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Welfare effects of transportation cost and food price volatility in the context of globalization in Nigeria

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Globalization has enhanced the development of the transport sector and more importantly, the distribution of agricultural produce and food globally. However, not much is known about how this has impacted the welfare of the poor in Nigeria. Therefore, the study probed the persistence and asymmetry in food and transport price volatility; creating a dummy with the period before and after the adventure of significantly improved internet facility like 3G allowed the study to observe the significant effect of this period on persistence volatility of food price returns; and exploring the welfare effects of these volatility dynamics. A bi-variate EGARCH model was deployed to estimate the heteroskedastic behavior in rural food price and transport returns (1995M1-2017M11) obtained from National Bureau of Statistics while a simple welfare framework was used to gauge the effect of the price fluctuations. Persistence volatility in food price declined after introduction of 3G innovation. The study also confirmed that the risk in transport market significantly transmitted to rural food price volatility. Volatility persistence was high (0.99% apiece) both in food and transport markets. Also, there was evidence of leverage effect in transport price volatility in Nigeria. The study revealed that due to persistent price volatility, households gave up an average/maximum of 12%/33% and 13%/44% of their food consumption and transport expenditure/returns accordingly to achieve household food stability. Using the Lucas (1987, 2003) threshold, the study concludes that the benefits of eliminating volatility in food and transport are high.

Key words: Food price volatility, welfare and globalization.

INTRODUCTION

The global food crises in 2008 and 2011 have been implicated as part of the major reasons for rising cost of food globally (FAO et al., 2015; Sehkar et al., 2017) with increasing impact on the poor in the low income countries (Odusanya and Akinlo, 2016). This has also complicated poverty and malnutrition in net food importing and low income countries in the sub-Saharan Africa (FAO et al., 2017, 2018). Rising food inflation in sub-Saharan African (SSA) has pushed more households into poverty (FAO et al., 2015); compromised good feeding habit (Haile et al., 2014); and negatively affected productivity (Ajibefun, 2015). Evidences in the literature have shown how these and other similar informational challenges have been tackled using the opportunities provided by globalization to make people live decent lives (Khor and Hormeku, 2006; Anderson, 2010; Labonté et al., 2011; Goryakin et

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al., 2015). Masson (2001) and Ikenberry, (2008) posited that countries that had embraced globalization within the construct of flexibility and competitiveness had witnessed tremendous growth in their economies. Similarly, Olayiwola et al. (2004), argued that with increased technological innovations and ideas, more jobs have been created which have consequently resulted into more incomes. Daulaire (1999) submitted that globalization has positive and significant effect on the nutritional consumption as well as health status of people. It is in view of this, Nigeria has deliberately accepted to open up her economy to embrace more technological innovations in every sphere of the economy with a view to enhancing productivity and ease of doing business. This is hinged on the conviction that such will help in solving the problem of food insecurity.

In the literature, quite a number of studies have examined the causal factors for uncertainty in food market fundamentals. A number of authors have argued strongly about the influence of the exchange rate (forex) on food and agricultural markets (Gilbert and Morgan, 2010; Ikuemonisan et al., 2018). The import of that study is that instability in the forex market hypes food price volatility for net food importing countries. In similar studies, the effects of volatility in oil (Alom et al., 2011; Tadesse et al., 2016; Nwoko et al., 2016) and restrictive trade policies (Abbott et al., 2011; Assefa et al., 2015; Abdulkareem and Abdulhakeem, 2016; Fasanya and Adekoya, 2017) on food price volatility have been examined, and findings revealed that increased subtleties in oil market and restrictive trade policies have induced food price volatilities in developing countries. In Nigeria, food and transport markets largely depend on exchange rate and global oil market dynamics. It is well known that a properly developed transport sector is an antidote to inefficient distribution of agricultural produce and food (Paul et al., 2009; Alstadt et al., 2012; Tunde and Adeniyi, 2012). Similarly, efficient transport system enhances productivity and food distribution (Riverson et al., 1991; Gordon, 1993).

