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Determinants of food availability and access in Ghana: what can we learn beyond the regression results?

The study analyses the determinants of food availability and access, and the causes of unsustainable food access in Ghana using three models. Regression results show that the effects of energy price, domestic and foreign interest rates, domestic prices and exchange rate on food availability are negative, while the effects of crop yield, arable land, liberalisation of agricultural trade and real income are positive. The analysis further shows the unique effects of energy price and human capital exceed their common effects. However, the common effects of domestic and foreign interest rates, inflation, crop yield, arable land, exchange rate, liberalisation of agricultural trade and income exceed their unique effects. The access model shows that the effects of domestic interest rate, exchange rate and oil price are negative. The unique effect of oil price exceeds the variable's common effect. However, the common effects of exchange rate, interest rate and income exceed their unique effects. The stability model shows that good news and higher incomes enhance sustainable food access. However, higher oil price and depreciation of the local currency distort sustainable food access. The policy implication is that government should jointly target variables with higher common effects when addressing food access and availability. Withdrawal of government fuel subsidy will increase consumers' risk of accessing food and hence threaten the sustainability of food access.

Keywords: physical availability of food, economic access to food, food security, Ghana

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Introduction

Developing economies continue to make strides in key aspects of their economy. Growth rates are on average encouraging, and there has been progress in infrastructural development and in moderating mildly the poverty rates in these regions. However, most of their populations remain undernourished due to either the non-availability of food or the lack of the economic means to access nutritious food that meets their energy dietary requirement. In 2008 and 2009, for instance, FAO estimated that the share of the population in developing countries suffering from hunger increased to nearly 20 per cent. In sub-Saharan Africa, estimates show an increase in the proportion of undernourished from 28 per cent in 2004/2006 to 29 per cent in 2008 (UN, 2009). Food insecurity due to either supply limitations or economic constraints has led governments to institute both medium-term and long-term programmes to address the problem. These include government safety net programmes such as subsidies on food and farm inputs and reductions in import taxes on food. In spite of these attempts, the number of undernourished and hungered households and individuals continues to surge. A major factor that influences food security is the availability of food at the country level which depends on domestic production and the ability of economies to import healthy and nutritious food. For instance, in sub-Saharan Africa, a food insecure region, the per capita dietary energy balance is negative. This is an indicator of a major food availability problem.

In Ghana, the recent economic achievements have been at the expense of the agricultural sector which is the largest employer employing about 41 per cent of all workers. The share of the agricultural sector in total GDP now stands at 26 per cent. Annual growth of the sector has decreased from 7 per cent in 2009 to 0.8 per cent in 2011 (Hjelm and Dasori, 2012). The major reason is that government expenditure on this sector has fallen from 4.1 per cent in 1990 to 0.7 per cent in 2000 (Global Nutrition Report, 2014). The implication is that income levels of people whose livelihoods largely depend on the agricultural sector are falling. Coupled with seasonal variability in weather, this has led to reduced food production in the country. Also, the continuous depreciation of the Ghana cedi (GHS) and the high inflation rates mean that the real wealth of these people is declining, posing food security concerns. What makes this crucial is that a large share of household budgets in Ghana is devoted to food expenditure. Consequently, food insecurity has increased in the country. For instance, in northern Ghana (the most food insecure region) 680,000 people are considered either severely or moderately food insecure (Hjelm and Dasori, 2012). The under-five mortality (72 deaths per 1,000 live births) and under-five stunting (23 per cent) rates remain high (Global Nutrition Report, 2014). It is no surprise that the country is ranked as the 33rd most undernourished country out of 83 countries (Global Nutrition Report, 2014). The current situation raises doubts about the sustainability of the current economic achievements in the country.

The 1970s definition of food security as a supply problem has since been contested. Sen (1981) argues that food insecurity is more of a demand issue, affecting the poor's access to food, than a supply issue, affecting availability of food at the national level. According to Smith *et al*. (2000), food insecurity is weakly linked to national food availability. Food security was defined at the 1996 World Food Summit as "people having at all times, physical, social and economic access to sufficient, safe and nutritious food which meets the dietary needs and food preferences for an active and healthy life" and includes stability and utilisation. Defined this way, food security has four distinct dimensions (availability, access, utilisation and stability) that are classified as indicators. Determinant indicators (availability and access) refer to the structural conditions that worsen or improve food security whilst outcome indicators (utilisation) capture results in terms of inadequate food consumption or anthropometric failures. The stability dimension is closely connected to availability and access as this requires attained food security to be sustainable. While it is important to ensure short-term

food availability and access, what is critical in the long term is to ensure stable food supply and food access. However, empirical studies on determinants of sustainable food access and availability are limited.

This study examines the determinants of food availability and access, and factors that can affect sustainability of food access at the aggregate level using data from Ghana. Availability covers both aggregate food availability and maize availability. Access and stability focuses on the maize crop since it is a major crop for food security in Ghana. The study analyses the roles of information (i.e. good and bad news) and economic factors in explaining sustainable food access. In this regard, a loose definition of food security is adopted since this study excludes the utilisation dimension. The reason is that long time series data for this dimension are unavailable.

Determinants of food security

The theoretical determinants of food security include income changes, distribution of income, education, land availability, yield of crop and land, waste in the food system, food prices and climate change (Laborde *et al*., 2013; Maetz, 2013). Higher incomes mean that the share of income spent on food will be less and therefore individuals are less vulnerable to price variation (Laborde *et al*., 2013). Also, higher income will increase the purchasing powers of individuals which means that they become more food secure. However, higher income is not a *prima facie* to improvements in food security as this depends on the pattern of income distribution. Even distribution of income will mean improvement in food security, but uneven distribution will adversely affect food security outcomes. Increased waste in the food system will adversely affect food availability. The limited physical availability of food giving demand will result in higher food prices which can distort consumers' access to food.

Higher energy price, increase in demand for biofuels, changes in the structure and level of food demand, speculation on financial and commodity markets, instability of currency exchange rates and restrictions on exports by some countries were among the factors that contributed significantly to the 2007-2008 food crisis (Maetz, 2013). Maetz (2013) argues that these factors predominantly were short-term oriented and that in the long term food security is likely to be affected by (a) level of agricultural investment, (b) climate change and (c) increasing fossil fuel prices. While the factors listed above are important for determining short-term food security, the stability dimension of food security becomes crucial in the long term. Maetz (2013) outlines that stable access and availability of food is affected by climate change, economic shocks and seasonality of agricultural production.

