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Food Price Spikes and Volatility in Local Food Markets in Nigeria

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Abstract

Beside the mixed evidences on transmission of international food price volatility to local markets and the desirability or otherwise of reliance on stabilisation policy to cushion the effects, very little is known about the key drivers of price spikes and volatility in sub-Saharan Africa. This paper is an attempt to bridge this gap, by focusing on the patterns, drivers, and policy responses to food price spikes and volatility across in Nigeria. The study was based on 16 years panel data on average monthly prices (2001:1 – 2016:12) of major food commodities across local markets in the 36 States of Nigeria, supplemented with monthly series of relevant domestic policy variables, and international prices, among other factors. Data analysis was mainly within the framework of fixed effects models. Findings suggest that food price upsurges in an average Nigeria market is more strongly related to spikes than volatility. International factors such as crude oil price, international food prices, and global beginning stock to use of coarse grains, and domestic policy variables such as real exchange rates, monetary policy rates and narrow money are strong influencers of spikes in the price of one or more food commodities in Nigeria's local markets. Higher petrol price and food production variability may substantially advance price instability in local food markets. Government policy actions at addressing volatile food prices immediately after the 2007/2008 food crises appeared to enhance food price stability. These findings call for greater attention on management of monetary policy, including the exchange rates, ensuring stable petrol price, limiting food production instability, mitigating spill-over of price upsurges from international markets and building farmers and consumer's resilience against food price changes, among others, as important pathways to address short and medium-term food price upsurges.

Keywords: Price Spikes, Price Volatility, Monetary Policy, Local Food Markets, Nigeria

JEL codes: E31, E52

1. Introduction

The global food crisis of 2007-08 coupled with the resurgence of food price spikes in 2010-11 and rising food price volatility ever since have brought a great deal of research attention to issues related to rising and volatile food prices. The common evidence has been that food price spikes and volatility have been unprecedentedly high across many regions of the world over the last decade (Ghosh *et al.*, 2011; Tadese, 2012; Minot 2011, 2014). Volatility is often regarded as variance and it is a measure of the dispersion of a random variable from its mean value. Thus, price volatility relates to the fluctuations (or instability) in price around its mean value over time or the risk of large, unexpected price changes (Omotosho and Doguwa, 2012; Tadesse *et al.*, 2014; Kalkuhl *et al.*, 2013) while a price spike is a large, quick, and temporary rise or fall in price (Tadesse *et al.*, 2014) following a short-term shock.

According to World Bank (2012) projections, the pattern will remain for most major food commodities over the next decade. The food price spikes and higher volatility of the past decade have also been reported as having had huge economic costs and exerted negative welfare impacts on many households, especially those of the poor, smallholders and female headed households in Africa (von Braun and Tadese, 2012; Minot 2011, 2014; Shittu *et al.* 2015; Kalkuhl *et al.*, 2016). Evidences however abound suggesting that the volatility levels, drivers and impacts vary widely across regions and countries, among crops and between processed and unprocessed foods as well as between traded and non-traded goods (Gilbert and Morgan, 2010; Minot, 2014). Emergency, and spontaneous (panicky) policy responses based on anecdotal assessments were helpful to reduce food price inflation in domestic markets in some countries, it however, fuelled international price dynamics and had adverse impacts on other importer countries (Martin and Anderson, 2012; Anderson, and Nelgen, 2012; Martin and Ivanic, 2016). It is therefore, imperative that in-depth analysis of food price spikes and volatility are undertaken across local markets and commodities in Africa as to provide information in support of intervention targeting and development programming in the sub-region.

Nigeria occupies a central place in Africa's and global food markets. The country is the largest producer of cassava (of which *garri* – cassava flakes is a major product) in the world, one of the Africa's largest producer of rice and ironically the largest importer of rice in the world (FAO, 2017). Hence, fluctuations in food prices in the country are more likely to be exported to other countries in Africa and beyond, while changes in regional or world prices are also more like to affect the country. This makes the country a suitable candidate for investigation on food prices movements. In the context of high and volatile food prices, an understanding of the drivers of food price spikes and volatility within the local commodity markets in Nigeria, and the impacts of government policy responses in managing the price shocks across the different states of the country becomes essential. This is more so given that there are very

few in-depth studies of the subject matter even though the country has been included – at national aggregate level - in a number of price transmission and impact studies, notable Minot (2014), Shittu *et al.* (2015), and Martin and Ivanic (2016), among others. The study is an attempt to fill this knowledge gap.

The focus of this paper is on price spikes and volatility as opposed to price trend, which is, reasonably expected long-term price changes that have little relevance to food crises. From a welfare perspective, price spikes and volatility are more important than trends in overall price levels. Price spikes can cause crises for consumers, investors, and farmers. This is because price spikes and volatility are the primary indicators of food crises (Abbott *et al.*, 2011). It is believed that a food crisis is more closely related to extreme price spikes, while long-term volatility is more strongly connected to general price risks (Tadesse *et al.*, 2014). The distinction between price spikes and volatility is to differentiate between factors that cause risks to poor consumers and those that engender uncertainties to agricultural producers. Both high and volatile prices create challenges for policy makers and the global community (FAO, 2011).

Literature identifies the major drivers of global food price spikes and volatilities. These include agricultural production shocks such as drought and unfavourable weather conditions leading to poor farm harvests in some major food producing countries; increases in input costs due to higher fuel and fertilizer prices, higher transportation costs; diversion of food crops to production of biofuels, and the introduction of policies to restrict food exports, import bans and increase in tariffs. Mitchell (2008) argues that the most important driver is the large increase in biofuels production in the United States and the European Union. Frankel (2006) and Krichene (2008) noted expansionary monetary policy in key industrial countries, which brought low interest rates, and a sudden fall in the value of the US dollar as a contributory factor to the world food price volatility.

In an attempt to distinguish how different factors affect price changes, Tadesse at al. (2014) summarized the potential drivers of food price changes into three categories: exogenous shocks, also called “root” causes; “conditional” causes; and “internal” drivers. The root causes, include, among others, extreme weather events, production shocks, oil price shocks and demand shocks. The root causes were regarded as exogenous factors because the possibility of a causal relationship between them and agricultural sector is minimal. The internal drivers of price spikes and volatility are factors that are activated by the same price dynamics and are referred to as endogenous shock amplifiers - examples of which are discretionary trade policies and speculative activities propelled by price expectations and reduction in global food stocks.

Many studies have examined the causes and drivers of food spikes and volatility at the global, regional (Tadesse at al., 2016) and/or country levels (Kornher and Kalkuhl, 2013) and have noted how changes in international and domestic factors affect food prices. While this has its

own merits, focusing on drivers of changes in worldwide aggregate or regional may mask information about unique drivers of spikes and volatility at the country level or specific regions within a country. This is because price spikes and volatility, and their distributional implications on household welfare may vary substantially across regions in a country due, among others, to the varying degree of price transmission and regions specific factors. For instance, Minot (2014) found in African countries, contrary to the conventional thinking, minuscule or statistically insignificant evidence of rising food price volatility. He noted that while some prices became more volatile during 2007–2010, a larger number of prices have become more stable in contrast to documentations by many workers on price volatility. Hence, it is crucial to better understand price changes and their drivers at a country level and in the regions within a country.

In the case of Nigeria, Masha (2000) indicated that the high inflation episodes in the country since the 1970s were largely driven by the growth of money supply and some factors reflecting the structural characteristics of the national economy. Mordi *et al.* (2007) noted that price inflation is triggered by excess money supply, scarce foreign exchange, severe shortages in commodity supply and continual labour and political unrest. High lending and interest rates on bank deposits, devaluation of the national currency Naira, and a very high and rising cost of production have contributed to rising general price levels in Nigeria (CBN, 2012). Shittu *et al.* (2015) identified monetary policy rates, Naira-to-Dollar exchange rate, domestic narrow money supply, and rise in pump price of the premium motor spirit (petrol) following the federal government "subsidy withdrawal policy" as important factors contributing to exacerbated food prices in Nigeria.

Recently, Nigeria has experienced a historically unprecedented increase in food prices, traceable in part to insurgency in the North-eastern region of the country and bombing of refineries in the "oil rich" Niger Delta region. The supply of food from the North-eastern region has been reduced drastically as unrest continues to prevail in the region. It is expected that continued shortage in food supply and a concomitant increase in food prices until the insurgency is reasonably contained. Reports from the Famine Early Warning System Network (FEWS NET) (2016) suggests that Nigeria would face a credible risk of famine in 2017 (and coming years) due to persistent conflict, severe drought and economic instability, which has accentuated mass population displacement, restricted market activity and normal livelihoods. A drop-off (shock) in oil revenue, which accounts for 70 per cent of Nigeria's state income, has dried up hard currency supplies needed to fund food and other vital imports in the country.

A number of emergency actions and policy responses have been implemented in Nigeria to combat and/or cushion the effects of price spikes and volatility, most especially in the wake of the global food price spikes of 2007/08 and the resurgence in 2011. These include release of strategic grain reserves, ban on maize export, review of tariff regimes, review of minimum

wages, provision of assistance to farmers in form of input subsidies to meet rising input costs, and reliance on trade and monetary policy instruments to stabilise prices, working within the statutory roles of the Central Bank of Nigeria's – Monetary Policy Committee (MPC).

In the wake of the liquidity crisis created by the global financial crisis in 2007, the MPC resorted to monetary easing between 2008 and 2010 with a view to addressing the problem of liquidity shortages that arose within the banking system (CBN, 2017). This entailed progressive reduction of the Monetary Policy Rate (MPR), the Cash Reserve Ratio (CRR) and the Liquidity Ratio (LR), among other measures, while the Open Market Operations (OMO) was suspended. This expansionary monetary policy stance was however jettisoned in periods after the 2007 – 2011 crises. Between 2012 and date, emphasis was placed on monetary tightening – progressively raising MPR, CRR and LR as well as the midpoint and band around the official exchange rate, while OMO are used to mop up or inject liquidity into the system as the monetary policy focus shifted to achieving price and exchange rate stability (CBN, 2017).

The main objective is to undertake in-depth, crop specific and state/zonal level analysis of the patterns and drivers of food price spikes and volatility in Nigeria. More specifically, the influence of both external and domestic factors – monetary, trade and fiscal policy as well as non-policy factors – on food price formation in Nigeria are assessed. Findings from this study are critical for policy development, consumers, farmers and other interest groups at the local and global level. The paper is organized as follows. Section 2 elaborates on the methodology. The study data, the descriptive results and the econometric results are presented in sections 3 to 5. The final chapter concludes the main findings of the study.

2. Methods

2.1 Empirical Model

Evidences in literature, as reviewed in the preceding section, suggest that price spikes and volatility in a domestic market may be linked with multiple and interconnected drivers including market fundamentals, international prices and GDP, and domestic macroeconomic environments, among others. Apart from these factors, price spikes or variability may also be influenced by location and commodity specific factors, some of which may be unobservable (Kornher and Kalkuhl, 2013). Hence, our empirical approach is to examine the determinants of the hypothesized domestic food price spikes and volatility across the panel of 36 States of Nigeria within the framework of fixed effect panel data model. This allows consistent estimation of the influence of observable time varying food price spike/volatility drivers, while controlling the influence of time invariant unobservable state specific sources of heterogeneity.

In modelling drivers of food price spikes/volatilities, lagged values of dependent variables are often introduced to account for the possibility that previous spike/volatility may influencing current ones. We thus introduced lagged dependent variables in our models. This practice however, tend to introduce dynamic bias (Nickell, 1981) into the model, warranting a resort to use of the dynamic difference or system generalized method of moment (GMM) in such model estimation. Nickell (1981), however, cautioned that these estimators are more appropriate (and should be used) for cases involving small period (T) and large panels (N). He noted that when time (T) is large (as is the case in the present study), the dynamic bias tends to disappear and a more straightforward fixed effects estimator can be applied to the dynamic model. Besides, the GMM approach comes with an estimation challenge: the number of instruments in difference and system GMM tends to explode as time (T) becomes large (Roodman, 2007). Given that we have a very long period (T=180), we presume that the possible dynamic bias that may arise with the introduction of lagged value of dependent variable (and its associated endogeneity) would be insignificant. Hence, a straightforward fixed effects (panel) regression models were estimated, as described in the following sub-sections.

2.1.1 Food Price Spikes Model

The general form of the fixed effects food price spike model for a commodity is given as:

$$\Delta \ln Y_{it} = \alpha(\Delta \ln Y)_{it-1} + X_{it}\beta + c_i + \varepsilon_{it} \qquad 1$$

Where: Y_{it} is the average price of the referenced commodity at local markets in the i^{th} state in time t. $\Delta \ln Y_{it} = \ln Y_{it} - \ln Y_{it-1}$ is the price spike [log price return] observed for the referenced commodity between the referenced month and the previous month. X_{it} is a row

vector of time-varying regressors; c_i is the unobservable time invariant state specific sources of heterogeneity in price spikes, while ε_{it} is the stochastic residual term assumed to be a Gaussian white noise with $E(\varepsilon \mid X, c) = 0$. i=1, 2, 3, …, I and t=1, 2, 3, …, T. I is the total number of states (36) in the country and T is the total number of months (180), covering from 2002:1 to 2016:12 for which price spikes and volatilities were estimated. The total number of observations equals 6480.

The fixed-effects (unlike random-effects) framework, is appropriate where c_i may be correlated with X_{it}, but X_{it} remains uncorrelated with ε_{it}. Using the framework thus, control some forms of endogeneity problems that may arise where some unobserved state specific factors like production or demand patterns, among others, contribute to observed food price spikes. The cluster robust option was applied in the model estimation.

For robustness check, we also estimated the seemingly unrelated regression (SUR) models of food price spikes and compare the results with those of estimated fixed effects model. We presumed that it is possible that spikes in a given market or commodity may be related to spikes (i.e. have spill over effects) in other markets or commodities. The fixed effects estimation framework does not control for the cross market and/or commodity correlations, which SUR does. However, while SUR models control for cross market/commodity correlations as well as allow some naïve ways of examining the possible influence of some observed time-invariant factors, it does not control for unobserved state/crop specific sources of heterogeneity which raise some forms of endogeneity concerns.

The seemingly unrelated regression food price spike model estimated is specified as:

$$\Delta \ln Y_{ijt} = \alpha \left(\Delta \ln Y \right)_{ijt-1} + X_{ijt}\beta_j + \theta D'_{ij} + e_{ijt} \qquad 2$$

Variables in the model are as defined in the fixed effects model, but with j introduced to represent specific food commodity. j=1, 2, 3, …, J. The total number of commodity considered (J) is eleven (11). The residual terms (e_{ijt}) are assumed to have zero mean, homoscedastic (σ^2) and independent across individual observations. However, the complexity is that errors may be correlated across equations (commodities) and markets in the states, such that $E(e_{ijt} e_{ijt}')=\sigma ijt'$, and $\sigma_{ijt}' \neq 0$ when j=j'. For the 11 equation systems, $E(\mathbf{ee}')=\sum \otimes \mathbf{I}_N$ with N=TI. Where $\sum=(\sigma_{ijt})$ is 11 by 11 positive-definite matrix and $\otimes$ is the Kronecker products of the 11 matrices. Description of the variables in the price spike models are presented in Table 1.