Although the effects of food price dynamics are mixed, while experts believe that sudden rise in food prices hurts net food buyers (FAO et al., 2011) others have argued that rising food and commodity prices induced by price volatility can yield higher income for net food sellers (Morales-Opazo et al., 2014). According to Haile et al. (2014), high risk is a disincentive to farmers and thus, it has negative correlation with food production as farmers tend to shift investments from risk prone to production of other non-agricultural production with less risk. It thus affects the welfare of the concerned distress producers and net consumers. Based on the monthly price data for selected agricultural commodities from the International Monetary Fund's International Financial Statistics, Moledina et al. (2004) separated unpredictable and unpredictable components contained in price movement using generalized autoregressive conditional heteroscedasticity (GARCH) and found that volatility in the selected food prices declined significantly. Besides, when the risk element was put in Lucas empirical framework to estimate volatility, the results showed that the benefits of eliminating price volatility are too small, less than 1% of consumption for the majority of commodities studied. Contrary to the findings of Moledina et al. (2004), Bellemare et al. (2013) using data collected on rural Ethiopian households, it was established that eliminating price volatility has welfare benefits. The study concluded that the welfare gains from eliminating price volatility are increasing in household income. The controversy about welfare implications of price volatility across countries in the SSA is not yet conclusive.

The intention of this study is to: probe the persistence and asymmetric in food and transport price volatility; examine whether or not transport price volatility spillover to food price volatility; creating a dummy of the period before and after the adventure of significantly improved internet facility like 3G to observe the significant effect of this period on persistence volatility of food price returns; and explore the welfare effects of these volatility dynamics.

CONCEPTUALITY AND METHODOLOGY

Nigerian food market

Nigerian food market is a large market with more than 192 million market participants at the domestic level. It is interesting to note that more than 65% of this population spend about 60% of their household income on food (Mgbenka and Mbah, 2016). According to National Bureau of Statistics (NBS, 2015), more than 70% of Nigerians live directly and indirectly on agriculture. According to Oladapo and Momoh (2007), the rise in food inflation particularly in Nigeria has been due to weak and poor policies that have failed to sufficiently achieve market stability and/or proportionately increase food supply. This has caused Nigerian government to be spending five times her income from food on food imports (Olusoji et al., 2014). The attendant effect of all these is rising retail prices. Retail prices are embedded with huge transaction costs to reflect both the risk involved in sourcing for information and/or what to sell however, policy strategies to improve the efficiency of pricing and marketing system have tremendously reduced transaction costs and stabilize food prices (Wright, 2009; Kornher and Kalkuhl, 2013). Majority of the farmers in Nigeria are not educated and they are generally unorganized (Mgbenka and Mbah, 2016). The state of their organization is often reflected in the chaotic and highly unpredictable agricultural and food market. This chaos is frequently noted across markets and along food value chain.

However, upon introduction of mobile phones in 2002 and subsequent follow up with massive penetration of 3G mobile in 2008, access to information has continued to improve. The complexity occasioned by barter system and other encumbrances surrounding food trading in most rural communities is increasingly being simplified by access to mobile phone and internet facilities. Although according to Internet World Stats (2017) and MM Group (2015), the level of internet penetration as at 2017 is about 34% representing only 11% of the world internet users while the world average is 54%. In Nigeria, between 2000 and 2017, internet users have grown from 0.2 to 98.4 million people. By implication, only about 50.2% of the populationare internet users as at December,

2017. Although the level of penetration is still very low, the gains so far include increased participation in governance of the peop le in the rural areas which has brought about intensive reconstruction of feeder roads, bridges, other marketing enhancing infrastructure and price stability policies (transparent subsidy administration). The intuition is that as internet intensity increases and penetrates the rural communities, food price volatility reduces, and transport cost and food price volatility should also be negatively signed. Similarly, there are sufficient evidences that efforts at reducing food price volatility have enhanced human welfare (Sassi, 2014).

Data

The data used in this study include food and transport consumer price indexes obtained from National Bureau of Statistics (NBS). NBS is a Nigerian government agency saddled with responsibility to collect household and macroeconomic data for the purpose of guiding public decisions and policies. Secondary data were sourced on: monthly consumer price index of rural food prices (RFCPI), transport cost (TRANS) for a period, 1995 - 2017 from National Bureau of Statistics (NBS). Similarly, information on the introduction of third mobile network generation on Global System for Mobile Communication [GSM] (3G respectively) in Nigeria was obtained from the website of Nigerian Communication Commission (NCC). 3G networks succeed 2G ones, offering faster data transfer rates and are the first to enable video calls. This makes them especially suitable for use in modern smartphones, which require constant high-speed internet connection for many of their applications. The available information obtained from NBS and NCC suggests that many rural areas are still not on the 3G networks grid as at 2018. Besides, the low literacy level of many of the farmers is another challenge that could have reduced the impact of this innovation on food price volatility.