Empirical studies on national food security have centred on the macro determinants of either food availability or food access. At the macro level, both demand-side and supply-side factors underlie food security trends in any economy. The relative importance of demand-side and supply-side factors have been argued by Feleke *et al*. (2005) who found that the latter are more powerful determinants of food security than the former. Counter arguments in favour of demand-side variables have also been documented (Kargbo, 2000; Carter *et al*., 2010; Herath *et al*., 2014; Tadese *et al*., 2014). However, the argument is neither here nor there as these variables can be viewed either directly or indirectly as supply or demand variables.

Crude oil price has both demand- and supply-side effects on food security. Rising oil price causes a substitution effect which increases biofuel demand. This causes a decline in food supply. Abbot *et al*. (2008), Mitchell (2008), Schnepf (2008) and von Braun *et al*. (2008) show that biofuel demand is the largest demand-induced price pressure. From the supply perspective, oil prices affect the price of fertilisers and chemicals used in crop production. Also, rising oil price increases transportation cost. All these mechanisms cause production costs to increase and, therefore, decrease food availability and accessibility. Mercer-Blackman *et al*. (2007), Headey and Fan (2008), Thomson *et al*. (2009), Vansteenkiste (2009), Bafes and Haniotis (2010), Algieri (2013), Tang and Xiong (2013) and Tadese *et al*. (2014) find support for a link between oil price and food security. However, Lombardi *et al*. (2010) did not find a link between oil price and food security.

Interest rate changes produce both demand- and supply-side effects. From the demand side, lower interest rate implies lower opportunity cost for holding stock/inventory. However, higher interest rate will discourage stock holdings due to higher opportunity cost for holding stock. Thus, lower interest rate or financial repression will cause the switch from Treasury bill holdings to agricultural contracts. It is suggested that the 2007/2008 food price hike was a result of speculative behaviour from the financial sector (Frankel 2008; Tadese *et al*. 2014). However, Krugman (2008) argues that if that were so then the world should have experienced increases in inventories which did not happen. Thus, according to Krugman (2008), speculative behaviour from the financial market cannot explain the 2007/2008 food price hike. From the supply side, interest rate represents the cost of capital. Rising interest rate imposes credit constraint especially on smallholder farmers who lack collateral. In developing countries such as in sub-Saharan Africa where agricultural activities are highly subsistence based, rising interest rate will adversely affect the scale of crop production and hence food security. Even for successful farmers, higher interest rate would mean higher cost of production and that will change the scale of production and the producer price of food. Thus, both food availability and accessibility are adversely affected with higher cost of capital. Vansteenkiste (2009), Byrne *et al*. (2013) and Algieri (2013) find support for a link between interest rate and agricultural commodity prices. Lombardi *et al*. (2010), however, did not.

Rising national income affects food security both via the supply and demand links. Rising national income means higher propensity to import by the domestic economy. As a result, food availability increases via higher import demand for food. Also, rising national income makes it possible for farmers to adopt high yielding varieties, apply fertilisers and pesticides, and use farm machinery, leading to higher crop yields and hence food availability. Lastly, rising national income implies higher domestic demand which conditioned on domestic supply can cause food prices to increase, making accessibility difficult if not impossible. Kargbo (2000), Carter *et al*. (2010), Herath *et al*. (2014) and Tadese *et al*. (2014) find

that rising gross domestic product (GDP) affects food security positively. Also, where rising GDP causes behavioural change among consumers, such as switching to the consumption of non-food products, demand for food will decrease, and this will be outweighed by supply. As a result, food prices will fall. This will improve both food availability and accessibility.

Depreciation of the local currency against the major trading currencies is also closely linked to food availability and access. Rising exchange rate implies higher prices for imports. Thus, depreciation of the local currency reduces the countries' ability to import, and that affects the aggregate food available for consumption. Also, increase in exchange rate affects agricultural activities through its impact on input prices. Higher input prices will cause domestic agricultural production to fall and hence affect food availability adversely. Thirdly, rising exchange rate causes internal inflation which reduces households' real income. Lower households' real income means less command over food. Kargbo (2000), Awokuse (2005), Kargbo (2005), Asfaha and Jooste (2007), Headey and Fan (2008), Mitchell (2008), Vansteenkiste (2009), Lombardi *et al*. (2010), and Algieri (2013) show that rising exchange rate significantly increases agricultural commodity prices. This was, however, not established by Akbari and Rankaduwa (2005).

Climate change can affect crop yield and agricultural productivity. Armah *et al*. (2011) indicate that climate change affects fertile land for agricultural production which reduces agricultural production. Gregory *et al*. (1999) indicate that the decrease in crop production and hence yield of wheat was a consequence of warming. In Ghana, Asante (2004) shows that the drought in 1981-1983 caused crop production to decline while Sagoe (2006) finds that root crop production was significantly influenced by variability in rainfall from 1970 to 2003. More generally, Herath *et al*. (2014) find a positive impact of irrigated land area on food security. Gregory *et al*. (2005), Misselhorn (2005), Badolo and Somlamare (2014) and Van Dijk *et al*. (2014) also show that climate variability/change can adversely affect food security.

The importance of human capital development, especially in farming communities, to food security has been established. A trained and healthy person is important for production and income increases because adaptation to and adoption of technology becomes tranquil. Gani and Prasaad (2007) find a positive correlation between food availability and calories and human development. Sakyi (2012) finds that education affects mild-to-moderate and severe food insecurity. Also, Foley *et al*. (2009) find that lower education is linked to higher food insecurity. The importance of land availability to food security has also been examined. Especially in sub-Saharan Africa where there are many land litigations, the association between land availability and food security is strong. Drafor *et al*. (2013) show that making one additional acre of land available to farmers increases production and farmers' income.

Methodology

The contribution of this paper lies in its broader scope: it looks both at national and commodity-specific food security. Also, it looks at the stability dimension of food security by examining how good and bad news, crude oil price, interest rate, exchange rate and real income per capita can affect volatility shock in maize prices (which is used as a measure of sustainable economic access to food). Thus, it examines consumers' risk factors of accessing food. Previous studies have analysed the access dimension of food security using the national consumer price index of food as a proxy. However, reference to the national average basket may not reveal information on the changes in the price of food items that are relevant to food security, i.e. those that are predominant in the consumption of the most food insecure people in the country. This study uses the national price of maize. Also, it goes beyond regression coefficients to establish the importance of variables in explaining food availability and food access. A combination of the beta weights, structural coefficients and commonality coefficients is used which means that any possible shared variance and suppressors can be determined. By estimating the commonality coefficient, the study addresses an important question: do variables contribute more when they operate in isolation or in combination with others?