2.1.2 Modelling Food Price Volatility

In this study, annual food price volatilities were computed for each commodity in each of months of the year 2002:1 – 2016:12, using the last 12 month ending in the particular month as the year (t) (details in section 2.2). It follows therefore that the volatility of each month of year t contains (is estimated with) overlapping information (price spikes) from the eleven (11) preceding months. Consequently, we conjectured that even in the absence of Nickel bias,

there may exist possibility of serial correlation given the way volatility was estimated. Thus, we estimate (for robustness check) another strand of the fixed effects model that could potentially handle serially correlated errors (equation 4) in addition to the (*basic)* fixed effects model (equation 3).

The estimated (*basic*) fixed effects model for the price volatility of a specific food commodity is specified as:

$$V_{it} = \alpha V_{it-1} + Z_{it}\beta + c_i + \varepsilon_{it} \quad 3$$

Where: V_{it} is the volatility of price spikes, while Z_{it} and c_i are as earlier defined.

The fixed effects model with first order autoregressive scheme is specified as:

$$V_{it} = \alpha V_{it-1} + Z_{it}\beta + c_i + \varepsilon_{it}$$

$$\varepsilon_{it} = \rho\, \varepsilon_{it-1} + u_{it} \quad 4$$

Where: u_{it} are error terms independently normally distributed with mean zero and constant variance; ρ is a measure of correlation between the empirical e_{ijt} and its lag, e_{ijt-1}. We examined the presence of serially correlated (AR1) disturbance using Bhargava et al. (1982) Durbin–Watson statistic. Bhargava *et al.* (1982) noted that in datasets with large panels, Durbin–Watson statistic estimates below 2 suggest rejection of the null hypothesis of serially independent errors. He noted however, that very low values may suggest that errors follow a random walk.

2.2 Variables Definition and Measurements

Food Price Spikes and Volatility

While (as mentioned earlier) price spikes relate to huge, quick but temporal upsurge and drop in price, volatility captures long term variation in prices. Price volatility is a measure of price dispersion from the mean which shows the risk that is related to price changes and signifies substantial long-term price movement. Price spike is measured using the logarithm of period (month) to period (month) prices of food items (P) over the entire years being considered (Tadesse *et al.*, 2014). It is formularized as

$$\Delta lnP_{mt} = \ln\left(\frac{P_m}{P_{m-1}}\right) = \ln(P_m) - \ln(P_{m-1}) \quad 5$$

where Δ represents difference operator, *m* represents month of the year and *t* represents the year.

Food price volatility has been assessed using the standard deviation of log price return and the coefficient of variation of the original price. Two broad views appear to be well projected in the literature with respect to the "time dimension" of volatility being examined. The first focuses on assessing volatility within months of specific (marketing) years over the entire

years for which volatility is studied (Balcombe, 2009; Minot, 2014). Volatility estimation (either the standard deviation of log price returns method or the traditional coefficient of variation approach) based on within months of specific marketing year only accounts for intra-annual volatility, but fails to consider inter-annual variability (Tadesse *et al.*, 2014; Geman and Ott, 2014). Following Balcombe (2009), volatility within months of a year can be specified as:

$$\sigma_{pt} = \sqrt{\left[\sum \frac{1}{N}(w_{mt} - \overline{w})^2\right]} \qquad 6$$

where σ_{pt} is the realized volatility for the year captured as the standard deviation of log returns of price over the year. $w_{mt} = \Delta lnP_{mt}$ is the log price returns and $\overline{w} = \sum \frac{1}{N} w_{mt}$ is the mean of the log price return. An advantage of the Balcombe (2009) methods is that it provides a convenient way to circumvent the trend/unit root problem. The conventional (normal) coefficient of variation is given as $\frac{\sigma}{\mu}$. Where σ is the standard deviation of (original) price over the months of a given period (one year) and μ is the mean value of price.

As noted earlier, it is fundamental to measure volatility with some insights into inter-year food price volatility. To achieve this, Tadesse *et al.* (2014) modified the conventional coefficient of variation by dividing σ by the mean price of the whole sample (years), and as such introduced a somewhat inter-year volatility, reflecting the measure of risks endured by consumers and farmers over a period of time longer than the cropping or marketing year. The modified formulation is given as:

$$CV_y = \frac{\sum_{m=1}^{12}\left(P_m - \overline{P_y}\right)^2}{\sum_{t=0}^{T} P_t} \frac{T}{12} \qquad 7$$

where *y* represents a specific year, *m* represents month, and T is *t* month (12) by total number of years under consideration.

Balcombe (2009) and Tadesse *et al.* (2014) estimate price volatility over marketing years with no overlapping observations. However, in our assessment, we employed both Balcombe (2009) and Tadesse *et al.* (2014) specifications with some modifications. As noted earlier, rather than estimating volatility over marketing years with no overlapping observations, our volatility estimate for each month of the year is with overlapping observations captured on 12 months (one marketing year) interval, starting progressively from December 2016 (through November of the same year) to the last month of year, 2001. By doing so, we are able to capture intra-annual volatility, and some elements of annual variability. Likewise, we employed the modified version of Tadesse *et al.* (2014) formulation, howbeit computed with overlapping observations to assess some inter-year dimensions of volatility across the entire sample period (years on interest).

Key control variables

The control variables are derived from literature review following Tadesse *et al.* (2014) and Kornher and Kalkuhl (2013). The variables are expected to influence domestic food price changes (spikes or volatility) in Nigeria. Description/measurement of variables such as beginning stock to use ratio, international food price spikes and volatility, exchange rates, crude oil price spikes and volatility, shocks in gross domestic products (GDP), international transaction costs (captured by liner shipping connectivity index), global food (grains) supply shocks, and GDP growth rates, among others, have been discussed comprehensively by these authors. Readers could consult their works. The variables are adapted for Nigeria. Other key control variables hypothesized to influence food price changes in Nigeria are discussed below.

Monetary Policy rates: This is the official interest rate fixed by the monetary policy committee of the central bank (of Nigeria) to control the supply of money, usually by targeting an inflation rate to ensure price stability and general trust in the currency. Monetary policy (interest) rates are more directly related to bank loans. Higher monetary policy rates are expected to reduce price inflation and stabilise price. The influence of interest rates on price volatility is usually via its linkage with storage. In a low interest rate environment, the cost of financing stockpiles is lower than when interest rates are high. A decrease in real interest rates lowers the cost (opportunity cost) of stocking/carrying inventories. As a result the demand for commodities raises and commodity prices increase, particularly if market participants anticipate (speculates) that fluctuation (shocks) in interest rate will persist (Frankel, 2006). It also expands expenditure and investment. Lower interest rates provide an inducement to retain current exhaustible commodities, as it decreases the cost of stocking (including the carrying cost of speculative positions). For a given anticipated price path, lower interest rates makes it easier for investors to bet on assets such as commodities (including foods); and under certain conditions, it can put upward pressure on futures price and, by arbitrage, also on spot prices.

Narrow money supply (M1): Since the seminal work by Frankel (1984), empirical studies on the influence of monetary conditions (and interest rates) on commodity prices have grown (Apergis and Rezitis, 2011; Hamilton, 2009; Barsky and Kilian, 2004). Narrow money supply (M1), includes physical money such as currency and coins, deposits at commercial banks, and any monies held in easily accessible accounts. However, it does not include elements such as loans by commercial banks, which is more directly related to monetary policy rate. Loans from banks are contained in the broad money (M2). An expansionary narrow money supply is thus expected to drive up commodity prices and vice versa. Although monetary policy shocks can help in predicting commodity price movements, monetary policy shocks are not the main sources of price fluctuations.

Per capita food production variability: This is an expression of the net food production variability per capita expressed in international dollars. For the calculation this variable, the

standard deviation of food production trend per capita was used. The data were extracted from food security indicator (FAO, 2016). Variability in food production may result from variations in the area planted or because of yield variations due to weather shocks. Food supply elasticity is usually low and the impacts of whether shocks are felt more quickly because farmers cannot harvest what they did not plant. Continuing heavy rainfalls can even destroy everything that is planted in reasonably large regions.

Even though production shocks often play substantial roles in food price variability, demand (especially income) shocks (Gilbert and Morgan, 2010) and policy shocks (Christiaensen 2009), may also be important factors. However, the degree to which food production shocks/variability translates into food price volatility also depends on consumers' demand elasticities. Generally, consumers are less willing to revise their consumption patterns, and in poor countries, may have few substitutes. In addition, the raw material from food commodity may constitute only a small portion of many processed foods. Thus, a large rise in commodity prices may even have a little impact on the price of final products.

Petrol price: Petrol price movements and the volatility of petrol prices can affect the volatility of commodity prices. Increases in petrol price increase transportation cost which in turn lead to hikes in prices. Among others, Shittu *et al.* (2015) found that hikes in petrol price due to the withdrawal of subsidies on petroleum products are a key driver of rising food prices in the country.

Real Effective Exchange rates: Higher real effective exchange rates capture changes in price competitiveness as a result of macroeconomic changes. If the real exchange rate of a country is rising, it implies that the country's goods are becoming more expensive relative to its competitors. Thus, increases in the real exchange rate will tend to increase net imports since it now becomes cheaper to import. This can expand current account deficit and reduce domestic aggregate demand, thereby reducing reduce inflation. Changes in exchange rates reallocate purchasing power and price incentives across countries without changing the overall food supply–demand balance (Gilbert and Morgan, 2010). Depreciation of Naira relative to Dollar (or other currency) is expected to raise prices to producers and consumers in Nigeria but lowers prices to consumers outside the country. Higher real effective exchange rate may excavate domestic price spikes and/or volatility.

Government Policy Actions (Dummies): The dummy variables are introduced to capture government policy stance in periods immediately after the 2007/2008 and its resurgence in 2010/21011 as well as the likely effects on food price spikes and volatility. The dummy variable for year 2008 to 2011 reflects policy regime in which (as mentioned earlier) government attempted to mitigate the effects of global food and financial crises of 2007/2008 through gradual liberalization of trade, release of reserved grains, review of minimum wages, provision of assistance to farmers in form of input subsidies, suspension of open market operation and monetary easing actions. The post 2011 dummy (year 2012 to 2016) describes

regime in which expansionary monetary (easing) policy stance was somewhat jettisoned with emphasis placed on monetary tightening. As noted earlier, Open Market Operations (OMO) was brought back to mop up or inject liquidity into the system with the in order to achieve price and exchange rate stability.

Seasonal (quarterly) Dummies: The dummy variables were introduced to control for the possible influence of seasons on price spikes or volatility. Although with possibility of mild overlaps, quarter 4 (October to December) or quarter 1 (January to March) may roughly represent early harvest or surplus/post-harvest seasons for most staples across regions of the country while quarter 2 (April to June) and quarter 3 (July to September) may coincide with onset of leans/post planting seasons. Generally price is expected to gradually fall in the early harvest/surplus seasons and rise at the onset of lean season/post planting period when crops are established on the field.

Borders: It is conjectures that the specificity of a state sharing border with another country may have stronger influence on price situation in the state compared to other states that do not share border. It is a dummy variable equalling one (1) if the state shares border with other country and zero (0) otherwise.

Distance to major seaport (km): The variable is used as proxy for transaction cost within the country. All else equal, distance is expected to be positively related to cost of transaction costs (including transportation costs) within the country, and consequently, commodity (food) price upsurges. Lagos ports are known as the economic doors to Nigeria. The Guardian (2017) noted on the basis of available statistics from the Nigerian Port Authority that Lagos ports complex alone claimed 97 per cent of the containers that are berthed in Nigeria in 2016.

3. Study Data and Sources

This study was based, primarily, on a panel data on State level monthly retail market prices of Nigeria's major staples across 36 states of Nigeria between 2001 and 2016. The food commodities are imported rice, local rice, maize, millet, sorghum, yam, garri (cassava flakes), meat, fish, beans and palm oil. The price data were collected from the National Bureau of Statistics (NBS) Office at Abuja, Nigeria, and were part of the data that are routinely collected towards computation and publication of the composite Consumer Price Indices (CPI) for the country.

Other data were extracted from the Annual Abstracts of Statistics, published by NBS; Statistical Bulletins of the Central Bank of Nigeria while the corresponding world prices were extracted from the World Consumer Prices section of the International Financial Statistics (IFS) published by the International Monetary Fund (IMF). Usable data on global beginning stock to use and supply are only available for rice and coarse grains (such as millet, maize, sorghum). Data on relevant domestic policy variables – interest rates, exchange rates, money supply, were extracted from the Central Bank of Nigeria (CBN) – Statistical Bulletins. Global monthly grain production, supply beginning stock and use were collected from the United Nations Department of Agriculture (USDA).

4. Descriptive Results

4.1 Food Price Spikes and Volatility Experienced in an Average Nigeria Market

Table 1 provides descriptive statistics of the food price spikes and volatility as experienced between 2002 and 2016 for each of the 11 major food commodities, while Figures 1a – 1c, 2a – 2c and 3a – 3c in the appendix depict the patterns of price spikes, intra-annual volatility as well as inter-year price volatility recorded in food prices over the years respectively.

As shown in Table 1, the mean price spike is approximately the same in all the grain markets. It can be concluded that on average the patterns of price spikes are similar across the grain markets. Although the mean price spikes of yam and *garri* are approximately equal, their respective minimum and the maximum values are substantially different. The absolute minimum and maximum values of price spikes for yam are more than twice that of *garri* respectively. The mean, minimum and maximum values of price spikes for meat and fish are also respectively different, suggesting different experience of short-term price upsurges among these food commodities. In terms of volatility assessment, the mean, minimum and maximum intra-annual price volatility estimates appear fairly similar for maize, millet and sorghum but higher in magnitudes compared to local and imported rice. The intra-annual price volatility appears to be slightly higher for local rice and other locally produced grains than for imported rice.

Table 1: Descriptive Statistics of Food Price Spikes and Volatility, 2002:1 – 2016:12 (National Average)

Commodity	Price Spike			Intra-annual Price Volatility			Inter annual Price Volatility		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Rice (imported)	-0.244	0.271	0.010	0.048	0.173	0.103	0.136	33.137	3.131
Rice (local)	-0.285	0.318	0.181	0.041	0.193	0.121	0.121	26.895	2.962
Maize	-0.320	0.306	0.009	0.074	0.250	0.157	0.323	24.900	4.001
Sorghum	-0.295	0.263	0.010	0.088	0.220	0.147	0.367	15.602	2.270
Millet	-0.281	0.223	0.010	0.080	0.223	0.145	0.366	21.021	3.152
Meat	-1.522	0.355	0.001	0.077	0.522	0.193	1.655	493.773	54.765
Fish	-0.623	0.603	0.009	0.090	0.397	0.184	2.307	187.208	43.297
Yam	-0.569	0.456	0.009	0.096	0.375	0.246	0.437	49.180	9.974
Garri	-0.214	0.183	0.008	0.080	0.205	0.152	0.433	20.426	4.231
Beans	-0.231	0.215	0.010	0.087	0.203	0.134	0.301	22.837	4.175
Palm oil	-0.151	0.303	0.013	0.044	0.146	0.095	0.494	127.448	3.200

Source: Authors' Computation

The seemingly higher within-year price volatilities in locally produced grains may be partly connected to weather/climate related, and production shocks including pests and diseases. This includes drought, flood, and inadequate water supply and seasonal unfavourable fluctuation in rainfall patterns, among others. Haile *et al.* (2013) noted that factors other than weather related shocks can emanate from changes in input supply and variations in the area planted.