Theoretical concept

Dawe and Slayton (2010) have argued that unpredictable price dynamics distort market to generate some wrong price signals and undefined expectations. These puncture the efficacy of market economy and it often results in market failure. This is the basis for government intervention in order to cater for the imperfection in the market mechanism. The ultimate outcome is to emplace market stability while achieving predictable price process, steady income flow and reducing poverty on the other hand. Inappropriate judgement of the economic dynamics and inadequate policy response has allowed poverty to remain pervasive in low income countries especially among the farming households and rural poor (Anderson et al., 2016). The pervasiveness of poverty has also been blamed on high rate of mismanagement and poor administration of limited productive resources (Mercy, 2015). To a large extent, this has rubbed off the expected gains from the agricultural sector. Now, the agricultural sector that used to contribute hugely to gross domestic product (GDP) in low income countries has lost its place. Yet, in Nigeria, the sector still has more than 60% of the labour force (National Bureau of Statistics). Two problems arose from this; decreasing output (inadequate food supply) and/or low returns on investments as well as consumers' inability to meet household food needs from domestic food supply. This situation is further made complex by increasing uncertainty in the food market. There is increase in both production and market risk hence, farmers' skepticism increases by the day. Producers factor the risk premium into current price by increasing the price above its mean value. Since an average household in Nigeria spends more than 60% of household income on food (Mgbenka and Mbah, 2016), pressure from food demand results into rising food inflation which contributes hugely to rising general inflation (Kornher and Kalkuhl, 2013). According to Sehkar et al. (2017), rising inflation rate continually decimates household welfare.

Nevertheless, theory supports that adequate information flow increases the functionality of market fundamentals and market efficiency thus, reducing uncertainty in the market. By implication, where uncertainty (conditional volatility) is high, market efficiency will be low and such effect on the welfare could be high enough for government intervention in terms of price stabilization policy strategy. In a bid to participate in the booming global markets, Nigeria embraced globalization and that began to open up her economy for global participation. The introduction of third mobile generation on Global System for Mobile Communication [GSM] (3G respectively) in some rural areas since 2008 has significant effect on the economy. It has increased ability to move and communicate easily with others all over the world in order to conduct business internationally. This is expected to reduce market inefficiency and uncertainty.

The theoretical underpinnings for this investigation are Efficient Market Hypothesis (EMH). In an efficient market, competition will ensure that opportunities for extraordinary risk-adjusted gain do not persist. EMH does not imply that prices will always be “correct” or that all market participants are always rational. However, it brings certainty and stability to market economy. Market efficiency simply describes a situation where the current price reflects all relevant information. That is, past price (X_{t-1}) is an unbiased predictor of current price X_t. When no informational cost is incurred, uncertainty in the market becomes minimal and even negligible. However, all information is not accommodated in the new price hence, risk becomes high. High risk is determined by the level of volatility and its persistence. The significance of transport market and internet facility to information flow in modern market has endeared us to interrogate the culpability of these exogenous factors in food price volatility in Nigeria. Therefore, efficient market allows prices to converge at its fundamental value which is a precursor to achieving a stable economy (low inflation rate). In other words, efficient market guarantees poverty alleviation which helps to minimize the welfare losses for producers and consumers.

In an efficient market system, economics agents and other market participants are able to alleviate potential losses using appropriate hedging instruments. In efficient food market, prices are relatively predictable. This implies that food production and food supply can be properly planned even over a long term period. The implication is that past prices of a food item (i) are the predictor of the current price realization.