Specifically, the study tests six hypotheses formulated from the results of the literature review: higher crop yield (1) and higher education (2) increase food access and availability, while higher energy price reduces them (3). Good news (4) and higher incomes (5) reduce consumers' vulnerability to stable food access, while higher energy price increases it (6).

Data sets

Table 1 shows the sources of data. Data from 1961 to 2007 are used to analyse the determinants of food availability at the aggregate level but, mainly for data availability reasons, the determinants of maize supply sufficiency are analysed using data from 1961 to 2011. The major problem with the different data sets is that the former does not capture the institutional dynamics during the period 2007-2011. The government of Ghana, as a way to leverage the effect of the 2007/2008 food price shock on domestic consumers, responded by removing import tariffs on rice and yellow maize. However, this was shortly reinstated. Lastly, data from 1970 to 2009 are used to analyse the determinants of economic access to food and stable food access.

Table 1: Sources of data used in the study.

Source	Variable
BP Statistical Review of World Energy	Crude oil price
FAO statistics	Food supply in kcal/capita/day; maize supply in kcal/capita/day
IMF International Financial Statistics	Domestic interest rate
Ministry of Food and Agriculture, Ghana	Average maize price
Penn World Tables www.ggdc.net/pwt	Human capital index
United States Department of Agriculture	Real exchange rate
World Bank World Development Indicators	Arable land as % of total land area; crop yield; domestic inflation; foreign interest rate; nominal exchange rate; real GDP per capita

Theoretical framework for food availability

The theoretical model of the study is adopted from Fosu and Heerink (2009). At the national level, total food supply is the sum of domestic food production (Q_{DFP}), food imports (Q_{FI}), food aid (Q_A) and carryover stock (Q_{ST}). Thus, aggregate food production (Q_{AFP}) is given in equation (1):

$$Q_{AFP} = Q_{DFP} + Q_{FI} + Q_A + Q_{ST} \tag{1}$$

Food import is dependent on world food price (F_{WP}), income per capita (*RGDPP*) of the importing country, cost and availability of off-shore financing (proxy by international interest rate, *IIR*), and exchange rate (*ER*). Food import is given in equation (2):

$$Q_{FI} = F(F_{WP}, RGDPP, ER, IIR) \tag{2}$$

where $\frac{\partial Q_{FI}}{\partial F_{WP}} < 0, \frac{\partial Q_{FI}}{\partial RGDPP} < 0, \frac{\partial Q_{FI}}{\partial ER} < 0, \frac{\partial Q_{FI}}{\partial IIR} < 0$

On the other hand, domestic food supply is a function of factor inputs, technology, quantity of infrastructural services and weather as is expressed in equation (3):

$$Q_{DFP} = q(L, A, K, F, C, V, I, IS, X) \tag{3}$$

where L is units of labour, A is acres of land, K is capital, F is fertiliser, C is agrochemicals, V is improved varieties of food crops, IS is the quantity of infrastructural services and X denotes weather. The objective is to maximise profit. The revenue from farming and the cost associated with farming are specified in equations (4) and (5) respectively:

$$R = P_F Q_{DFP} \tag{4}$$

$$AC = C(Q_{DFP}, r_L, r_K, r_A, r_F, r_C, r_V, r_I, r_{IS}) \tag{5}$$

The profit function can be represented as:

$$\max \prod = P_F Q - C(Q, r_L, r_K, r_A, r_F, r_C, r_V, r_I, r_{IS}) \tag{6}$$

where r_L, r_K, r_A, r_F, r_C, r_V, r_I, r_{IS} denote prices of labour, capital, land, fertiliser, agrochemicals, improved varieties of food crops, irrigation services and infrastructural services, respectively. The first-order condition ($\frac{\partial \prod}{\partial Q}$) of equation (6) produces domestic food availability as expressed in equation (7) where P_F is the price of food. The domestic food availability function is convex in price of food and weather. That means as food prices increase the incentive to supply more food increases. Also, favourable weather improves cultivation conditions and this helps enhance domestic supply. However, domestic food supply is concave in input prices:

$$\begin{aligned} &Q = Q_{DFP} = q(PF, rL, rK, rA, rF, rC, rV, rI, rIS, X) \\ &\frac{\partial Q}{\partial P_F} > 0, \frac{\partial Q}{\partial r_i} < 0, i(= L, K, A, F, C, V, I, IS), \frac{\partial Q}{\partial X} > 0 \end{aligned} \tag{7}$$

Food aid import is exogenously determined but the carry over stock is dependent on domestic interest rate. The food aid import and carry over stock equations are represented by equations (8) and (9) respectively:

$$Q_A = A \tag{8}$$

$$Q_{ST} = F(DIR), \frac{\partial Q_{ST}}{\partial DIR} < 0 \tag{9}$$

The next stage involves the substitution of equations (2), (7), (8) and (9) into equation (1). The resulting model, equation (10), is the total national food supply which is a function of both demand-side and supply-side variables:

$$\begin{aligned} &Q_{AFP} = Q_{DF}(P_F, r_i, X) + Q_{FI}(F_{WP}, RGDPP, ER, IIR) + \\ &A + Q_{ST}(DIR) \end{aligned} \tag{10}$$

Empirical framework

The final model for food availability to be estimated is shown in equation (11):

$$\begin{aligned} &\ln Q_{FA} = \alpha + \beta_1 \ln OP_{t-i} + \beta_2 DIR_{t-i} + \beta_3 IIR_{t-i} + \\ &\beta_4 \ln RGDPP_{t-i} + \beta_5 \ln CY_{t-i} + \beta_6 HCI_{t-i} + \beta_7 \ln ER_{t-i} + \\ &\beta_8 ARL_{t-i} + \beta_9 DP_{t-i} + \varepsilon_t \\ &\beta_1, \beta_2, \beta_3, \beta_7, \beta_9 < 0; \beta_4, \beta_5, \beta_6, \beta_8 > 0 \end{aligned} \tag{11}$$