The estimated inter-year price volatility values for imported rice and local rice are fairly equal. Nevertheless, the observed volatility range (difference between the minimum and maximum values) is wider for imported rice. Intra and inter-annual price variability are also considerable higher for meat and fish. With respect to tubers, both within and between year price variability are more pronounced in the yam than the *garri* market. This is expected because substantial progress has been made in terms on rising productivity of cassava through the development of high yielding, drought and diseases resistant cassava varieties compared to yam. The Table also reveals comparatively low level of intra-annual and inter-year price volatility in palm oil.

4.2 Patterns of Food Price Spikes and Volatilities in an Average Nigeria Market

As shown in Appendix 1 (Figures 1a – c), there have been substantial short-term fluctuations (spikes) in prices of food items in a typical market in Nigeria over the observed period. The food spikes graphs show some extraordinary short-term spikes in prices of foods at some specific time periods over the length of years. For example, the observed short-term spikes in imported price appear not to differ substantially from the patterns observed over the years. However, there are instances of comparatively high spikes prior to the 2007/08 food crises; towards mid-2010 and in the third- quarter of 2014. Whether these observed variations can be explained from econometrics standpoint is examined later in this study. Unlike for sorghum with several episodes of price spikes, there have not been unusual fluctuations (upsurges) in the price of maize over the last decade.

Whereas there are spreads of noticeable spikes in the price of *garri* and palm oil, spikes in yam price feature moments of comparatively low spikes especially between late 2008 and December 2010. The second episode of food crises in 2011 heralded another period of higher spikes in yam prices. There are few cases of unexpected lager spikes in meat and fish prices.

With regard to food price volatility (Appendix 2), there are noticeable intra-annual volatilities in prices of most crops over the years (Figures 2a-c). However, the patterns for commodities such as rice, sorghum, maize, millet and *garri* appear not to have deviated markedly from the patterns observed before the 2007/08 crises. The results also show intra-annual volatilities for palm oil, yam and local rice. In general, food price volatility begun to rise progressively from late 2012, and markedly from 2014 without a clear indication of return to earlier

patterns. Whether the observed intra-annual volatilities can be explained by some factors are examined in this study.

It can be observed (Appendix 3) that inter-annual volatilities (Figures 3a-c) have remained steady for most food commodities until late 2013. Since then progressive rise in inter-year volatilities has been beyond what was observed across commodities except in animal product markets. While the rising inter-annual pattern is worrisome, the observed inter-annual volatility in 2016 is very alarming. Volatility peaks observed in 2016 are more than double the all-time peaks of 2007/2008 and 2010/2011 for most food commodities.

5. Econometric Results

5.1 Determinants of food price spikes

As mentioned earlier, the SUR model allows examination of the influence of time constant variables, which is impossible within the fixed effects framework. Our initial estimates of the SUR models of price spikes, however, consistently revealed across all food commodities, that none of the time-invariant factors such as location (zonal) dummies, distance from each state to the major seaport (Lagos), and whether (or not) a state shares border/boundary with other country is statistically significant. The results are not presented here, but are available on request. Consequently, we concluded that not being able to account for influence of time invariant factors, is not of concern in the use of fixed effects framework in this study. We thus, excluded the time invariant variables in the parsimonious version of the SUR models estimated.

Results of the factors influencing spikes in food prices are presented in Tables 2a-c. Here, only the results for commodities in which the estimated models indicate statistical significance are discussed. The results suggest that a spike in the price of a food commodity in a given period (month) is less likely to be followed by a greater spike in the price of the food item in the immediate succeeding month. Spikes in the domestic price of staples such as local rice, maize, sorghum (Table 2a), millet, yam (Table 2b), beans and garri (Table 2c) are amplified by short-term rises in their corresponding international prices. Given that food price spikes are associated with the short-term spill-over effects from food international price (Balcombe, 2009), efforts should be geared towards diluting spill-over of price upsurges from international food markets. Existing empirical studies conclude that unexpected price spikes do not only make poor consumers and landless worse-off but also farmers that are net-food buyers since they cannot quickly adjust farm production within the short-term in response to price upsurges (Aksoy and Isik-Dikmelik, 2008; Anríquez *et al.*, 2013). Nevertheless, price spikes can be beneficial for food producing households especially in the medium and long-term when households are able to adjust production to high-value crops.

Short-term spikes in the domestic food prices of the grains, fish, garri, beans and palm oil (Table 2a-c) are negatively linked to depreciation of local currency. This would mean that a weaker Naira is unlikely to substantially increase the rate of growth of food price inflation in the country.

Table 2a: Determinants of Spikes for Rice, Maize and Sorghum Price (N=6480)

Variables	Imported Rice		Local Rice		Maize		Sorghum	
	Fixed Effects	SUR	Fixed Effects	SUR	Fixed Effects	SUR	Fixed Effects	SUR
Lagged food price spikes	-0.168***	-0.221***	-0.206***	-0.262***	-0.341***	-0.340***	-0.213***	-0.275***
	-12.960	-29.030	-17.620	-31.980	-7.360	-37.550	-20.830	-31.400
Spike in international price of food commodity	1.1E-3	6.5E-4	2.9E-3	2.4E-3**	0.369***	0.128***	0.169***	0.139***
	0.850	0.800	1.670	2.580	7.490	4.380	6.720	5.510
Global stock to use ratio	-0.092***	-0.036	-0.139***	-0.061	-0.634***	-0.448***	-0.515***	-0.367***
	-5.840	-0.970	-4.800	-1.470	-8.510	-4.000	-8.420	-3.520
Global grain supply shocks	-0.005***	-0.003	-0.011	-0.008**	0.046***	0.020	0.016	0.011
	-3.430	-0.990	-1.560	-2.100	5.220	1.270	1.650	0.770
Real effective exchange rate	-0.001***	-0.001**	-0.001***	-0.001**	-0.001***	-0.001	-0.002***	-0.002***
	-6.180	-2.230	-5.700	-2.120	-4.580	-1.010	-6.260	-3.010
Petrol price in Nigeria	1.6E-3**	7.3E-4	2.2E-3**	1.2E-3	1.1E-3	4.5E-3	7.4E-5	-2.9E-4
	2.330	0.710	2.330	0.970	-1.010	0.320	-0.090	-0.220
Narrow money supply	-0.008***	-0.007***	-0.007***	-0.007***	-0.011***	-0.009***	-0.010***	-0.008***
	-11.770	6.290	-8.930	-4.840	-14.900	-5.180	-10.510	-5.010
Monetary policy rate	-0.095***	-0.096**	-0.078***	-0.067	-0.050	0.022	-0.070**	-0.077
	-4.630	-2.390	-3.070	-1.450	-1.400	0.350	-2.110	-1.300
GDP shocks	-0.706	-1.998	-1.413	-2.756	-2.209	-3.525*	-0.523	-0.365
	-0.810	-1.360	-1.260	-1.620	-1.510	-1.850	-0.390	-0.210
Oil price shock	0.001***	0.001***	0.001**	0.001***	0.001**	4.2E-3	-0.002***	-0.001***
	6.330	5.540	2.490	3.140	2.790	1.080	-3.620	-3.270
Liner shipping connectivity index	-0.683***	-0.606**	-0.420***	-0.262	0.598**	0.955**	0.491**	0.429
	-6.350	-2.330	-2.960	-0.870	2.170	2.210	2.140	1.070
Seasonal Dummy (Quarter 2)	0.001	0.002	-0.003	-0.001	0.006	-0.001	0.005	0.007
	0.270	0.590	-0.780	-0.310	1.020	-0.210	0.840	1.320
Seasonal Dummy (Quarter 3)	-0.002	-0.001	4.7E-3	0.001	-0.001	3.1E-3	0.017***	0.019***
	-0.580	-0.240	0.130	0.200	-0.110	0.050	3.580	3.210
Seasonal Dummy (Quarter 4)	-0.001	0.001	-0.024***	-0.021***	-0.045***	-0.043***	-0.014**	-0.008
	-0.270	0.340	-4.410	-4.190	-6.040	-6.920	-2.140	-1.320
Year 2008 to 2011 (period of monetary easing policy stance)	0.063***	0.046***	0.059***	0.034**	0.023**	-0.010	0.028***	0.008
	10.470	3.440	8.470	2.200	2.340	-0.510	2.950	0.430
Year 2012 to 2016 (period of monetary tightening policy stance)	0.038***	0.031***	0.034***	0.022**	0.002	-0.011	0.005	-0.004
	7.900	3.300	5.540	2.020	0.240	-0.780	0.610	-0.300
R-square		0.068		0.081		0.084		0.064
F-value	53.670***		53.670***		59.470***		64.580***	
Prob>F	0.000		0.000		0.000		0.000	

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Quarter 1 was dropped as a base for the seasonal dummies while dummy variable capturing years prior to 2008 was also dropped as the base period.

Table 2b: Determinants of Price Spikes for Millet, Beef, Fish and Yam (N=6480)

Variables	Millet		Beef		Fish		Yam	
	Fixed Effects	**SUR**	**Fixed Effects**	**SUR**	**Fixed Effects**	**SUR**	**Fixed Effects**	**SUR**
Lagged food price spikes	-0.269***	-0.309***	-0.274***	-0.274***	-0.361***	-0.361***	-0.382***	-0.386***
	(-12.86)	(-32.40)	(-16.19)	(-23.07)	(-29.06)	(-32.60)	(-28.78)	(-34.48)
Spike in international price of food commodity	0.477***	0.298***	-0.044	-0.019	0.243***	0.240***	0.656***	0.582***
	(11.83)	(8.03)	(-1.07)	(-0.37)	(12.99)	(9.15)	(13.80)	(9.37)
Global beginning stock to use ratio	-0.401***	-0.255**					-	-
	(-6.33)	(-2.41)						
Global grain supply shocks	0.011	0.004					-	-
	(1.16)	(0.29)						
Real effective exchange rate	-0.001***	-0.001*	-3.4E-3	-3.5E-4	-0.004***	-0.004***	1.1E-3	2.1E-3
	(-3.12)	(-1.68)	(-1.25)	(-0.04)	(-6.95)	(-5.13)	(0.26)	(0.22)
Petrol price in Nigeria	1.8E-3	1.3E-3	1.8E-5	2.9E-4	-0.001***	-0.001***	1.0E-3	8.8E-4
	(1.63)	(0.98)	(0.02)	(0.15)	(-5.18)	(-4.19)	(0.73)	(0.41)
Narrow money supply	-0.009***	-0.007***	-0.005***	-0.004*	-0.001	-1.0E-3	-0.005**	-0.004*
	(-8.90)	(-4.59)	(-4.67)	(-1.85)	(-0.31)	(-0.05)	(-2.72)	(-1.71)
Monetary policy rate	0.006	-0.036	-0.188***	-0.166**	-0.389***	-0.377***	0.116**	0.115
	(0.19)	(-0.60)	(-6.70)	(-2.05)	(-7.44)	(-5.33)	(2.40)	(1.27)
GDP shocks	0.178	-0.162	1.343	1.969	-2.348	-2.065	-4.553**	-4.272
	(0.17)	(-0.09)	(1.11)	(0.77)	(-1.36)	(-0.91)	(-2.36)	(-1.49)
Oil price shock	-0.001*	-3.2E-3	2.5E-3	-1.6E-3	3.7E-3	-3.0E-3	5.3E-4	2.6E-3
	(-1.90)	(-0.88)	(-0.56)	(-0.31)	(-0.87)	(-0.65)	(0.13)	(0.44)
Liner shipping connectivity index	0.616***	0.391	-1.204***	-1.102**	-1.689***	-1.626***	0.923***	0.938
	(3.01)	(0.97)	(-6.75)	(-2.09)	(-4.76)	(-3.53)	(3.21)	(1.60)
Seasonal Dummy (Quarter 2)	0.004	0.007	0.037***	0.036***	0.017**	0.017**	0.019**	0.020**
	(0.79)	(1.29)	(5.60)	(4.30)	(2.65)	(2.29)	(2.22)	(2.12)
Seasonal Dummy (Quarter 3)	0.015***	0.015**	0.040***	0.039***	0.018***	0.017**	-0.018**	-0.019**
	(2.87)	(2.57)	(6.68)	(4.53)	(2.99)	(2.32)	(-2.09)	(-1.99)
Seasonal Dummy (Quarter 4)	-0.012*	-0.008	0.014**	0.015*	0.033***	0.034***	-0.040***	-0.039***
	(-1.89)	(-1.42)	(1.98)	(1.71)	(4.77)	(4.38)	(-6.00)	(-4.09)
Year 2008 to 2011 (period of monetary easing policy stance)	0.025**	0.006	-0.060***	-0.067**	0.007	0.002	0.031	0.021
	(2.48)	(0.32)	(-4.17)	(-2.58)	(0.32)	(0.11)	(1.59)	(0.72)
Year 2012 to 2016 (period of monetary tightening policy stance)	0.006	-0.002	0.007	0.002	0.004	0.001	0.009	0.004
	(0.67)	(-0.13)	(0.67)	(0.10)	(0.28)	(0.06)	(0.72)	(0.20)
R-square		0.081		0.083		0.145		0.155
F-value	48.150***		151.19***		88.100***		90.880***	
Prob>F	0.000		0.000		0.000		0.000	

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Quarter 1 was dropped as a base for the seasonal dummies while dummy variable capturing years prior to 2008 was also dropped as the base period.