To capture volatility in time series, the family of GARCH model has been frequently used (Mensi et al., 2014; Gardebroek and Hernandez, 2013; Nelson, 1991; Bollerslev, 1986; Engle, 1982). Some food price series are different from other time series because they exhibit complex dynamic risk phenomenon. This risk phenomenon creates uncertainty and reduces market efficiency. That is, true prices are never reflected in the market. This risk sensation leads to unpredictable movement in prices. On the basis of this uncertain information (risk), economic agents generate probabilistic assessment of both predictable and unpredictable components in price process. This study follows the idea of Ramey and Ramey (1995) to obtain unpredictable components in the price process where the variance of the residuals is proposed as the measure of volatility (Dehn, 2000; Moledina et al., 2004).

In the literature, Engle (1982) developed a model called Autoregressive Conditional Heteroscedasticity (ARCH) to capture this risk phenomenon. In order to cater for the shortcomings of the ARCH model, Bollerslev (1986) improved on the shortcomings of ARCH model to develop the Generalized ARCH (GARCH) model. However, in response to symmetric assumption, Nelson (1991) developed the Exponential GARCH (EGARCH) model with a conditional variance formulation that can successfully capture asymmetric response in the conditional variance.

Furthermore, to compute the conditional volatility for each of the selected series, the log returns of each of the price series were obtained. Some pre-diagnostic tests including unit root, Ljung and ARCH LM tests were carried on the return series. Upon rejection of the null hypothesis, the study proceeded to estimate Exponential Generalized Autoregressive Conditional Heteroscedasticity under three functional forms of conditional density (Normal, t-distribution and Generalized Error Distribution-GED). The best specification for conditional variance (volatility) for each of the selected series was selected based on the model that best minimized the selection criteria: Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Hannan-Quinn Criterion (HQC) subject to the result of the post diagnostic results. Therefore, the post diagnostics (Ljung and ARCH-LM) tests were also carried out on the on the squared residuals obtained from each of the equation (return series) mentioned earlier.

To confirm the adequacy of the EGARCH model under the appropriate functional form of conditional density, such that there should be no strong evidence to reject null hypotheses for no presence of autocorrelation and no ARCH effect for each of the series. At 5 and 1% significant level, the effect of persistence and leverage effects in the selected price series will be assessed. Similarly, to estimate the spillover effects of transport market (TRANS) food price volatility, the forecast of the conditional volatility obtained earlier was introduced into the EGARCH equation selected for the food price series. To observe the effect of the innovations on food price volatility dynamics, a dummy variable capturing period before and after the advent of 2G & 3G internet.

Computing conditional volatility

Given that $e_{it}=\sigma_{it}z_{it}$; $|z| \sim i.i.d$ $z_{it}|\Omega_{t-1} \sim N(0,1)$; then variance equation for EGARCH model (1,1) model is specified as:

$$log\sigma_{it}^2 = \omega_i + \beta \log(\sigma_{it-i}^2) + \gamma \frac{\varepsilon_{it-1}}{\sqrt{\sigma_{it-1}^2}} + \alpha \left[\frac{|\varepsilon_{it-1}|}{\sqrt{\sigma_{it-1}^2}} - \sqrt{\frac{2}{\pi}} \right], \quad (1)$$

And for bi-variate EGARCH model is stated thus:

$$log\sigma_{it}^2 = \omega_i + \beta \log(\sigma_{it-i}^2) + \gamma \frac{\varepsilon_{it-1}}{\sqrt{\sigma_{it-1}^2}} + \alpha \left[\frac{|\varepsilon_{it-1}|}{\sqrt{\sigma_{it-1}^2}} - \sqrt{\frac{2}{\pi}} \right] + \delta_1 \sigma_j^2 \quad (2)$$

where ω, β, γ, α and δ_1 are parameters to be estimated. These parameters are defined as i = Rural Food Consumer Price Index/Transport Consumer Price Index; γ= captures leverage effect; γ< 0 means conditional volatility of i responds to -ve shock more than +ve shock; γ> 0 means conditional volatility of i responds to +ve shocks more than -ve shocks; α = captures magnitude of conditional shocks on the conditional variance; β denotes the volatility persistence; σ_1^2 = exogenous factor introduced into the variance equation for food price volatility (conditional variance of transport price returns {transport cost volatility}/σ_2^2 = Period before and after introduction of 2G & 3G.