Food availability (Q_{FA}) is defined as food supply (measured as the total supply of available food) in kilocalories per capita per day. The oil price (*OP*) is the real world price of crude oil in USD per barrel, and the end of period discount rate is used to measure domestic interest rate (*DIR*). The study uses the international interest rate (*IIR*, defined as the lending interest rate charge by US banks on loans to prime customers) to capture the cost of off-shore financing. Real GDP per capita (*RGDPP*) is defined as the ratio of gross domestic product to mid-year population (in constant 2005 USD) and used to capture the importing country's income. Crop yield (*CY*), defined as the total amount of crops harvested per hectare of land, is used to capture soil fertility and improved seed varieties. Owing to data availability the index of human capital per person (*HCI*) is employed as a measure of human capital development. It relates to the average years of schooling and returns to education. The official exchange rate (*ER*) is defined as the annual averages based on the monthly averages. The study also includes arable land as a per cent of total land area (*ARL*). This includes land defined by FAO as land under temporary crops, temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporary fallow. This variable captures land availability for agricultural purposes. Lastly, domestic prices (*DP*), measured as the annual rate of growth of the GDP implicit deflator, show the rate of price change in the whole economy. Since food price index is closely connected to general price levels, this study uses domestic inflation as a proxy for food prices.

The study estimates an analogous model for maize supply, equation (12):

$$\begin{aligned} &\ln Q_{MA} = \alpha + \beta_1 \ln OP_{t-i} + \beta_2 DIR_{t-i} + \beta_3 ATL_{t-i} + \\ &\beta_4 \ln RGDPP_{t-i} + \beta_5 \ln CY_{t-i} + \beta_6 HCI_{t-i} + \beta_7 \ln ER_{t-i} + \\ &\beta_8 DP_{t-i} + \varepsilon_t \\ &\beta_1, \beta_2, \beta_7, \beta_8 < 0; \beta_3, \beta_4, \beta_5, \beta_6 > 0 \end{aligned} \tag{12}$$

Maize supply (total supply of maize available) in kilocalories per capita per day is used to measure maize availability (Q_{MA}). The study includes a dummy for liberalisation of agricultural trade (ATL_t) which takes one for period after 1983 and zero for periods prior to 1983. In Ghana, prior to 1983, the agricultural market was highly regulated with government control on prices. The rigidity which characterised the period among other things led to economic recession. In order to rectify the situation, the government adopted a more market driven economy where all government controls on prices were removed. The liberalisation of agricultural trade is expected to increase efficiency and productivity among local farmers.

The model for food access is given in equation (13). The price of maize is a function of both supply-side and demand-side variables:

$$\begin{aligned}&\ln PM_t = \alpha + \beta_1 \ln OP_{t-i} + \beta_2 DIR_{t-i} + \beta_3 RER_{t-i} + \\ &\beta_4 RGDPP_{t-i} + \varepsilon_t \\ &\beta_1, \beta_2, \beta_3 > 0; \beta_4 > 0 / < 0\end{aligned} \tag{13}$$

where PM is the price of maize measured as the average wholesale price of maize.

The last section of the study evaluates the roles of information and economic factors in explaining sustainable food access. In this regard, the study uses the asymmetric EGARCH model (Nelson, 1991). Volatility shocks in maize prices are approximated to mean stability of food access. The study augments the conditional variance of the EGARCH with exchange rate, oil price, domestic interest rate and real GDP per capita. The representations of the mean equation and the conditional variance of the EGARCH are shown in equations (14) and (15) respectively:

$$d\ln mp_t = \eta + d\ln mp_{t-1} + \theta GARCH_t + \varepsilon_t \tag{14}$$

$$\begin{aligned}&\log(\delta_t^2) = \omega + \sum_{j=1}^{q} \beta_j \log(\delta_{t-j}^2) + \sum_{i=1}^{p} \alpha_i \left| \frac{\varepsilon_{t-i}}{\delta_{t-i}} \right| + \\ &\sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\delta_{t-k}}. + \phi_v Z_{v,t}\end{aligned} \tag{15}$$

$\log(\delta_t^2)$ implies that the leverage effect is exponential which means that forecasts of the conditional variance are guaranteed to be nonnegative. The test of asymmetric effect is $\gamma < 0$. If $\gamma \neq 0$ then the impact is asymmetric. Thus, bad news and good news impact differently on volatility shocks in maize prices. If γ is negative then it means that good news reduces volatility shocks in maize prices. Beta measures persistence in conditional volatility. When beta is large it means that volatility takes a longer time to die out following a crisis in the market. Alpha measures the magnitude effect or the symmetry effect of the model (GARCH effect). Long-term volatility is given as $\exp\left(\frac{\omega}{1-\beta}\right)$. Z is a vector of economic variables assumed to affect volatility shocks in maize prices.

Econometric technique

The fully modified OLS technique of Phillips and Hansen (1990) is adopted as the estimation technique. The FM-OLS is a semi-parametric instrumental variable estimate that corrects for serial correlation and endogeneity problems. Thus, the method is designed to eliminate the asymptotic bias term of the ordinary least square parameter. According to Phillips (1995) the technique is robust to stationary and non-stationary series. Also, it is argued that even in the presence of no cointegration relationship the fully modified least squares method produces consistent and efficient estimates. The method modifies the variables and estimates directly to remove the existing nuisance parameters. It uses both the transformation of the data and estimates. The FM-OLS estimator is given as:

$$\hat{\theta}_{FME} = \left(\sum_{t=1}^{T} z_t z_t' \right)^{-1} \left(\sum_{t=1}^{T} z_t y_t^+ - T \begin{bmatrix} \hat{\lambda}_{12}^{+\prime} \\ 0 \end{bmatrix} \right) \tag{16}$$

where $y_t^+$and $\hat{\lambda}_{12}^+$ are the correction terms for endogeneity of regressors and serial correlation in errors respectively. The correction terms for endogeneity and serial correlation are expressed in equations (17) and (18) respectively:

$$y_t^+ = y_t - \hat{\omega}_{12} \hat{\Omega}_{22}^{-1} \hat{v}_2 \tag{17}$$

$$\hat{\lambda}_{12}^+ = \hat{\lambda}_{12} - \hat{\omega}_{12} \hat{\Omega}_{22}^{-1} \hat{\Lambda}_{22} \tag{18}$$

where $\hat{\Omega}$ and $\hat{\Lambda}$ are the long-run covariance matrices computed using the residuals $\hat{v}_t = (\hat{v}_{1t}, \hat{v}_{2t})'$. $\hat{v}_{1t}$ is the residual computed from equation (19) and $\hat{v}_{2t}$ is obtained directly from equation (21) or indirectly from equation (22):

$$y_t = x_t' \beta + D_{1t}' \gamma + v_{1t} \tag{19}$$

$$\Delta y_{2t} = \varepsilon_{2t} \tag{20}$$

$\varepsilon_t = (v_{1t}', \varepsilon_{2t}')$ is assumed strictly stationary with zero mean and infinite covariance matrix $\sum$.