Table 2c: Determinants of Price Spikes for *garri,* Beans and Palm Oil (N=6480)

Variables	Garri		Beans		Palm Oil	
	Fixed Effects	**SUR**	**Fixed Effects**	**SUR**	**Fixed Effects**	**SUR**
Lagged food price spikes	-0.333***	-0.357***	-0.331***	-0.003***	-0.105***	-0.125***
	-21.820	-35.660	-15.000	-81.070	-9.480	-16.510
Spike in international price of food commodity	0.420***	0.263***	0.653***	0.003***	4.7E-4	4.1E-4
	10.750	6.740	11.860	79.630	1.540	0.990
Real effective exchange rate	-0.001***	-0.001*	-0.003***	-0.001***	-0.001***	-0.001***
	-3.930	-1.880	-8.660	-2.920	-8.550	-3.490
Petrol price in Nigeria	-3.7E-3***	0.000***	-1.5E-3*	-8.8E-4	-2.9E-3***	0.000***
	-3.180	-3.080	-1.880	-1.030	-5.300	-3.370
Narrow money supply	-0.009***	-0.008***	-0.007***	-0.001	-0.012***	-0.012***
	-7.960	-5.070	-9.160	-0.640	-13.510	-11.040
Monetary policy rate	-0.023	-0.037	-0.143***	-0.079**	-0.261***	-0.262***
	-0.760	-0.650	-5.060	-2.170	-13.240	-7.040
GDP shocks	-6.083***	-6.145***	-5.014***	0.202	1.089*	0.880
	-5.210	-3.440	-4.410	0.170	1.710	0.740
International Crude Oil price shocks	2.7E-3	0.001*	4.8E-3	0.001***	-4.7E-3**	-4.4E-3*
	0.720	1.770	1.410	3.500	-2.200	-1.820
Liner shipping connectivity index	0.534***	0.520	-0.699***	-0.476**	-1.060***	-1.049***
	2.820	1.420	-4.350	-2.000	-10.530	-4.330
Seasonal Dummy (Quarter 2)	0.017***	0.018***	0.015**	0.001	-0.012***	-0.011***
	2.780	3.180	2.700	0.310	-3.120	-2.920
Seasonal Dummy (Quarter 3)	-0.005	-0.006	0.023***	-0.003	0.016***	0.017***
	-0.760	-0.990	4.800	-0.740	3.470	4.220
Seasonal Dummy (Quarter 4)	-0.019***	-0.018***	-0.016**	-0.018***	0.017***	0.018***
	-2.800	-3.060	-2.060	-4.500	3.810	4.480
Year 2008 to 2011 (period of monetary easing policy stance)	0.035**	0.019	0.099***	0.043***	-0.005	-0.009
	2.440	1.060	7.330	3.510	-0.800	-0.740
Year 2012 to 2016 (period of monetary tightening policy stance)	0.029***	0.021	0.062***	0.024	0.008	0.006
	2.970	1.630	7.920	2.740	1.450	0.700
R-square		0.123		0.573		0.070
F-value	184.800***		184.700***		130.270***	
Prob>F	0.000		0.000		0.000	

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Quarter 1 was dropped as a base (quarter 1) for the seasonal dummies while dummy variable capturing years prior to 2008 was also dropped as the base period.

In small magnitudes, spikes in the domestic prices of rice (Table 2 a) are more directly related to higher prices of petrol. However, higher petrol has negative effects on spikes in *garri,* beans and palm oil. Geman and Ott (2014) noted petrol price as an important factor affecting food prices. Higher prices of petrol heighten spikes in rice markets having enormous implications for food security in terms of access to the food calorie needs, especially among poor households leading to higher rates of malnutrition in the country. Shocks in GDP is less likely to increase food price spikes in Nigeria. This is contrary to findings at a global scale in other studies. For instance, Tadesse *et al.* (2014) found that global demand shocks have significant and positive influence on spikes in maize, rice and soybean prices.

Narrow money supply has a negative and significant relationship with food price spikes. It means that expansionary narrow money supply has calming effects on food price spikes in Nigeria. This may be suggestive of how narrow money supply could be useful as a macro-economic policy strategy for addressing potential short-terms price upsurge (spike) in food markets and in manipulating agricultural sector in the country. Though, narrow money supply may hurt farmers in the short-run since contractionary monetary policy tends to depress inflation and may shift price, and therefore profit, away from farmers who could have taken advantage of higher price to improve welfare. Some previous studies (Abeygunawardena and Gunatilake, 1993; Tiwari, 2010; Lee and Park, 2013; Kornher *et al.*, 2014) have linked money supply with price inflation and volatility into the food sector.

Liner Shipping Connectivity Index (LSCI) is statistically significant and positively related to spikes in the prices of food commodities such as millet, *garri,* yam and sorghum. This means that an increase in the percentage points of (LSCI) leads to higher spikes in these commodities. Lower costs of international trade can enhance greater demand for importing those commodities from Nigeria. The external demand pressure from other countries, especially in the face of inadequate or low supply (production) in the country can trigger significant price upsurges. However, a lower international transaction cost (higher per cent points of LSCI) has reducing effects on spikes in rice, fish, beans and palm oil prices.

Higher beginning stock to use ratio of coarse grains has negative effects on spikes in prices of storable commodities such as rice, maize, millet and sorghum in Nigeria. Higher beginning stock can absorb supply or demand shocks by acting as buffer to markets in the period of low production and consequently suppress price swings (Geman and Ott, 2014).The results suggest that on the average, spikes in the prices of locally grown cereals, roots and tubers and beans appears to be generally low in the last quarter of the year, and relatively high in the second and third quarters. The findings may give an indication of when government schemes such safety nets can be targeted to vulnerable household groups. Increase monetary policy rates is negatively related to food price spikes, meaning that lower interest rates may heighten food price spikes in the country. As mentioned earlier, for a given anticipated price path, lower interest rates makes it easier for investors to bet on assets such as commodities

(including foods); and may put upward pressure on futures price and, by arbitrage, also on spot prices.

The results suggest that oil price spikes have increasing effects on prices of rice, maize and palm oil. However, it has decreasing effects on the price of millet, sorghum, yam and *garri*. The significance of the findings is that factors such as biofuels demand and production (such as fertilizer, transportation) which have been linked with oil price changes (Tadesse et al., 2014), among others, may be relevant in explaining food price changes in the country. The coefficient of the dummy variable for the year 2008-2011 are statistically significant and positive for rice, *garri,* beans, millet, maize, suggesting that average spike in each of these food items is higher during the periods than the previous years. The combinations of monetary policy instruments (coupled with suspension of the open market operations), and other actions during this period appear to have an increasing effects of price of staples. This development is unhealthy for net-food consumers because of the likely welfare loss. Although the country appears to have embarked on monetary tightening in post 2011, average spike in the price of rice, *garri* and beans still seem higher than that of 2007/2008 food crises- albeit lesser in magnitudes than the observed spikes between year 2008 and 2011.

5.2 Determinants of Volatility in Food Prices

Tables 3a - c present our econometric results on drivers of food price volatility in Nigeria. The Bhargava et al. (1982) Durbin–Watson statistic associated with each of the estimated fixed effects model (with AR1 process) indicates presence of serially correlated errors in the estimated model.

Table 3a: Determinants of Price Volatility of Rice, Maize and Sorghum (N=6480)

Variables	Imported Rice		Local Rice		Maize		Sorghum	
	Fixed Effects (FE)	FE with AR1	Fixed Effects (FE)	FE with AR1	Fixed Effects (FE)	FE with AR1	Fixed Effects (FE)	FE with AR1
Volatile international price of the food commodity	-5.37E-6	1.49E-05	1.7E-3***	1.7E-3***	0.057	0.050	-0.095**	-0.104***
	(-0.16)	(0.51)	(4.15)	(5.17)	(1.32)	(0.78)	(-2.68)	(-3.24)
Global beginning stock to use ratio	-0.027***	-0.014**	0.013	0.012**	-0.017	-0.025	0.025	0.034
	(-6.63)	(-2.3)	(0.8)	(1.71)	(-0.44)	(-0.52)	(1.13)	(1.56)
Real effective exchange rate	0.001***	0.001***	3.3E-3**	3.9E-3**	-2.3E-3	-1.4E-3	3.0E-3**	2.72E-3**
	(5.16)	(5.54)	(2.9)	(2.8)	(-1.15)	(-0.47)	(2.44)	(2.09)
Petrol price in Nigeria	5.17E-6	1.78E-05	-.5E-4	-6.9E-6	1.87E-06	2.88E-05	-4.6E-4	-2.8E-5
	(0.25)	(0.98)	(-0.52)	(-0.34)	(0.05)	(0.66)	(-1.45)	(-1.3)
Narrow money supply	-0.001**	-0.001**	-0.001**	-0.001**	-2.1E-3	-0.001	-1.1E-3	-2.6E-3
	(-2.88)	(-2.56)	(-2.69)	(-2.84)	(-0.67)	(-1.23)	(-0.45)	(-0.93)
Monetary policy rate	0.049***	0.042***	0.020*	0.013	-0.019	-0.010	0.021	0.007
	(4.55)	(3.11)	(1.7)	(0.91)	(-0.98)	(-0.31)	(1.48)	(0.5)
GDP growth rate	-4.0E-3*	0.000189	3.3E-3	0.001***	0.001	0.001	2.5E-3	0.001*
	(-1.75)	(0.77)	(0.89)	(3.11)	(0.6)	(1.18)	(0.89)	(1.78)
Food production variability	-0.021	-0.016	-0.010	-0.010	-0.071	-0.103	0.124***	0.124**
	(-0.61)	(-0.43)	(-0.34)	(-0.24)	(-1.19)	(-1.15)	(3.18)	(2.98)
Liner shipping connectivity index	0.283***	0.204**	0.206**	0.134	-0.031	0.050	0.135	0.002
	(4.48)	(2.46)	(2.8)	(1.5)	(-0.22)	(0.24)	(1.61)	(0.02)
Volatile international crude Oil price	-0.088***	-0.066***	-0.086***	-0.066***	0.005	-0.011	0.004	0.022
	(-4.68)	(-4.24)	(-4.85)	(-3.85)	(0.27)	(-0.29)	(0.24)	(1.1)
Seasonal Dummy (Quarter 2)	-0.001**	-0.000319	-0.001**	-0.001	-0.001	-0.001	-0.002***	-0.002**
	(-2.86)	(-0.44)	(-2.1)	(-0.69)	(-1.37)	(-0.59)	(-6.03)	(-2.28)
Seasonal Dummy (Quarter 3)	-0.0004	-0.000481	-0.001***	-0.001	-0.001	-0.002	-0.001**	-0.001
	(-1.2)	(-0.61)	(-3.08)	(-1.08)	(-0.99)	(-0.86)	(-2.63)	(-1.18)
Seasonal Dummy (Quarter 4)	-0.001*	-0.001	-0.001***	-0.001	-0.001*	-0.001	-0.001**	-0.001
	(-1.96)	(-0.82)	(-4.38)	(-1.2)	(-1.9)	(-0.71)	(-2.52)	(-1.05)
Year 2008 to 2011 (period of monetary easing policy stance)	-0.005**	-0.010***	-0.013***	-0.014***	0.001	-0.002	-0.012***	-0.011**
	(-2.15)	(-3.01)	(-3.06)	(-4.07)	(0.08)	(-0.23)	(-4.08)	(-2.79)
Year 2012 to 2016 (period of monetary tightening policy stance)	-0.003	-0.005**	-0.009***	-0.009***	-0.003	-0.004	-0.008***	-0.006**
	(-1.61)	(-2.09)	(-4.07)	(-3.32)	(-0.64)	(-0.69)	(-4.12)	(-2.32)
F_value	27481.61***	1484.75***	15296.79***	1881.56***	80850.48***	1403.9***	16040.27***	2199.41***
Durbin-Watson		1.347		1.442		1.281		1.592
Baltagi-Wu LTI		1.348		1.443		1.282		1.600

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Quarter 1 was dropped as a base for the seasonal dummies while dummy variable capturing years prior to 2008 was also dropped as the base period. Fixed effects= Fixed effects model without AR1 process

Table 3b: Determinants of Price Volatility of Millet, Beef, Fish and Yam (N=6480)

Variables	Millet		Beef		Fish		Yam	
	Fixed Effects (FE)	FE with AR1	Fixed Effects (FE)	FE with AR1	Fixed Effects (FE)	FE with AR1	Fixed Effects (FE)	FE with AR1
Lagged dependent variable	0.950***	0.916***	0.937***	0.901***	0.935***	0.877***	0.944***	0.904***
	(163.32)	(179.91)	(226.02)	(162.74)	(224.65)	(152.44)	(269.26)	(176.97)
Volatile international price of food commodity	-0.109	-0.091	-0.208***	-0.192***	-0.219***	-0.181***	-0.116	-0.065
	(-1.54)	(-1.5)	(-4.72)	(-3.27)	(-4.8)	(-4.5)	(-1.46)	(-0.81)
Global beginning stock to use ratio	0.011	0.026	-	-	-	-	-	-
	(0.43)	(0.99)						
Real effective exchange rate	2.7E-2*	2.4E-3	0.001***	0.001***	0.001	7.9E-4	1.3E-3	-1.5E-3
	(1.94)	(1.52)	(3.09)	(4.42)	(1.64)	(0.35)	(0.46)	(-0.72)
Petrol price in Nigeria	-5.4E-4	-4.1E-5*	1.2E-3*	1.37E-3***	1.4E-4	8.24E-5**	3.3E-4	6.96E-5**
	(-1.43)	(-1.7)	(2.03)	(3.25)	(0.28)	(2.26)	(0.74)	(2.09)
Narrow money supply	-0.001**	-0.001***	0.002***	0.002***	-0.002***	-0.002***	-0.001***	-0.002***
	(-2.27)	(-3.21)	(3.43)	(3.46)	(-4.54)	(-4.32)	(-3.21)	(-3.57)
Monetary policy rate	0.032*	0.019	0.144***	0.142***	0.052	0.013	-0.024	-0.086***
	(1.97)	(1.08)	(4.16)	(5.04)	(1.52)	(0.52)	(-0.81)	(-3.62)
GDP growth rate	1.0E-3	4.3E-3	0.001**	0.001	0.002***	0.001**	0.002***	0.002***
	(0.29)	(1.3)	(2.22)	(1.46)	(5.4)	(2.14)	(4.79)	(4.9)
Food production variability	0.119**	0.130**	0.199**	0.185**	0.440***	0.494***	0.192***	0.124*
	(2.7)	(2.85)	(2.97)	(2.47)	(5.34)	(6.89)	(3.58)	(1.92)
Liner shipping connectivity index	0.256**	0.145	0.895***	0.843***	0.457**	0.197	-0.140	-0.577***
	(2.5)	(1.26)	(4.2)	(4.85)	(2.24)	(1.24)	(-0.73)	(-3.82)
Volatile international crude Oil price	0.008	0.017	0.051	0.017	0.027	0.053*	-0.009	0.011
	(0.35)	(0.81)	(1.56)	(0.53)	(0.93)	(1.79)	(-0.21)	(0.35)
Seasonal Dummy (Quarter 2)	-0.001**	-0.001	-0.003***	-0.003*	-0.002***	-0.001	-0.001	3.52E-5
	(-2.54)	(-1.19)	(-5.4)	(-1.88)	(-4.4)	(-0.96)	(-0.81)	(0.03)
Seasonal Dummy (Quarter 3)	-0.001	-0.001	-0.003***	-0.004**	-0.001*	7.35E-5	-0.001	1.55E-6
	(-1.57)	(-0.63)	(-4.81)	(-2.08)	(-1.75)	(0.05)	(-1.42)	(0.00)
Seasonal Dummy (Quarter 4)	-0.001**	-0.001	-0.004***	-0.005***	-0.002**	1.9E-3	-0.002**	- 1.1E-2
	(-2.54)	(-0.82)	(-6.86)	(-2.92)	(-2.16)	(0.13)	(-2.57)	(0.81)
Year 2008 to 2011 (period of monetary easing policy stance)	-0.009**	-0.009**	-0.011*	-0.012*	-0.036***	-0.036***	-0.019***	-0.017***
	(-2.21)	(-2.1)	(-1.79)	(-1.76)	(-5.51)	(-5.95)	(-3.9)	(-2.99)
Year 2012 to 2016 (period of monetary tightening policy stance)	-0.007**	-0.006**	-0.018**	-0.018***	-0.021***	-0.017***	-0.014***	-0.011**
	(-2.6)	(-2.18)	(-5.01)	(-3.75)	(-4.67)	(-4.09)	(-4.03)	(-2.84)
F_value	9926***	2250.40***	10683.24***	2465.29**	19319.07***	2058.37***	17756.81***	2817.73***
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Durbin-Watson		1.570		1.643		1.419		1.481
Baltagi-Wu LTI		1.571		1.647		1.421		1.490

