0.159	0.006	0.168	-0.037	0.158	0.008	0.167
South-West	0.345*	0.193	0.349*	0.197	0.275*	0.190	0.350*	0.197
Urban sector	1.303	0.810	1.459	1.721	1.419	0.889	1.297	1.714
Married household head	0.048	0.250	0.049	0.265	0.038	0.247	0.043	0.265
Male household head	-0.213	0.160	-0.219	0.167	-0.209	0.160	-0.222	0.167
Head had secondary education	0.354*	0.192	0.366*	0.195	0.345*	0.192	0.379*	0.194
Rice price shocks	-0.624	0.520	-0.651	0.602	-0.587	0.520	-0.659	0.601
Sorghum price shocks	-1.530**	0.641	-1.621**	0.818	-1.448**	0.639	-1.648**	0.815

continued next page

Table 4 Continued

Variables	Wasting model 1				Wasting Model 2			
	Pooled probit model 1		Correlated random probit model 1		Pooled probit model 2		Correlated random probit model 2	
	Coeffi	Std Err	Coeffi	Std Err	Coeffi	Std Err	Coeffi	Std Err
Millet price shocks	-0.024	0.787	-0.047	0.869	-0.079	0.779	-0.014	0.867
Meat price shocks	0.390	0.326	0.410	0.363	0.386	0.323	0.401	0.362
Fish price shocks	3.605***	0.970	3.794***	1.113	3.582***	0.953	3.814***	1.111
Egg price shocks	0.372	1.328	0.320	1.429	0.303	1.311	0.403	1.426
Root & tuber price shocks	0.159	0.326	0.176	0.380	0.174	0.320	0.158	0.378
Pulses price shocks	0.243	0.399	0.262	0.464	0.256	0.394	0.242	0.463
Fat & oil price shocks	-0.481	0.527	-0.517	0.557	-0.461	0.527	-0.517	0.556
Fruit price shocks	14.380	14.250	16.249	15.113	16.577	14.512	13.778	15.006
Vegetable price shocks	-19.474	25.101	-18.417	28.933	-23.365	26.061	-23.867	28.450
Milk & dairy price shocks	2.261**	1.131	2.331	1.430	2.175**	1.111	2.365*	1.428
Sugar price shocks	0.356	0.615	0.381	0.651	0.334	0.606	0.376	0.649
Non-food price shocks	9.055	19.595	10.439	23.846	8.534	19.442	7.996	23.732
Constant	0.252	0.457	0.026	0.450	-1.096	0.253	0.106	0.601
Log pseudolikelihood	-894.877		-894.792		-898.136		-895.416	
Wald chi2	107.790		74.95		105.260		74.630	
Prob> chi2	0.000		0.046		0.000		0.049	
lnsig2u			-2.250	1.098			-2.313	1.158
sigma_u			0.325	0.178			0.315	0.182
rho			0.095	0.095			0.090	0.095
LR test of rho=0: chibar2(01)			1.010				0.900	
Prob>= chibar2			0.158				0.172	

Significance: * p < 0.10, ** p < 0.05, *** p < 0.01

under-five children in Northern Ghana. Policies that will guarantee access to fish and dairy products within the context of the economic circumstance of the country are likely to be crucial for the reduction of child wasting in Nigeria. It is also acknowledged that although nutrition-sensitive agricultural commodity-specific pricing policies are critical for better nutrition outcomes, the effect on nutrition may be limited without a substantial improvement in income, and recognition of the complementary efforts from, and synergies with, relevant interplaying sectors such as education and health.