$$\Delta x_t = \hat{\Gamma}_{21}' \Delta D_{1t} + \hat{\Gamma}_{22}' \Delta D_{2t} + \hat{v}_{2t} \tag{21}$$

$$\hat{v}_{2t} = \Delta \hat{\varepsilon}_{2t} \tag{22}$$

Results and discussion

Preliminary analysis of the data shows that the series have unit root in levels, but become stationary after first-differencing, while cointegration tests based on Bounds test and Hansen's test show the evidence of cointegrating relationship (data not shown[1]).

Determinants of physical availability of food: aggregate analysis

This section presents the main findings on determinants of food availability at the aggregate level (model 1 in Table 2). Energy price has a significant adverse impact on food availability. An oil price increase of one per cent is expected to decrease supply sufficiency by 0.047 per cent. As discussed above, higher crude oil price increases production cost via its

[1] The results are available upon request from the author.

Table 2: Determinants of physical availability of, and economic access to, food in Ghana (fully modified least squares estimates).

Model and data time period	Physical availability of food		Economic access to food
	1. Aggregate analysis Kcal/person/day (1961-2007)	2. Disaggregate analysis Kcal/person/day (maize) (1961-2012)	3. Average price of maize (1970-2009)
‡Energy price	-0.047***[0.246]{0.184} (0.003)	-0.1228**[-0.418]{0.352} (0.0504)	4.567*** [0.626]{0.257} (0.503)
Domestic interest rate	-0.002***[0.012]{0.373} (0.057)	0.0043[-0.354]{0.513} (0.0035)	0.136*** [0.494]{0.664} (0.029)
Foreign interest rate	-0.010***[0.105]{0.512} (0.0004)		
‡Real per capita GDP	0.338***[0.314]{0.542} (0.013)	0.781***[0.323]{0.143} (0.242)	1.170 [0.015]{0.178} (2.380)
Domestic prices	-0.0007***[0.133]{0.531} (0.3E-5)	-0.0006[0.106]{-0.0113} (0.0009)	
‡Crop yield	0.0002***[0.340]{0.886} (9.5E-6)	0.353*[0.122]{0.688} (0.1933)	
Human capital index	0.377***[0.497]{0.502} (0.010)	1.209***[1.532]{0.850} (0.235)	
Exchange rate	-0.021***[0.180]{0.779} (0.005)	-0.096***[-0.657]{0.515} (0.0277)	2.832*** [0.622]{0.616} (0.442)
Arable land, % total land	0.015***[0.094]{0.788} (0.0014)		
Liberalisation of agricultural trade		0.294**[-0.159]{0.615} (0.116)	
Constant	4.700*** (0.067)	-4.868*** (1.656)	-25.179* (14.361)
Long run variance	0.00003	0.0151	1.996

***,**,* indicate 1%, 5% and 10% significance levels
Cointegration equation deterministic: constant; additional regressor deterministic: trend
Model 1: long-run covariance estimate (Prewhitening with lags=3 from HQ max lags=3, Bartlett Kernel, Newey-West fixed bandwidth=4.0000); models 2 and 3: Long-run covariance estimate (Prewhitening with lags=1 from HQ max lags=3, Bartlett Kernel, Newey-West fixed bandwidth=4.0000)
‡Energy price, crop yield and real GDP per capita are in logs
Figures in ( ) represent standard errors

effect on agricultural inputs which adversely affect domestic supply sufficiency. Frankel (2008), Byrne *et al*. (2013) and Tadese *et al*. (2014) obtained similar results.

The effect of domestic interest rate on food availability is negative. An increase in domestic interest rate by one percentage point is expected to decrease food availability by 0.2 per cent. Higher domestic interest rate increases the opportunity cost of holding inventories and thus decreases the speculative activities in the agricultural sector. Also, higher domestic interest rate imposes credit constraint on farmers which affects their scale of production hence lowering food supply sufficiency.

The impact of international interest rate on domestic food availability is also negative. An increase of one percentage point in foreign interest rate is expected to decrease food availability in Ghana by 1 per cent. The result implies that financial repression in the US economy will increase agricultural contracts and increase agricultural stock holdings in the domestic economy. This could be evidence suggesting that the financial crisis which hit the US economy in 2007/2008 caused speculative behaviour in the agricultural future market in Ghana. Another implication of this result is that as the cost of off-shore financing increases, there is a decrease in the domestic economy's propensity to import. The result that financial repression both domestically or externally will increase agricultural contracts is confirmed by Mercer-Blalckman *et al*. (2007), Thomson *et al*. (2009) and Bafes and Haniotis (2010).

Real per capita GDP has a direct and significant impact on food supply sufficiency. A one per cent increase in real per capita GDP increases domestic food supply by 0.338 per cent. Rising real per capita GDP suggests increased capability of domestic farmers to apply more fertilisers and pesticides, use high yielding varieties and purchase farm equipment. The positive relationship between real per capita GDP and food supply sufficiency suggests that the substitution effect associated with rising real per capita GDP is outweighed by the larger production scale effect associated with real per capita GDP. The positive link between real per capita GDP and food availability (food security) is shown by Carter *et al*. (2010), Herath *et al*. (2014) and Tadese *et al*. (2014). The impact of domestic prices on food availability is negative. A one percentage point increase in domestic inflation is expected to decrease food availability by 0.07 per cent. Rising domestic inflation pressures implies a decrease in domestic real income. As a result, the application of fertilisers and pesticides, use of high-yield seeds and purchase of agricultural equipment by farmers decrease. Consequently, domestic food production decreases, making food scarce.

The impact of crop yield on food availability is positive. A one per cent increase in crop yield increases food availability by 0.0002 per cent. This relationship suggests that rainfall variability and the non-application of fertilisers will cause crop yields to fall, causing large-scale food scarcity. The impact of human capital development is also positive. A one percentage point increase in the human capital index will cause food availability to increase by 37.7 per cent. This positive link indicates that investing more in education will generate positive impacts on food supply sufficiency at the national level. The positive impact of human development on

food availability is reinforced by Gani and Prasaad (2007).