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Quarter 1 was dropped as a base for the seasonal dummies while dummy variable capturing years prior to 2008 was also dropped as the base period. Fixed effects= Fixed effects model without AR1 process

Table 3c: Determinants of Price Volatility of *garri*, Beans and Palm Oil (N=6480)

Variables	Garri		Beans		Palm Oil	
	Fixed Effects (FE)	FE with AR1	Fixed Effects (FE)	FE with AR1	Fixed Effects (FE)	FE with AR1
Lagged dependent variable	0.946***	0.896***	0.946***	0.890***	0.940***	0.903***
	(231.71)	(161.33)	(264.74)	(153.92)	(180.12)	(165.55)
Volatile international price of food commodity	-0.191***	-0.144**	-0.255***	-0.280***	-4.8E-4***	-4.4E-5***
	(-4.53)	(-2.55)	(-4.33)	(-5.09)	(-5.35)	(-3.37)
Real effective exchange rate	1.3E-3	-9.81E-05	4.4E-4	-2.75E-05	3.6E-4	-1.5E-5
	(-0.72)	(-0.66)	(0.29)	(-0.19)	(0.57)	(-0.2)
Petrol price in Nigeria	-4.3E-4*	-2.07E-05	-3.41	-4.72E-06	4.2E-6	0.000
	(-1.7)	(-0.9)	(-1.13)	(-0.21)	(0.3)	(0.49)
Narrow money supply	-4.7E-3*	-0.001**	0.001	0.000216	-0.001***	-0.001***
	(-1.78)	(-2.6)	(1.48)	(0.73)	(-5.22)	(-5.64)
Monetary policy rate	-0.016	-0.028*	0.008	-0.019	0.007	-0.007
	(-0.92)	(-1.69)	(0.41)	(-1.17)	(0.85)	(-0.83)
GDP growth rate	3.5E-3	0.001**	-3.2E-4	5.43E-05	-1.9E-3	-1.3E-3
	(1.2)	(2.54)	(-0.14)	(0.19)	(-1.14)	(-0.85)
Food production variability	0.038	0.034	0.068	0.050	0.094**	0.068**
	(0.97)	(0.75)	(1.68)	(1.13)	(2.75)	(2.47)
Liner shipping connectivity index	-0.035	-0.133	0.139	-0.092	0.060	-0.036
	(-0.29)	(-1.29)	(1.28)	(-0.9)	(0.98)	(-0.66)
Volatile international crude Oil price	0.009	-0.001	0.055**	0.075***	0.012	0.013
	(0.53)	(-0.03)	(2.86)	(3.64)	(1.23)	(1.15)
Seasonal Dummy (Quarter 2)	-0.001**	-0.001	-0.001*	-0.001	-4.8E-3	-4.2E-3
	(-2.35)	(-1.11)	(-1.86)	(-0.95)	(-1.64)	(-0.77)
Seasonal Dummy (Quarter 3)	-3.6E-4	-1.8E-3	-0.001**	-0.001	-3.1E-3	-3.1E-3
	(-0.1)	(-0.18)	(-2.21)	(-0.92)	(-1.1)	(-0.53)
Seasonal Dummy (Quarter 4)	-1.3E-3	-2.0E-3	-1.9E-3	-9.4E-4	1.8E-3	2.8E-3
	(-0.22)	(-0.21)	(-0.49)	(-0.1)	(0.55)	(0.5)
Year 2008 to 2011 (period of monetary easing policy stance)	-0.003	-0.005	-0.014***	-0.012***	-0.005*	-0.006**
	(-0.66)	(-1.22)	(-3.6)	(-3.08)	(-1.77)	(-2.56)
Year 2012 to 2016 (period of monetary tightening policy stance)	-0.002	-0.003	-0.010***	-0.007**	-0.004*	-0.005**
	(-0.6)	(-1.09)	(-3.14)	(-2.5)	(-1.93)	(-2.76)
F_value	13468.03***	1947.08***	25861.19***	1821.23***	14533.77***	2618.53***
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000
Durbin-Watson		1.448		1.387		1.599
Baltagi-Wu LTI		1.454		1.410		1.615

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Quarter 1 was dropped as a base for the seasonal dummies while dummy variable capturing years prior to 2008 was also dropped as the base period. Fixed effects= Fixed effects model without AR1 process

There are statistically significant relationship between international food prices and volatility of the prices of some specific domestic foods. To keep space, we present results of influencers of within year volatilities. The coefficients of the lagged values of domestic price volatility are positive, suggesting that higher food price volatility in a month may have increasing effects on volatility in another month of the year. This establishes some level of volatility persistence. However, it is diffused at a lesser degree. Volatility of international price of rice appears to have a significant and positive influence (albeit of small magnitude) on the volatility of local rice. Volatile international price of rice is unlikely to increase volatility of prices of other locally produced foods (Table 3 a). When volatility of international price of traded food commodity remains high, it is more likely to be transmitted to the domestic price of same/similar products as investors are unable to reasonably forecast future price. This is in line with results of studies by Huh *et al.* (2012) and Kornher and Kalkuhl (2013). Given that high price volatility could dampen farmers, industrials and other investors' decisions, instability of the world rice market may spell doom for investors in local rice production/businesses in Nigeria. This situation is unfavourable for growth in agricultural (rice) production and food security in the country since the country has enormous potentials for local rice production.

The beginning stock to use stocks of rice has negative and significant (albeit weak) effects on imported rice price volatility (Table 3 a) as expected. A number of previous studies (Balcombe, 2009; Huh *et al.* 2012; Serra and Gil, 2012) has documented a significant negatively relationship between beginning stock and food price volatilities. The positive relationship between beginning stock-to-use of rice and volatility of local rice price seems counterintuitive. Where previous studies established a positive relationship, the variable was insignificant (Tadesse *et al.*, 2014). Ordinarily, stocks absorb production deficits by raising available supply. Higher food stocks at the start of marketing year is thus expected to ensure higher food supply during the year, thereby helping to mitigate price instability. The somewhat contrary evidence found in the case of local rice might be related to unstable macro-economic conditions, including trade policies and political environment which may have upturned the possible dampening effects of the beginning stock. Tadesse *et al.* (2014) noted that the effect of exogenous shocks (such as stock-to-use) on price volatility may depend on the prevailing economic and political environment.

Narrow money supply expansion calms volatility of rice, sorghum (Table 3 a), fish, millet, yam (Table 3 b) and palm oil (Table 3 c), but raise the volatility of beef (Table 3 b) prices. Theoretically, when money supply increases, aggregated demand tends to increase leading to higher price level, including that of food commodities. However, volatility of price may not necessarily increase. Changes in money supply can influence agricultural prices through the mechanism of interest rates. Hence, by managing money supply through effective monetary policies, the country can also influence food price rise or volatility to some extent.

Higher monetary policy rates (interest rates fixed by monetary policy committee) are responsible for the higher volatilities of some food commodities such as imported rice, local

rice (Table 3 a), and beef (Tables 3 b) and lower volatility of prices of yam (Table 3 b) and *garri* (Table 3 c). The most important avenue on which interest rate stimulates price volatility is through the cost of stocking. Although interest rates may be a poor indictor of food price volatility (Musaka, 2015), all else equal, decrease in real interest rates may decrease carrying cost of inventories and increase commodity prices (Frankel, 2006). The foregoing projects how monetary policy rates may be manipulated to influence food prices in the country.

The effects of petrol prices on volatility of food commodities are mixed. For example, higher petrol price has more escalating effects on fish and beef price volatility (Table 3 b), and a dampening (mild) influence on volatilities of *garri* and millet. Geman and Ott (2014) noted that both petrol price movements (and volatility) can affect the volatility of commodity prices. That higher prices of domestic price of oil (petrol) heighten volatility in animal protein markets having enormous implications for the quality of proteins produced and consumed by the average Nigerian. The quantity of meat consumed in Nigeria (2 kg per person and per year) is still below the ECOWAS Zonal average of 8 kg per person per year (Okello *et al.*, 2014; Bénard *et al.,* 2010). Hence, high food price volatility (as may be induced by higher oil (petro) price), can further diminish consumption, especially among poor households leading to higher rates of malnutrition in the country.

Higher real effective exchange rates (Naira to other currencies) increases grain volatility. This suggests that appreciation of real exchange rate is what is required to substantially reduce food price volatilities in Nigeria local markets. While this contradicts evidences in Gilbert (2008) as well as Piesse and Thirtle (2009) that indicated that exchange rate depreciation might not have been sufficiently large to cause substantial change in prices; it agrees with evidences in most studies (Mitchell, 2008; Balcombe, 2009; Cornia *et al.*, 2012).

Effort to stabilize Naira (to Dollar) exchange rates and/or ensure its appreciation can enhance food security in the country. In their studies, Lee and Park (2013) and Geman and Ott (2014) established that appreciation of exchange rate (for local currency) can substantially lower volatility of domestic price. GDP growth can be regarded as demand side shock. We found GDP growth rates to have significant and positive effect on the domestic price volatility of local rice, *garri*, yam and beef suggesting that higher economic growth is more likely to enhance volatility in the price of these products. This is in line with some previous studies (Lee and Park, 2013; Tadesse *et al.*, 2014) which reported that higher GDP growth rates can significantly enhance food price volatility. However, higher GDP growth rates are inversely related to the volatility of imported rice, millet and fish.

The results indicate that volatility crude oil price increases volatility of the domestic price of rice, but depresses volatility of fish (Table 3 b) and beans (Table 3 c). The importance of oil prices in explaining food price volatility shows that food and crude oil markets have become more interwoven. Jungho and Koo (2009) and Musaka (2015) noted that crude oil price and exchange rate are significant predictors of volatility of agricultural commodities. More volatility crude oil price can result in higher demand for biofuel commodities such as maize,

millet, soybeans among others, leading to higher prices of the food commodities (and/or related foods such imported and local rice). Ordinary, increased demand for biofuel food commodities stimulates reallocation of production resources with the attendant impacts of production and prices of biofuel and non-biofuel food commodities. Besides production and biofuel effects, changes in crude oil price also affect food price volatility though a real income effects because of their dominant impact on the overall economy (Tadesse *et al.*, 2014). Food production variability seems to enhance domestic price volatility of local rice, yam, millet, sorghum and palm oil. It is largely believed that production variability is strongly linked to more extreme weather conditions as a result of global warming and changes in input supply and variations in area planted (Haile *et al.*, 2013). Efforts to mitigate large fluctuation in food outputs of these crops are crucial for investment decisions and food security in the country.

The Liner Shipping Connectivity Index (*LSCI)* is positively related with volatility of food such imported rice, millet, maize and beef but inversely related to the volatility of yam price. At the moment, the findings would suggest that the easier it is to ship these commodities to the rest of the world (greater access to global trade), the higher their price volatilities at the domestic market. However, greater connection to global shipping networks (lower cost of international trade) could stabilize yam price. This is important for export yam export in Nigeria. Maritime transport is the keystone of global trade and a key engine driving globalization.

The results suggest generally that across seasons of the year (as captured by quarterly dummies), food price volatilities have remained relatively calm and/or undistinguished for most foods. The implication is that heightened food price volatility is unlikely to be a serious seasonal concern within the year in the country. The dummy variable (year 2008 to 2011) captures volatility experience prior during the monetary easing government policy regime in response to 2007/2008 global food crises. The coefficients of the dummy variable suggest that price volatility generally reduce for food commodities during the periods than the periods after. The implications are that government actions during the periods seem to be effective in calming food price volatility in the country. Looking at price volatility after 2011, results show that the coefficients associated with post 2011 dummy (year 2012 to 2016) are still generally negative and statistically significant for food items but the magnitudes are slightly lower except for beef. This suggests that with the exception of beef, average food price volatility remains slightly higher after 2011 than in the year 2008-2011.

6. Conclusion

Food price spikes and volatility have become major concerns for policy makers and development practitioners across the globe. Although a few studies have been conducted on food price volatility in Africa, little is known about the key drivers of price spikes and volatility in the region, and in Nigeria in particular. The available studies also document mixed and inconclusive evidence on the patterns of food price volatility in Africa.

With specific focus on Nigeria, this study examines the patterns of food price spikes and volatility and the impact of certain domestic and international factors on the volatility of eleven food commodities in the country. We found that domestic food price volatility of previous periods may have increase (albeit little) influence on the volatility of the current year. Thus, establish mild volatility persistent in the economy. However, higher spike in a previous period is less likely to progressively advance spikes in the current period. For some specific commodities, seasonal dimension (quarterly dummies) reveal some distinguishing patterns on price spikes. Spikes in the prices of locally grown cereals, roots and tubers and beans are generally lower in the last quarter of the year and tends to be higher in second and third quarter. However, food price volatility appears to remain calm across different quarters of the year. Government policy response to food crises of 2007/2008 between year 2008 and 2011 appears to have some decreasing effects on volatility during the period, even though there some level of price spikes. Finding suggests that on the average, food price volatility has not increased beyond the patterns observed prior observed before 2007/2008 food crises contrary to an assumption that food price volatility has become stronger in Africa (including Nigeria) after the 2007/2008 food crises periods.

A mix of domestic, international and external factors affect food price spikes and volatility. Higher spikes in international food prices are positively related to spikes in domestic food prices. Likewise, higher volatilities in domestic prices of local rice are closely linked to volatility of rice price at the international market. Thus, one of the policy challenges will be to reduce spill-over of food price upsurges from external (international) commodity markets into the country. In addition, volatility of international crude oil price play a substantial role in explaining food price volatility with the possibility of escalating volatility of local rice price in the country. As suggested, beginning stock to use ratio generally dampens both food price spikes and price volatility. Macro-factors such as exchange rates, narrow money supply and monetary policy rates seem to play a more important role in explaining food price spikes and/or volatility. Increases in petrol price and food production variability, GDP growth rates and transaction cost for international trade are further significant factors driving food prices upsurges in some food commodities in Nigeria. The challenge of food price upsurges is more of management of price spikes than volatilities.