The results thus show that a statistically insignificant relationship between income (proxy by per capita household expenditure) and the likelihood of child wasting. The finding is similar to the work of Vollmer et al. (2017), which showed a null to quantitatively very weak association between economic growth and a reduction in child wasting in low- and middle-income countries. However, the finding contradicts Biadgilign et al. (2016) who found a significant and inverse relationship between income growth and child wasting in Ethiopia. A further analysis of our income variable based on classification according to income poverty status (relatively income poor and non-poor household dummy) indicates a statistically significant and positive coefficient of the income poverty dummy. This shows that wealthier households have a lower probability of experiencing child wasting compared to poor households. Our finding therefore shares some similarity with Biadgilign et al. (2016) in Ethiopia. It can be inferred that an income-related intervention that is targeted at poor households may be more effective in reducing the overall prevalence of wasting among farm households in the country than a general (distribution-neutral) income growth strategy. Broadly, income can be utilized to purchase foods that are not produced by the households and other nutrition-related non-food items (Ahamad et al., 2013; Omondi and Kirabira, 2016) which, all else being equal, should result in a reduction of the likelihood of wasting. Nevertheless, Vollmer et al. (2017) noted that if growth in incomes is unequally distributed, so that poor people are excluded from the benefits of economic prosperity, the reduction effect (of the income growth) on under-nutrition could be low, on average.

The results indicated that some variables are significant. Households whose heads had an educational level below secondary school have a greater likelihood of having a child experiencing wasting. This resonates with the work of Vollmer et al. (2017), which revealed a negative relationship between higher parental (both paternal and maternal) education and child wasting. Glewwe (1999) argues that formal education equips future parents with direct nutrition and health knowledge, which positively influences their child nutrition. Some studies (Frost et al., 2005; Abuya et al., 2011; Fadare et al., 2019) have shown that parental level of education plays a positive role in enhancing child nutritional status in developing countries. Using insecticide-treated bednets for children to sleep (which reduces the incidence of Malaria and associated illnesses) will reduce the probability of wasting. This finding also corroborates some research (for example, Sage, 2017) that notes a strong connection between having mosquito nets in the household and a lower risk of child wasting. However, the source of drinking water for the household appears to have little significance for child wasting among the households.

5. Conclusion and recommendations

An understanding of how food prices interact to shape nutrition outcomes is vital for formulating nutrition-sensitive food-price-related agricultural policies to improve the nutritional outcomes of children in Africa. Nigeria needs such a pricing policy, especially given the historical experiences of food price shocks, with possible upward future trends. The possibility that Nigeria's agricultural policy emphasis would tilt towards an incentive food product pricing strategy for farmers also presents a unique opportunity for such a policy to be made more nutrition sensitive. Empirical studies that seek to examine the effects of food price shocks on nutrition outcomes are therefore critical for policy design. Consequently, this study focussed mainly on the nexus between food price shocks and nutrition outcomes, while also accounting for the role that income, education, and interventions from other relevant nutrition/health programmes could play in the evolution of stronger and coherent policy pathways for better nutrition outcomes in Nigeria.

Using a nationally representative agricultural household data, we found a higher prevalence of child wasting and stunting concentrated in Northern Nigeria, and in households characterized by low income, low level of education, and no utilization of insecticide-treated bednets. The results of the econometric analyses suggest that, except for the prices of rice, vegetables, fish and milk/dairy proteins, more severe shocks in the retail prices of foods are unlikely to substantially increase the prevalence of child undernutrition. Specifically, severe shocks in the price of rice and vegetables can substantially enhance the risks of child stunting while a higher prevalence of child wasting is positively associated with greater shocks in the prices of fish and milk/dairy proteins. Increased income, higher educational attainment and use of insecticide-treated bednets for child to sleep reduce the likelihood of experiencing child stunting and/or wasting. The findings suggest that agriculture-led food price policies that aim at promoting agriculture through higher price incentives (for farmers) on crop/livestock products are unlikely to pose a serious nutritional threat to farm households, provided that rice, vegetables, fish and dairy proteins are shielded from such price increases.

Nonetheless, considering the nutritional effects for both consumer and producer populations, for food price policy to be more nutrition sensitive it should be well guided, and geared towards calming excessive surges in food prices and, specifically the prices of vegetables, rice, fish and dairy proteins. These results have policy and programme implications for strategic grain reserve and buffer operations, a reduction

of post-harvest losses, minimum support price on farm outputs, taxes along marketing chains, agricultural trade policy on food supply (importation), and consumer-oriented subsidies, especially for the poorest household groups. It is also acknowledged that the effects of the food pricing policy on nutrition outcomes may be dampened without substantial improvement in income, access to higher education and interventions from the health sector.

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