The effect of arable land as a percentage of the total land on food availability is positive. An increase in land of one percentage point leads to a 1.5 per cent increase in food availability. This suggests that making more land available for agriculture makes it possible to increase agricultural production *ceteris paribus*. By implication, land scarcity due to, for instance, reallocation of land for industrial and residential activities will affect the scale of agricultural production hence food security.

Rising exchange rate has an adverse effect on domestic food availability. An increase of one percentage point in exchange rate decreases food availability by 2.1 per cent. The link between exchange rate changes and food availability is also shown by Headey and Fan (2008), Mitchell (2008), Lombardi *et al*. (2010) and Algieri (2013). The result shows that, at the aggregate level, both supply-side and demand-side variables are important determinants of food availability in Ghana.

The variance in the dependent variable shared with each independent variable is examined using the beta weights (data in [ ]), structure coefficients (data in { }) and commonality coefficient simultaneously. This, according to Courville and Thompson (2001), is useful to determine if there is shared variance and suppressors in the regression. A beneficial property of the structure coefficient is that it is not affected by associations between independent variables, as a structure coefficient is simply a Pearson r between independent variable and dependent variable (Courville and Thompson, 2001). However, the structural coefficient cannot tell us which variables share this variance. The commonality coefficient addresses this question. The result shows that the beta weight ranks human capital development as the most important variable and domestic interest rate as the least important variable. The second most important variable is crop yield which is followed by real GDP per capita, crude oil price, exchange rate, domestic inflation and foreign interest rate. The beta weights become invalid if there is multicollinearity. Analysis of the structure coefficient, however, ranks crop yield as the most important variable and crude oil price as the least important variable. The second most important variable is arable land which is followed by exchange rate, real GDP per capita, domestic inflation, foreign interest rate, human capital development and domestic interest rate. A comparison of the beta weights and structure coefficients reveals that domestic interest rate, foreign interest rate, real GDP per capita, domestic inflation, crop yield, exchange rate and arable land share variance. This means that the beta weights minimise their contribution and assign that shared variance to other independent variables.

The commonality coefficients show that the importance of variables grows when they operate in combination with other variables (Table 3). For instance, independently, crop yield contributes 0.016 to total variance in the dependent variable. This means that when excluded from the model the variance of the dependent variable will fall by that magnitude. However, in combination with other independent variables, crop yield contributes 0.710 to the total variance in the dependent variable. Similar observations are derived for arable land and exchange rate. The unique and common effects of energy price are similar which means the contribution of oil price is more independent. The unique effect of domestic interest rate is zero which means zero contribution to the total variance when it operates independently. However, the common effect is greater than zero which means that domestic interest rate performs better in group than in isolation. All the common coefficients are positive indicating that there are no suppressors in this model.

Table 3: Commonality coefficients for aggregate food availability model.

Variables	Unique effect	Common effect	Total effect
Energy price	0.0119	0.0195	0.0314
Domestic interest rate	0.0000	0.1287	0.1287
Foreign interest rate	0.0037	0.2391	0.2428
Real GDP per capita	0.0239	0.2480	0.2719
Domestic inflation	0.0074	0.2537	0.2611
Crop yield	0.0164	0.7098	0.7262
Human capital index	0.0217	0.2115	0.2332
Exchange rate	0.0015	0.5602	0.5617
Arable land, % total land	0.0003	0.5739	0.5742

Determinants of food availability: disaggregate analysis

Next the study focuses on the determinants of availability of maize. The impact of oil price on maize availability is negative (model 2 in Table 2). A one per cent increase in oil price will cause maize availability to decrease by 0.123 per cent. As discussed, higher crude oil price increases the cost of inputs and pesticides, causing domestic production of maize to fall. Higher crude oil price will also increase demand for biofuels and allocation of land to the production of maize for energy, limiting the supply of maize for food. Thus, energy price is an important determinant of food security both at the aggregate and disaggregate levels. Real per capita GDP is positively related to maize supply sufficiency: a one per cent increase in real per capita GDP will increase maize supply by 0.781 per cent. This is due to the enhanced capability of farmers to purchase agricultural inputs. The impact of domestic inflationary pressures on maize availability seems to be adverse but statistically is not significant.

Human capital development has a positive impact on maize availability for the reasons stated above. The implication is that investing in education will help improve food security at the national level. The impact of real exchange rate on maize supply adequacy at the national level is negative: an increase of one percentage point in exchange rate will decrease maize supply sufficiency by 9.6 per cent. The implication is that depreciation of the local currency will restrain maize production, limiting its availability at the national level and consequently worsening food security in the economy. Rising exchange rate, apart from generating internal inflation pressures which reduce the real income, decreases the country's import capability for food and increases the cost of agricultural inputs. Since most maize consumed is grown domestically, the negative impact of exchange rate on maize supply sufficiency in Ghana can be explained via the higher input cost and internal domestic

inflation effects. The impact of crop yield is positive. The estimated coefficient suggests that one per cent increase in crop yield will increase maize availability by 0.490 per cent. The impact of domestic interest rate seems to be positive but is not statistically significant. This suggests no speculative behaviour in the maize market either during the periods of loose monetary policy or financial repression.

Lastly, the study looks at the impact of liberalisation of agricultural trade on maize availability. Liberalisation of agricultural trade leads to competitive price setting in the agricultural market. This generates incentives among local producers to increase the scale of production to benefit from trade. Consequently, domestic production increases which affects supply adequacy. However, in Ghana, the liberalisation of agricultural trade in 1983 was accompanied by tight monetary and fiscal policies and exchange rate policy. These other macroeconomic policies produce adverse impacts on agricultural production. Thus, the negative impacts of these macroeconomic policies could outweigh the positive effects of liberalisation of agricultural trade, making the overall impact on food security negative. The problem is we do not know which effect dominates. The actual effect of liberalisation of agricultural trade can be delineated by applying a decomposition approach. The approach adopted here is not to decompose the total changes but control for the effects of the macroeconomic policies. By controlling for these effects it is believed that the effect of the agricultural trade variable will partially if not wholly reflect the actual effect of liberalisation of agricultural trade on food security. The coefficient for the liberalisation of agricultural trade dummy is positive. Thus, the mean expected maize availability conditioned on liberalisation of agricultural trade is positive. This suggests that liberalisation of agricultural trade increases maize availability. The percentage effect of liberalisation of agricultural trade in 1983 on maize supply is 0.34[2]. Also, this result shows that both supply-side and demand-side variables are important determinants of maize supply adequacy.