Besides policy actions toward management of monetary policy, exchange rates and ensuring stable petrol price and limiting food production variability and spill overs from international

markets, governments should endeavor to raise resilience of farmers and consumers to handle price fluctuations. This can be achieved on the production side by supporting contract farming and price insurance mechanisms, and on the consumer side through safety nets, cash transfers and access to financial services.

References

Abbott, P. C., Hurt, C. and Tyner, W. E. (2011). What's driving food prices in 2011? Farm Foundation

Abeygunawardena, P. and Gunatilake, H. M. (1993). Impact of Money Supply on Aggregate Price Levels: Evidence from Sri Lanka Sri Lankan Journal of Agricultural Economics 1(1):1-15.

Aksoy, A., Isik-Dikmelik, A., 2008. Are Low Food Prices Pro-Poor? Net Food Buyers and Sellers in Low Income Countries. Net Food Buyers and Sellers in Low-Income Countries (June 1, 2008). World Bank Policy Research Working Paper Series.

Anderson, K. and Nelgen, S. (2012). Trade barrier volatility and agricultural price stabilization. World Develoment 40(1), 36–48.

Anríquez, G., Daidone, S., Mane, E., 2013. Rising food prices and undernourishment: A cross-country inquiry. Food Policy 38, 190-202.

Apergis, N. and Rezitis, A. (2011). Food Price Volatility and Macroeconomic Factors: Evidence from GARCH and GARCH-X Estimates. Journal of Agricultural and Applied Economics, 43, 1(February 2011):95–110

Balcombe, K. (2009): The evolving structure of world agricultural trade. Chapter: The nature and determinants of volatility in agricultural prices: an empirical study from 1962-2008. FAO, Rome: 109-136.

Barsky, R. B., and Kilian, L. (2004). Oil and the Macroeconomy since the 1970s. The Journal of Economic Perspectives, 18(4), 115-134.

Bhargava, A., Franzini, L. and Narendranathan, W. (1982). Serial Correlation and the Fixed Effects Model. *The Review of Economic Studies* 49(4): 533-549.

Central Bank of Nigeria (2017). Monetary Policy. http://www.cbn.gov.ng/monetarypolicy/conduct.asp

Central Bank of Nigeria (2013). Quarterly Statistical Bulletin, 2 (1) March 2013– Tables. CBN, Abuja, Nigeria. Available at: http://cenbank.org/documents/Statbulletin.asp.

CBN (Central Bank of Nigeria) (2012). 2012 Statistical Bulletin: Domestic Production, Consumption and Prices, CBN, Abuja, Nigeria. Available at: http://cenbank.org/documents/Statbulletin.asp.

Christiaensen, L. (2009). Revisiting the Global Food Architecture. Lessons from the 2008 Crisis. Review of Business and Economics, 54, 345–361.

Cornia, G. A., Deotti, L. and Sassi, M. (2012). Food Price Volatility over the Last Decade in Niger and Malawi: Extent, Sources and Impact on Child Malnutrition. WP 2012-002: February 2012

FAO (2011).The State of Food Insecurity in the World: How does international price volatility affect domestic economies and food security? Food and Agriculture Organisation of the United Nations, Rome

FAO (2017). Nigeria at a glance. http://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance en/

FAO (2016). Food security indicators. http://www.fao.org/economic/ess/ess-fs/ess-fadata/ en/#.WaUu3ch97IU

FAO. (2011). Food outlook: Global market analysis. November, 2011. Rome.

Frankel, J. (2006). "The Effects of Monetary Policy on Real Commodity Prices" NBER Working Paper 12713.

Geman, H. and Ott, H. (2014). A re-examination of food price volatility, Working Paper 6, ULYSSES project, EU 7th Framework Programme, Project 312182 KBBE.2012.1.4-05, http://www.fp7-ulysses.eu/ , 68 pp.

Ghosh, J. Heintz, J. and Pollin, R. (2011). Speculation on Commodities Futures Markets and Destabilization of Global Food Prices: Exploring the connections, Political Economy Research Institute Working Paper 269, Amherst: University of Massachusetts.

Gilbert, C. L. (2008): Commodity Speculation and Commodity Investment. Geneva, Switzerland: Department of Economics, University of Trento, Italia

Gilbert, C.L. and C.W. Morgan (2010): Food price volatility. In: Philosophical Transactions of the Royal Society B: Biological Sciences 365 (1554): 3023-3034.

Haile, G.M., Kalkuhl, M. and von Braun (2013): Short-term global crop acreage response to international food prices and implications of volatility. ZEF-Discussion Papers on Development Policy 175. Center for Development Research, Bonn.

Hamilton, J. D. (2009). Causes and Consequences of the Oil Shock of 2007-08 (No. w15002). National Bureau of Economic Research

Huh, H. S., Lee, H.H. and Park, C.Y. (2012): International transmission of food prices and volatilities: A panel analysis. Technical report. Asian Development Bank, Manila.

Jungho, B. and Koo, W. W. (2009). A dynamic approach to the FDI-environment nexus: the case of China and India. *Journal of International Economic Studies*, *13*(2), 87-109.

Kalkuhl, M., von Braun, J and Torero, M. (2016). Food Price Volatility and Its Implications for Food Security and Policy. https://www.zef.de/fileadmin/downloads/Buch_Zusamen fassung_englisch_Homepage.pdf

Kalkuhl, M., Edenhofer, O., & Lessmann, K. (2013). Renewable energy subsidies: Second-best policy or fatal aberration for mitigation?. Resource and Energy Economics, 35(3), 217-234.

Kornher, L. and Kalkuhl, M. (2013). Food Price Volatility in Developing Countries and its Determinants. *Quarterly Journal of International Agriculture* 52(4):227-308.

Krichene, N. (2008). "Recent Inflationary Trends in World Commodities Markets." IMF Working Paper WP/08/130.

Lee, H. and Park, C. (2013). International Transmission of Food Prices and Volatilities: A Panel Analysis. ADB Economics Working Paper Series. No. 373

Martin, W., Anderson, K. (2012). Export restrictions and price insulation during commodity price booms. American Journal of Agricultural Econonomics 94(2), 422–427.

Martin, W., and Ivanic, M. (2016). Food Price Changes, Price Insulation, and Their Impacts on Global and Domestic Poverty. In *Food Price Volatility and Its Implications for Food Security and Policy* (pp. 101-113). Springer International Publishing.

Masha, I. (2000). "New Perspectives on Inflation in Nigeria", *CBN Economic and Financial Review*, 38(2).

Minot, N. W. (2011): Transmission of world food price changes to markets in Sub-Saharan Africa. Discussion Papers 1059. International Food Policy Research Institute (IFPRI), Washington, D.C.

Minot, N. (2014). Food price volatility in sub-Saharan Africa: Has it really increased? *Food Policy* 45, 45–56.

Mitchell, D. (2008): A Note on Rising Food Prices. Washington, D.C., USA: World Bank Development Economics Group

Mordi, C.N.O., Essien,E.A., Adenuga, A.O., Omanukwue, P. N., Ononugbo, M. C., Oguntade, A. A., Aben, M.O and Ajao, O. M. (2007). The dynamics of inflation in Nigeria. CBN Occasional Paper No.32

Nickell, S. J. (1981). Biases in dynamic models with fixed effects. Econometrica, 49(6):1417–26.

Okello, A., Welburn, S., and Smith, J. (2014). Crossing institutional boundaries: mapping the policy process for improved control of endemic and neglected zoonoses in sub-Saharan Africa. *Health policy and planning*, *30*(6), 804-812.

Omotosho, B. S. and Doguwa, S. I. (2012): Understanding the Dynamics of Inflation Volatility in Nigeria: A GARCH Perspective. *CBN Journal of Applied Statistics* 3(2):51-74

Piesse J, and Thirtle C (2009): Three bubbles and a panic: an explanatory review of recent food commodity price events. *Food Policy*. 34: 119-129. 10.1016/j.foodpol.2009.01.001.

Serra,T.,Gil,J.M.,2012.Price volatility in food markets: can stock building mitigate price fluctuations? European Review of Agricultural Economics 40 (3), 1–22.

Shittu, A. M., Obayelu, O. A. and Salman, K. K. (2015). Welfare Effects of Policy-Induced Rising Food Prices on Farm Households in Nigeria. AGRODEP Working Paper 0010 April 2015

Tadesse, G., Algieri, B., Kalkuhl, M. and von Braun, J. (2014). Drivers and triggers of international food price spikes and volatility. *Food Policy* 47: 117–128

The Guardian (2017). Nigeria loses fortunes to over-dependence on Lagos ports. https://guardian.ng/features/nigeria-loses-fortunes-to-over-dependence-on-lagos-ports/

Tiwari, A. (2010). Impact of supply of money on food prices in India: A causality analysis. ICFAI University, Tripura. https://mpra.ub.uni-muenchen.de/24679/

von Braun, J. and G. Tadesse (2012): Food security, commodity price volatility and the poor. In: Aoki, M., T. Kuran and G. Roland (eds.): Institutions and Comparative Economic Development. Volume 2012. IAE, Palgrave Macmillan, Basingstoke.

World Bank (2012) Food Price Watch, August 2012

Appendix 1: Patterns of Food Prices Spikes of Major Food Commodities in Nigeria, 2001:2 – 2016:12 (National Average)