The beta weights (i.e. assuming no multicollinearity) rank human capital development as the most important variable and domestic inflation as the least important variable in explaining the variance in the dependent variable. Exchange rate is the second most important variable, followed by crude oil price, domestic interest rate and real GDP per capita. The structure coefficient on the other hand ranks human capital development as the most important variable and domestic inflation as the least important variable. However, the second most important variable that shares variance with the predicted dependent variables scores is crop yield which is followed by liberalisation of agricultural trade, exchange rate, domestic inflation and crude oil price. A comparison of beta weights and structure coefficients for crop yield, liberalisation of agricultural trade and domestic inflation reveals that there is a shared variance between these variables and other variables. This means that the beta weight calculation process minimises the contribution of these variables by assigning that shared variance to other independent variables. Lastly, the structure coefficient for domestic inflation is near zero which means it contributes little direct variance to predicted dependent variable scores. Since the beta weight is slightly higher it can be concluded that domestic inflation is a suppressor.

[2] $\left(\left[\frac{\exp(0.3)}{\exp(0.5*(0.146)^2)}\right]-1\right)$

Table 4: Commonality coefficients for the maize availability model.

Variable	Unique effect	Common effect	Total effect
Energy price	0.0428	0.0124	0.0552
Domestic interest rate	0.0185	0.0987	0.1172
Real GDP per capita	0.0120	-0.0030	0.0090
Domestic inflation	0.0047	-0.0046	0.0001
Crude oil price	0.0017	0.2082	0.2099
Human capital index	0.1961	0.1250	0.3211
Exchange rate	0.0287	0.0889	0.1176
Liberalisation of agricultural trade	0.0029	0.1652	0.1681

The commonality coefficient shows that the unique effect for oil price is slightly higher than the common effect (Table 4). By implication, in explaining maize availability, oil price performs higher in isolation than in a group. A similar observation applies to human capital development. The common coefficients for the rest of the variables exceed their unique effects which mean that these variables perform higher in groups than in isolation. The common coefficient for real GDP per capita and domestic inflation are negative which means that these variables confound the predictive power of other variables. Thus, real GDP per capita and domestic inflation are suppressors.

Determinants of economic access to food (maize)

This section presents the result on the determinants of economic access to food focusing on maize as a crop (model 3 in Table 2). The impact of oil price on maize price is positive. The estimated coefficient indicates that a one per cent increase in oil price will increase maize price by 4.6 per cent. Higher oil price increases maize production costs (which are transferred to consumers in the form of higher prices) and increases the use of maize lands for energy rather than food production, causing the price of maize to surge given demand. A higher maize price will limit regional, community, household and individual access to maize, thereby worsening economy-wide food security.

The impact of domestic interest rate on maize price is positive. The estimated coefficient implies that an increase of one percentage point in domestic interest rate will increase maize price in Ghana by 14 per cent. An increase in interest rate will increase the cost of acquiring capital for maize production, leading to a drop in production and an increase in the producer price of maize in the domestic economy. This will make it difficult for regions, communities, households and individuals to have access to maize, and consequently there will be economy-wide food insecurity.

The impact of exchange rate on maize price is positive. The result indicates that an increase of one percentage point in exchange rate will cause maize price in the Ghanaian economy to increase by 2.8 per cent. The reduction in the country's capability to import, internal inflation, which decreases the real income in the economy, and the higher cost of imported agricultural inputs cause maize price to

Table 5: Commonality coefficients for economic access model.

Variable	Unique effect	Common effect	Total effect
Energy price	0.2958	-0.2452	0.0506
Domestic interest rate	0.1287	0.2090	0.3377
Exchange rate	0.1334	0.1569	0.2903
Real GDP per capita	0.0001	0.0242	0.0243

increase which limits regional, household and individual economic access to food. The impact of real per capita GDP seems to be positive but is not statistically significant.

The beta weight ranks crude oil price and exchange rate as the most important variables and real GDP per capita as the least important variable. However, the structure coefficient ranks exchange rate and domestic interest rate as the most important variables and real GDP as the least important variable. A comparison of the beta weights and the structure coefficients for real GDP per capita and domestic interest rate reveals that these variables share variance. This means that the beta weight minimises their actual contribution by assigning that shared variance to other independent variables. The result shows no signs of suppression. The commonality coefficient reveals that domestic real GDP, interest rate and exchange rate perform better in groups than in isolation. The unique effect of oil price is high which means that this variable contributes more in isolation than in group. The common effect of energy price is negative which means this variable confounds the predictive power of another (Table 5).

Determinants of consumers' risk of accessing food

This section addresses the determinants of consumers' risk of accessing maize using the asymmetric EGARCH model. Since the EGARCH model is a regression of stationary series, the series were transformed to become stationary. The EGARCH model presented here passed the test of serial correlation (test for correct specification of the mean equation) and remaining ARCH effect (i.e. test for correct specification of the variance equation). The first part of Table 6 shows the mean equation where the effect of volatility shocks in maize prices on maize price is assessed. The effect is positive, which means that volatility shocks in maize prices increase consumers' risk of accessing maize. The interesting part of this result is shown in the variance equation where the study analyses how good news and bad news in the maize market and other macroeconomic variables affect volatility shocks in maize price (i.e. consumers' risk of accessing food). The magnitude (i.e. GARCH effect) effect is negative and statistically significant (given by alpha). Also, the coefficient of beta is positive and statistically significant but fairly small. This means that volatility takes a shorter time to die out following a crisis in the maize market. The long-term volatility (i.e. $\exp\left(\frac{\omega}{1-\beta}\right)$) is 0.040 which is low, indicating that long-term volatility shocks in maize prices are low. The coefficient γ designates the asymmetric effect and leverage effect. Firstly, the coefficient is significantly different from zero which means that there is asymmetry in the maize market. In other words, good news and bad news in the maize market have differentiated impacts on volatility shocks in maize prices. The negative coefficient indicates that positive shocks (good news) generate less volatility shocks than negative shocks (bad news). The implication is that good news in the maize market increases consumers' access to maize and hence ensures stability.