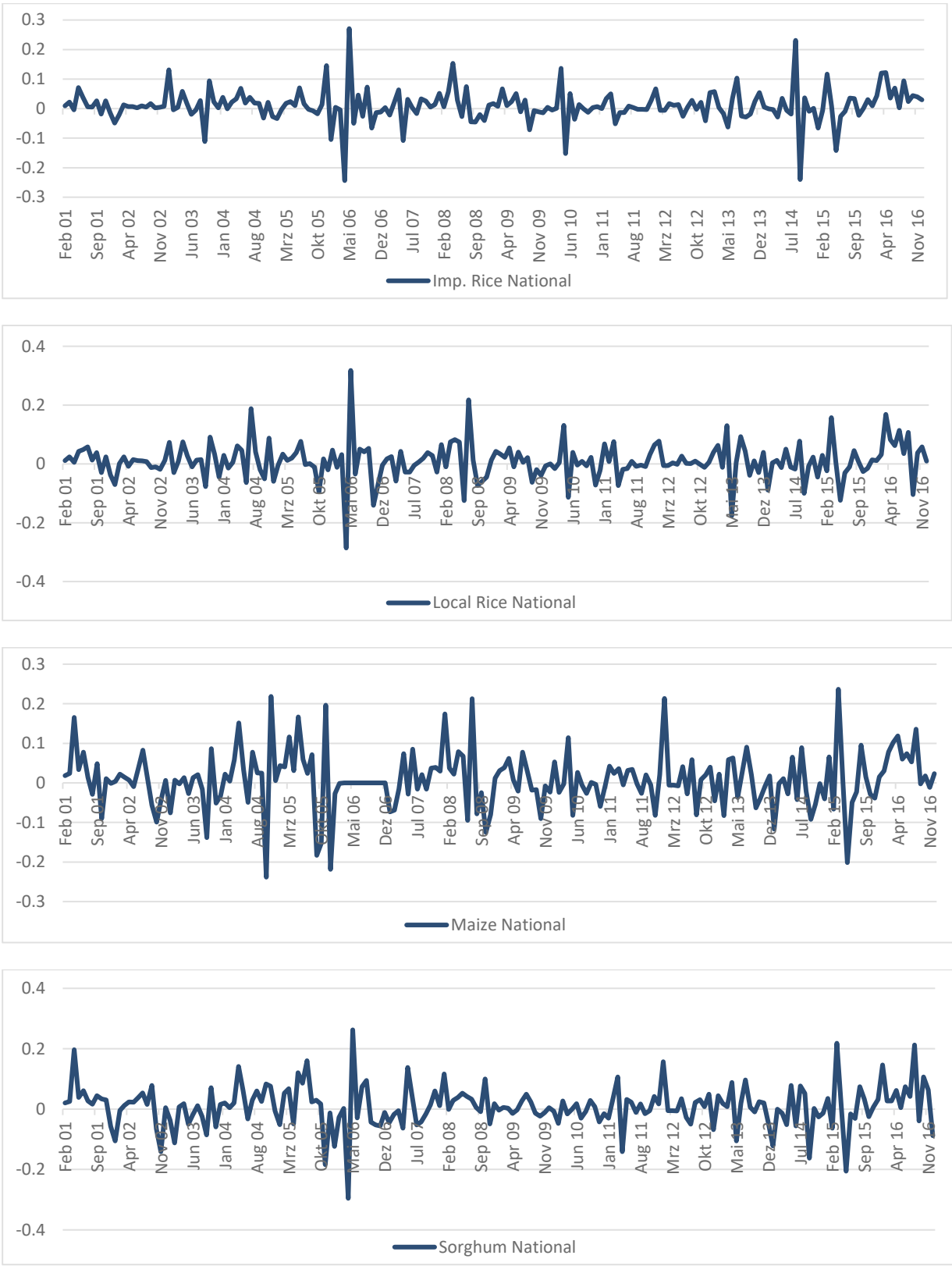

Figure 1 a: Domestic Price Spike of Imported Rice, Local Rice, Maize and Sorghum

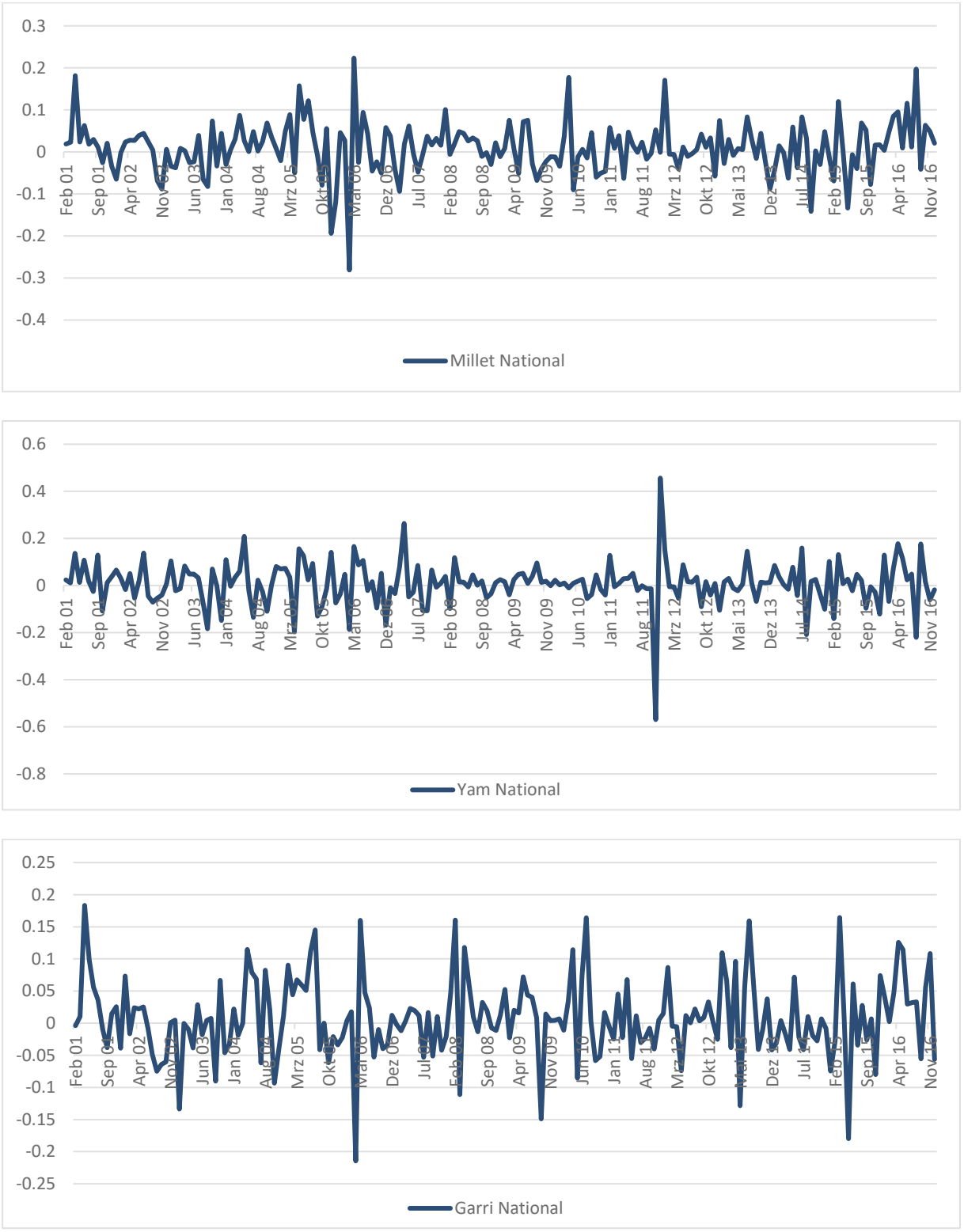

Figure 1 b: Domestic Price Spike of Millet, Yam and *garri*

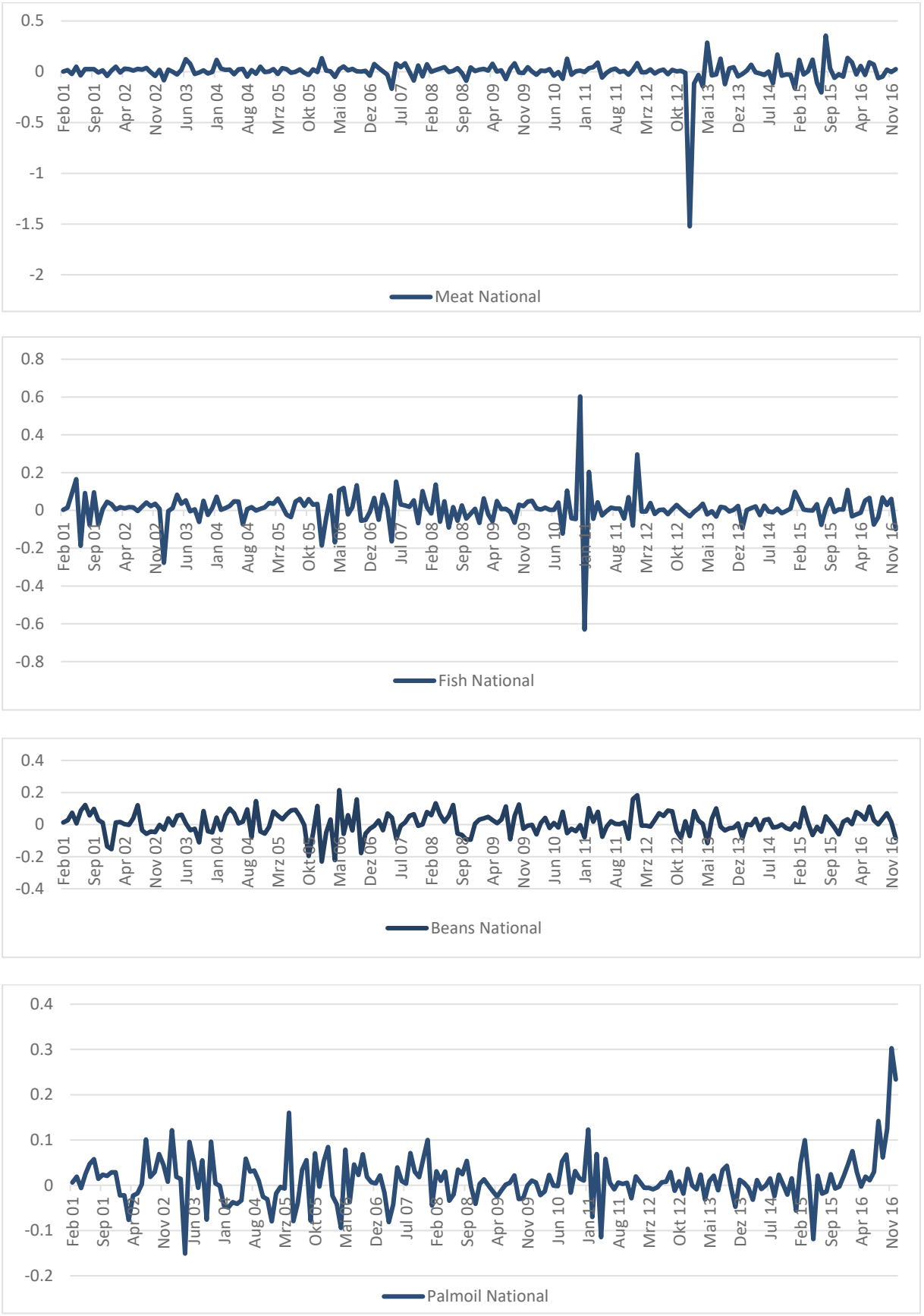

Figure 1 c: Domestic Price Spike of Meat, Fish, Beans and Palm oil

Appendix 2: Patterns of Intra-year Food Price Volatility in Major Food Commodities in Nigeria, 2002:1 – 2016:12 (National Average) -Modified Balcombe Specification.

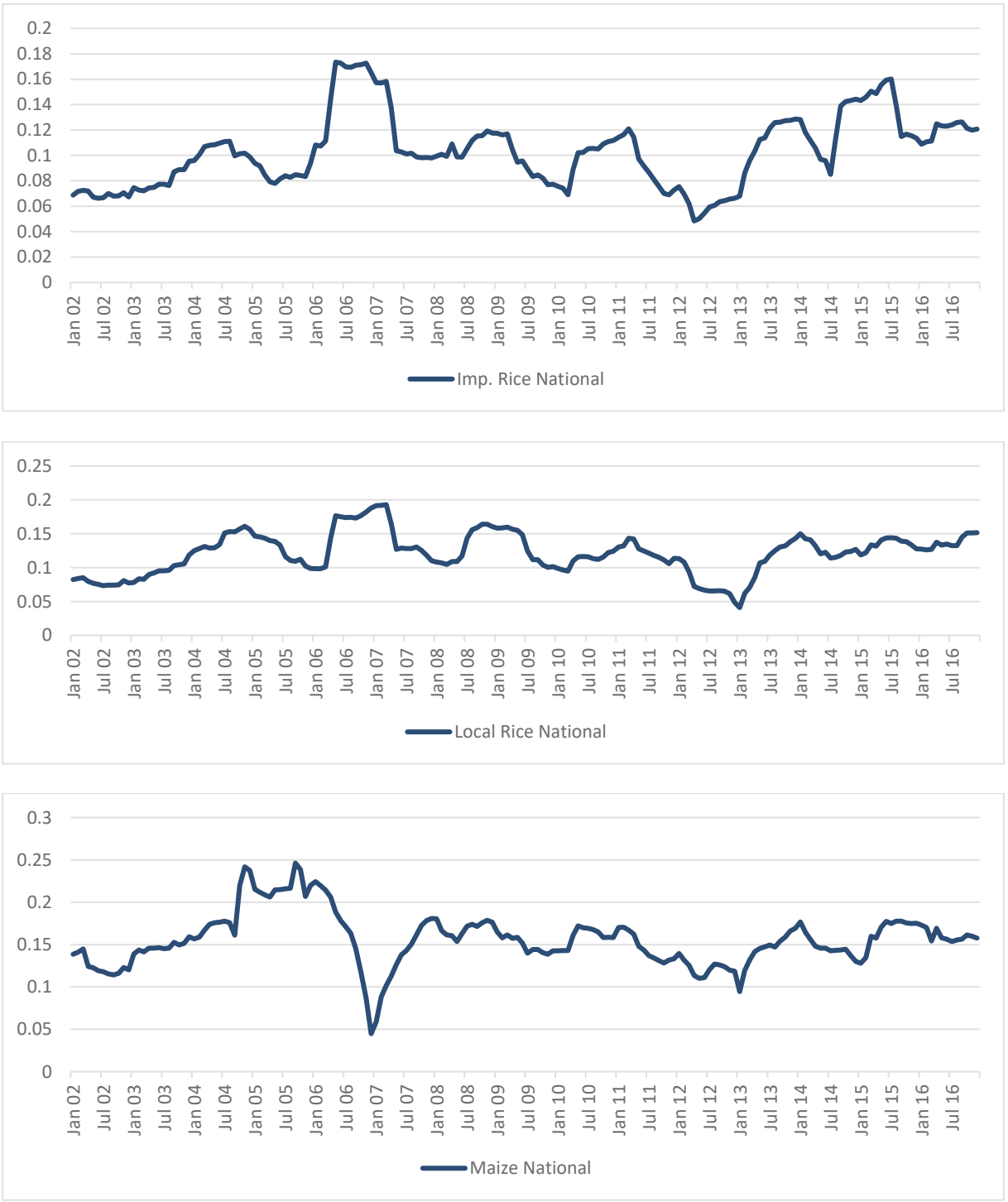

Figure 2 a: Intra-year Imported Rice, Local Rice and Maize Price Volatilities (Modified Balcombe Specification)

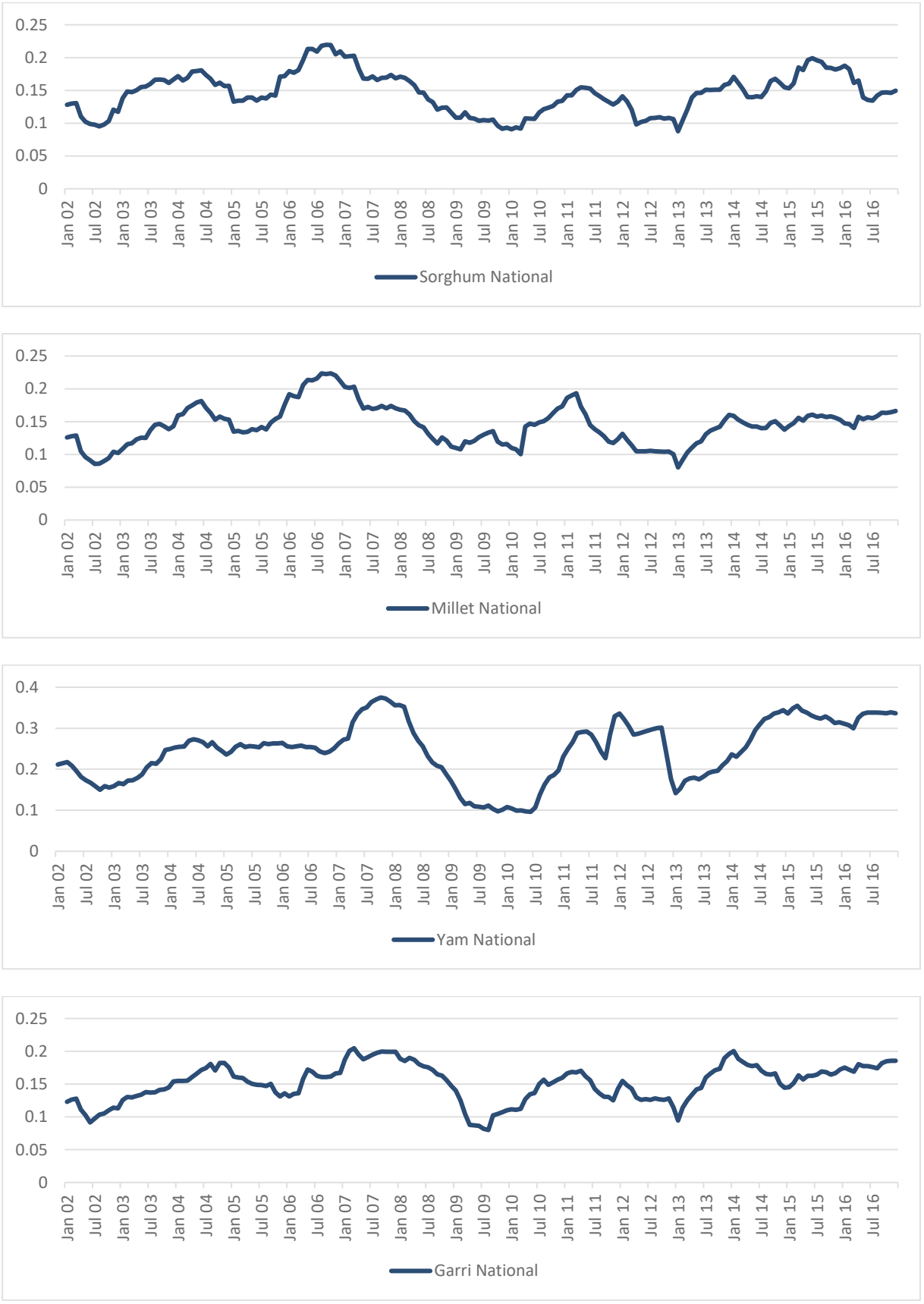

Figure 2 b: Intra-year Sorghum, Millet, Yam and *garri* Price Volatilities (Modified Balcombe Specification)