Table 6: Determinants of volatility shocks in maize prices on maize prices for the period 1970-2009 according to the asymmetric EGARCH method.

Mean equation			
Variables		*Coefficients*	
Garch		5.364** (0.003)	
Price of maize (-1)		-0.052** (7.02E-05)	
Constant		-0.273* (0.047)	
Variance equation			
Constant		-1.968* (0.2005)	
α		-0.4138** (0.0095)	
γ		-0.462** (0.063)	
β		0.387* (0.063)	
Exchange rate		0.082** (0.004)	
Interest rate		0.0003 (0.001)	
Crude oil price		0.1443** (0.026)	
Real GDP per capita		-0.039* (0.017)	
R-square	0.413	Mean Dependent variable	0.283
Adjusted R-square	0.380	SD. Dependent variable	0.395
S.E. of regression	0.311	AIC	0.902
Log-likelihood	-6.140	SBC	1.376
Durbin Watson	1.837	HQC	1.071

Presample variance: backcast (parameter = 0.7)
Figures in parenthesis represent standard errors
**, * indicate 1% and 5% significance levels, respectively

Next, how changes in key macroeconomic indicators such as exchange rate, interest rate, real GDP per capita and crude oil prices affect volatility shocks in the maize market are examined. The effect of exchange rate is positive: a one per cent change in exchange rate is expected to increase volatility clustering in the price of maize by 0.082 per cent. Consequently, continuous depreciation of the local currency implies that the consumers' risk of accessing the maize crop will increase, threatening the sustainability of food access. The effect of domestic interest changes on volatility shocks in maize price seems to be positive but is not statistically significant.

The effect of crude oil price changes on volatility clustering in maize prices is positive. Specifically, a one per cent change in international crude oil price is expected to increase volatility shocks in maize prices by 0.144 per cent. The transmission channels are through input cost and largely transportation cost. The real income for maize consumption of households and individuals will decrease by 1.44 per cent by way of proportionality which makes it less likely for them to access the quantity of maize that meets their energy dietary requirement. Consequently, there will be a decrease in national food security. From a social perspective, therefore, withdrawal of government subsidies on petroleum products will only aggravate the woes of the ordinary people. The fiscal relief on the government budget and the energy saving potentials associated with withdrawing such subsidies are justifiable but the result presented here gives a reason for the government to weigh the effects.

Lastly, the effect of real income per capita is negative. The estimated coefficient indicates that a one per cent

increase in real income per capita is expected to reduce volatility clustering in maize prices by 0.039 per cent. The main transmission mechanism here is through the supply effect which will cause general maize prices to fall. This means that consumers' risk of accessing food will reduce; hence sustainability in food security improves. The general implication is that economy-wide growth is consistent with stable food security.

Conclusions and policy implications

The study analyses three questions: what factors determine food availability at the aggregate and disaggregate level, what factors determine food access, and what are the sources of consumers' risk of accessing food? Other questions that follow from the first two questions are: what is the importance of each independent variable in explaining total variance in dependent variable, and do variables perform well in isolation or in group?

External and domestic tight monetary policies reduce food availability. The implication is that external and domestic financial repression will increase agricultural contracts, hence increase food availability. However, there was no evidence for speculative behaviour in the local maize market as a result of domestic financial repression. The relationship between income and availability is symmetric for food in general and maize as a crop. However, the effect is stronger in the commodity-specific case than the general case. Thus, the income elasticity for maize is higher than that for food. The positive coefficient means that higher incomes are associated with improved food availability. Domestic prices have a negative effect only in the general case. This means that lower inflation rates will increase food availability. The effect of crop yield is positive in both cases, but the effect is strongly felt in the maize market. The implication is that land degradation and climate change will impact negatively on food availability due to decreased crop yield. Also, genetic crop improvement will help improve food availability. The effect of human capital development is positive in both cases, but strongly felt in the commodity-specific case (where the effect is elastic). This means that increased government commitment to education via investment in infrastructure and human resource will improve food availability. The effect of exchange rate is negative in both cases, but the effect is much stronger in the commodity-specific case. This means that food insecurity (i.e. unavailability of food) is a corollary of depreciation. Stabilising the exchange rate will therefore help improve food availability. Increase in agricultural lands increases food availability, meaning that continuous increases in urbanisation which create competition between agricultural production and settlement activities will reduce food supply and worsen food security. The policy implication, therefore, is that a land tenure security policy by government can increase farmer investments. The effect of liberalisation of agricultural trade is positive. This means that a more integrated agricultural sector will increase food supply via the efficiency effects it generates.

The estimated commonality coefficient shows that energy price and human capital development contribute more variance when they operate in isolation than when they operate in combination with other variables. This further suggests that government can target these variables independently. However, the results show that domestic interest rate, foreign interest rate, domestic inflation, crop yield, arable land, exchange rate, liberalisation of agricultural trade and real income contribute more in variance when they operate in combination than when they operate in isolation. This means that for policy purposes these variables should be targeted simultaneously in addressing food availability problems.

The effect of price of oil and exchange rate on maize prices is positive. This means that higher oil price, tight monetary policy and depreciation of the local currency will distort consumers' access to maize. The close link between the energy and agricultural sectors implies that switching to other cheap sources of energy or having a more diversified energy portfolio will help mitigate the transmission effect from energy to the food sector. The other policy implication is that government must discriminate in its energy subsidy policy. The effect of income is, however, not significant. The commonality coefficient reveals that oil price contributes more in variance when it operates in isolation than when it operates in combination with other variables. The policy implication is that government can singly target this variable when addressing food access concerns. However, exchange rate, interest rate and real income contribute more in variance when they operate in combination with other variables than when they operate in isolation. The policy implication here is that these variables should be jointly targeted in addressing food access problems in the country.

Lastly, the result reveals that good news creates smaller volatility shocks in the maize market than bad news. Thus, positive shocks enhance sustainable food access and reduce consumers' risk of accessing maize. Also, higher incomes create less volatility clustering in maize prices. By implication, economy-wide goal of economic growth is consistent with sustainable food access. However, higher oil price and depreciation of the local currency increase volatility shocks in the maize market, distorting accessibility. This means that higher energy price and depreciation of currency increase consumers' risk of accessing maize. The policy implication is that a government decision to withdraw fuel subsidies in the agricultural sector will end up distorting consumers' sustainable access to food.

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