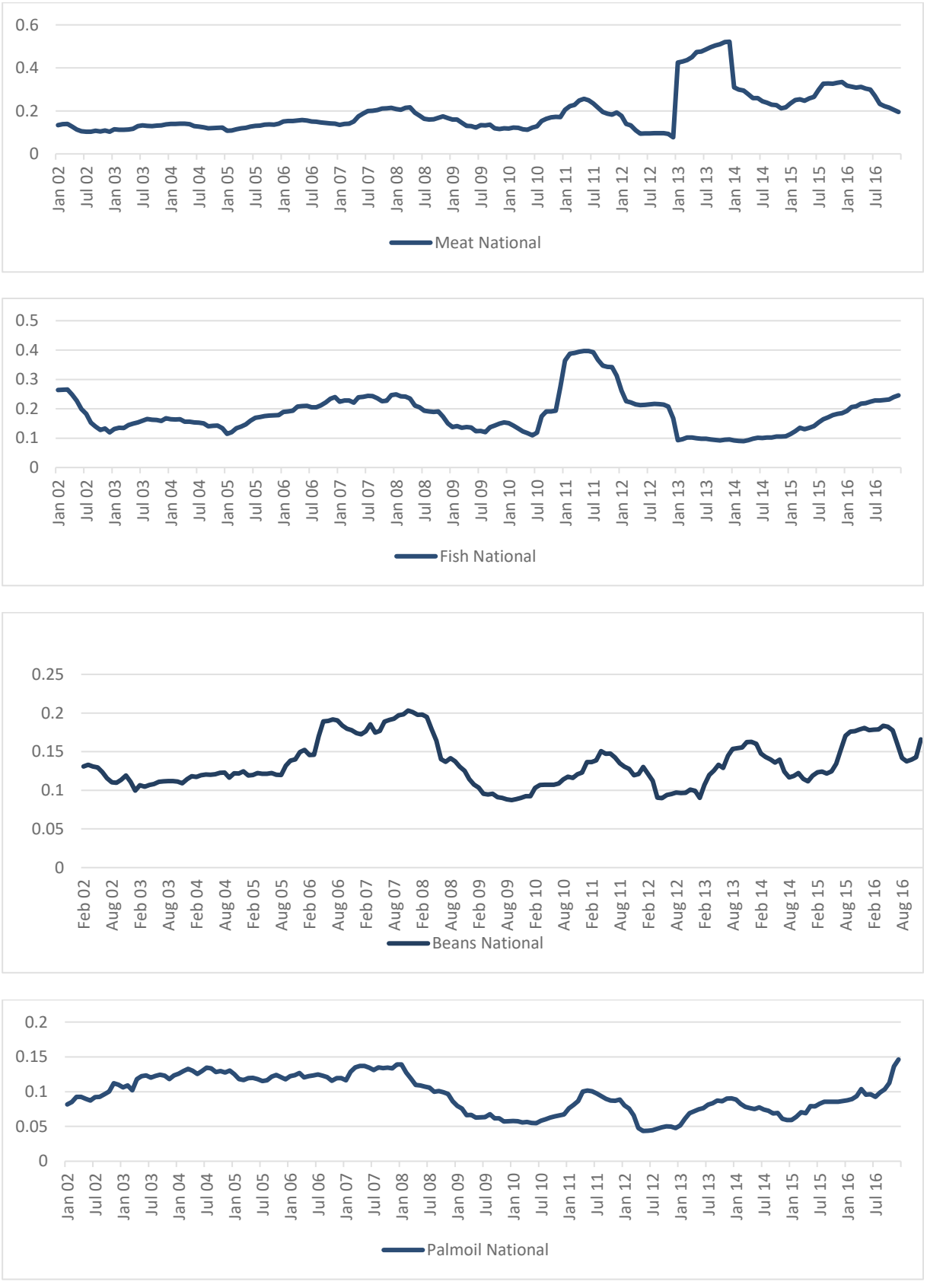

Figure 2 c: Intra-year Meat, Fish, Beans and Palm oil Price Volatilities (Modified Balcombe Specification)

Appendix 3: Patterns of Inter-year Food Price in Major Food Commodities in Nigeria, 2002:1 – 2016:12 (National Average)-Modified Tadesse et al. specification

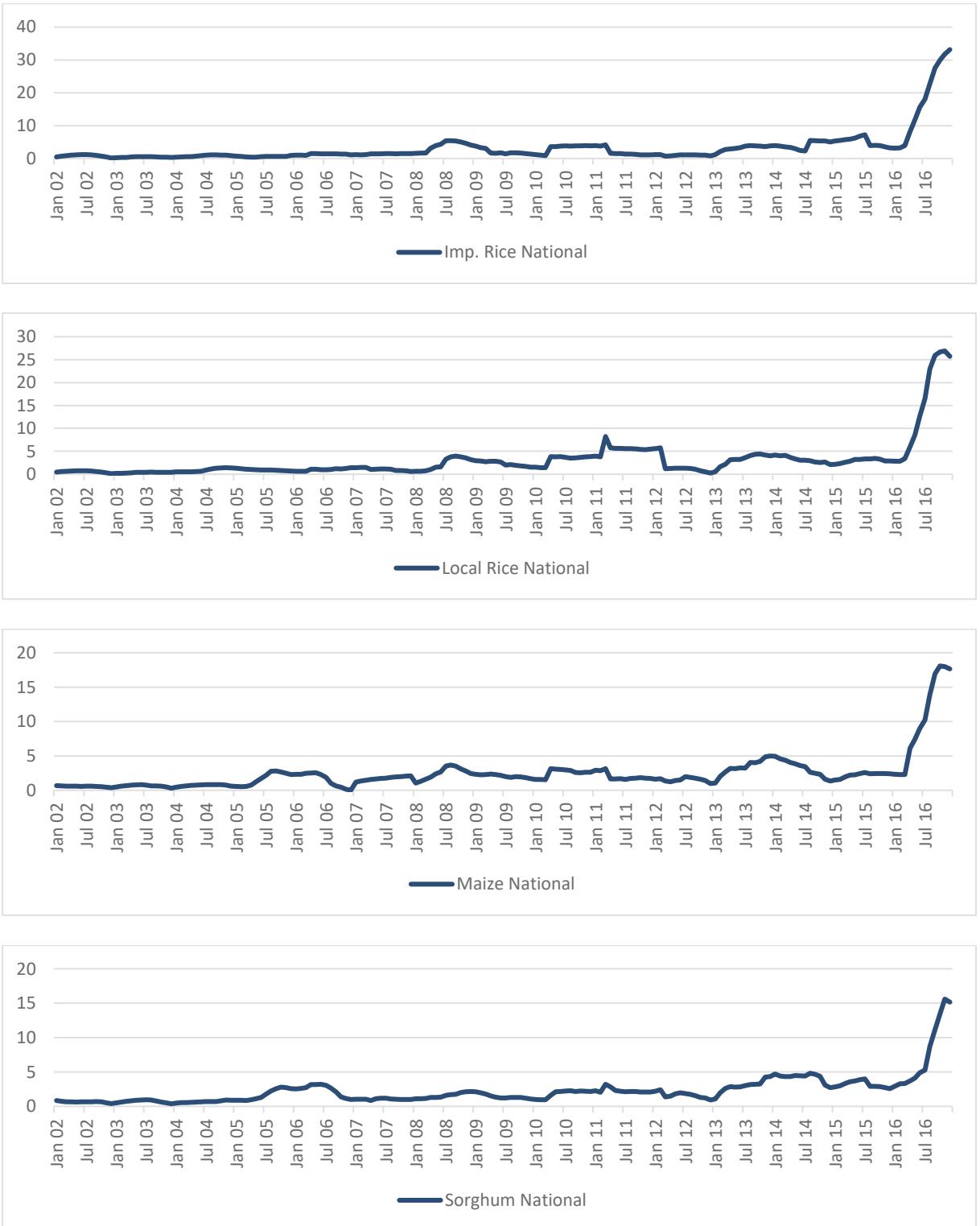

Figure 3 a: Inter-year Imported Rice, Local Rice, Maize, and Sorghum Price Volatilities (Modified Tadesse et al. specification)

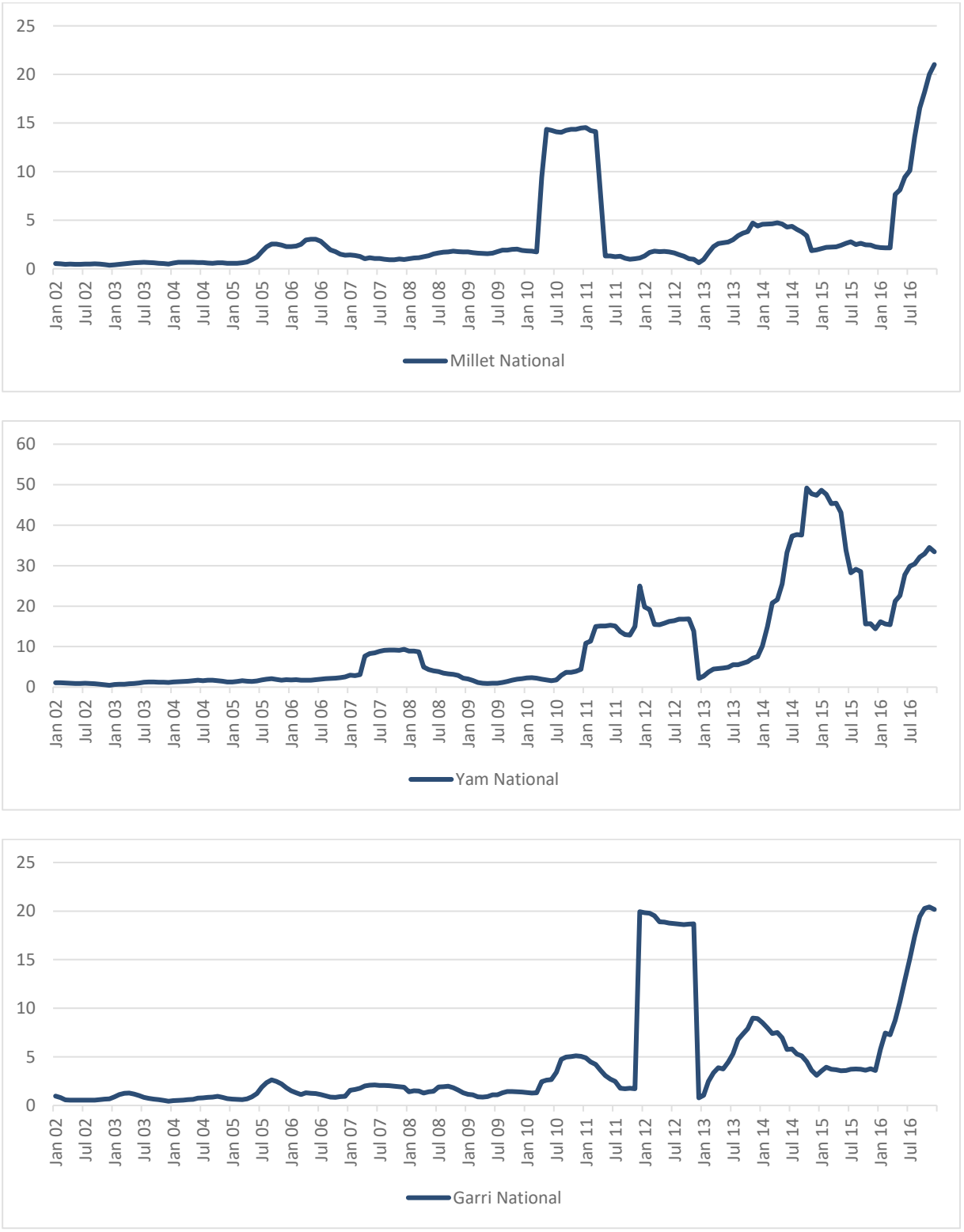

Figure 3 b: Inter-year Millet, Yam and *garri* Price Volatilities (Modified Tadesse et al specification)

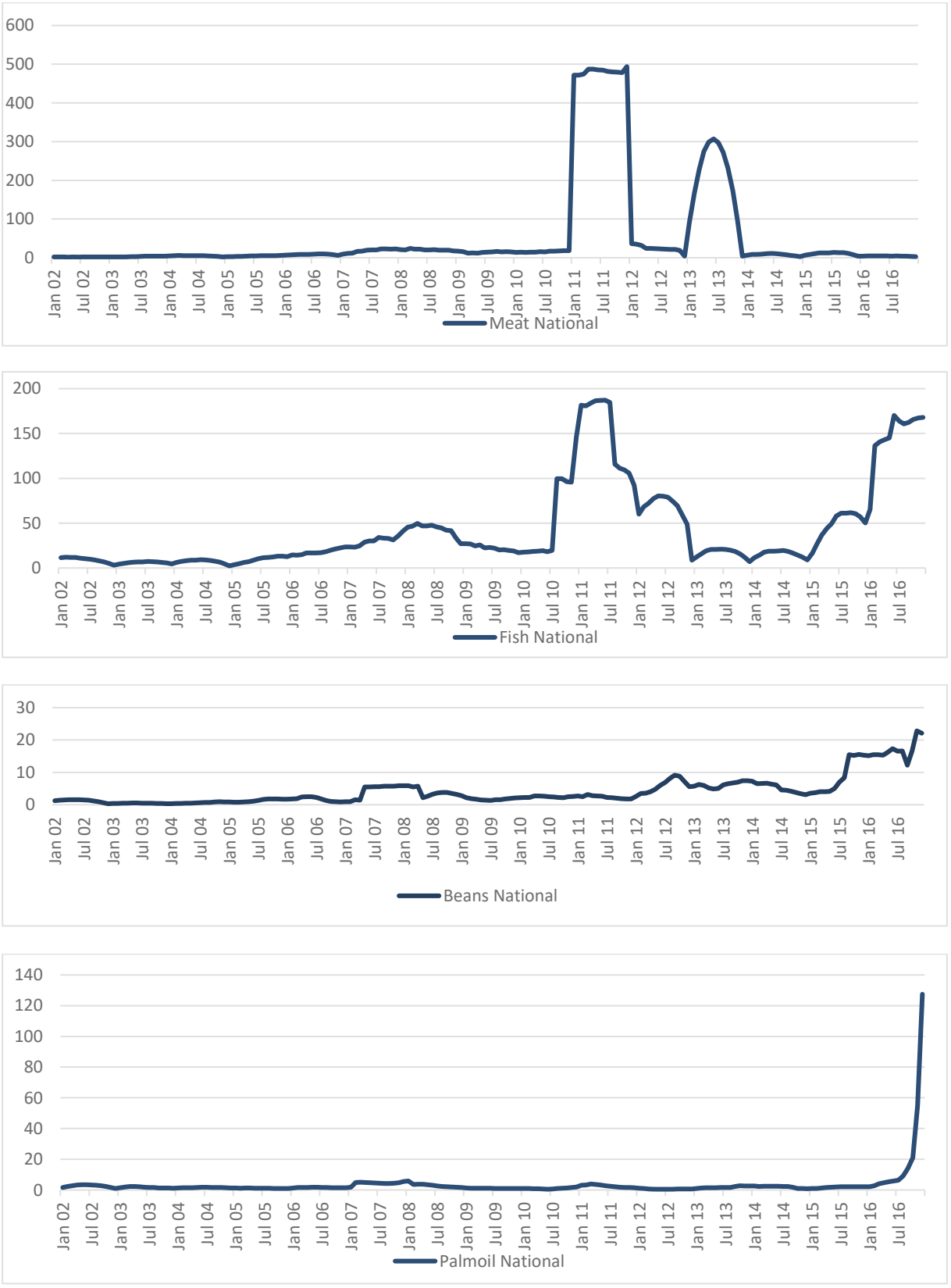

Figure 3 c: Inter-year Meat, Fish, Beans and Palm Oil Price Volatilities (Modified Tadesse and colleagues' specification)