$([= 1\ after\ introduction\ of\ 2G\ \&\ 3G\ \text{but before introduction of } 2G\ \&\ 3G, \sigma_j^2 = 0])$;

β= Persistence; H_0 = β_1= 0 (No persistence); and H_1 = $\beta_1 \neq 0$; H_0 = γ= 0 (No leverage); and H_1 = $\gamma \neq 0$.

Given that R_{it} is returns of the selected series Ri, R_{t-k} are lagged R_{it}, ε_t stands for error term (white noise). Therefore, ω_i, α_1, α, β, $and\ \gamma$ are parameters to be determined for each of the equations.

Following the findings of Fasanya and Adekoya (2017) on the significance of breakdate in predicting price volatility, we include break date in the Mean equation as follows:

$$R_{it} = c + \emptyset_1 R_{it-1} + \theta_1 B_{it} + \varepsilon_{it}, \quad (3)$$

$$R_{it} - \mu_{it} = e_{it}. \quad (4)$$

where R_{it} stands for returns of rural food price, B_{it} is the break dates which implies that B_{it}=1 if t ≥ B and 0 if otherwise. θ is the coeficient term that characterises the breakdate.

Welfare cost of food price volatility

Lucas (2003) defines welfare cost of volatility (λ) as the amount that the consumer must be compensated against risk in consumption. It is the utility level where consumer is indifferent to both deterministic and risky stream adjusted by compensation. However, evidences have shown that risk averse consumers usually show preference for a deterministic consumption stream over a risky stream with the same mean. According to Moledina et al. (2004) and Lucas (2003), consumers in food markets across developing countries are risk averse. Therefore, these attributes hype the preference of risk averse consumers for a deterministic consumption stream. Drawing from the aforementioned, compensation parameter (λ) is calculated using mathematical relationship given as:

$$\lambda = \frac{1}{2} \gamma \sigma_{it}^2. \quad (5)$$

where the compensation parameter depends on the level of risk present (σ^2) and aversion people have for risk (γ). This study adopts the highest magnitude of risk aversion ($\gamma = 4$) as scaled by Lucas (2003) and Moledina et al. (2004) to estimate welfare cost of volatility (λ). σ^2 = mean/maximum/minimum value of condition volatility (variance) for RFCPI & TRANS where $\varepsilon_t \sim N(0, \sigma^2)$; γ = degree of risk aversion and the expectation is taken with respect to the common distribution of shocks.

Therefore, the welfare cost of price volatility (λ) obtained by the level of volatility calculated from Equation 1.

Finally, to estimate the welfare cost of food price volatility, the mean, maximum and minimum values of the conditional volatility forecast was integrated into the welfare framework designed by Lucas (1987) to gauge and measure the welfare cost of risk behaviour in food prices. According to the literature on this work, the decision threshold is 1, below which the effect of food price volatility is negligible but above the threshold, the effect of food price volatility calls for appropriate price stabilization policy measure to cushion the effects on household welfare.

Expectation

Efficient marke proposes no opportunity for risk adjusted profit.

Therefore, risk behavior in price is eliminated. That is, the higher the food price volatility, the lower the efficiency of the food market and vice versa.

On the implication of that on welfare

At low price volatility, the welfare impact (cost = λ) of price volatility as estimated from Equation 5 is expected to be below the Lucas threshold (1). However, if it is more than 1 then it is sufficiently high enough to alter household welfare and appropriate price stabilization policy will bring social benefits.

The intuition is that the introduction of communication innovation (3G) would reduce risk associated with pricing mechanism. That is, information gathering and flow cost less. However, the ultimate objective is to minimally reduce uncertainty in such a manner that it will not hurt household welfare. If after introduction of 3G, the welfare impact of food price volatility reduces below the Lucas threshold, then the innovation is sufficiently effective to stabilize food prices. However, if despite the introduction of the innovation the welfare impact is still higher than Lucas threshold, then it implies such innovation is not sufficiently effective.

RESULTS AND DISCUSSION

Descriptive statistics of price and price volatility

The values of skewness, kurtosis and Jarque-Bera statistics obtained in this study show that the selected series are not normal distributed. Jarque-Bera test rejects null for normality test for each of the series. The values of standard deviation equally raise suspicion on the instability in RFCPI and TRANS series.

Diagnostic tests

There are overwhelming evidences of stationarity at levels, autocorrelation and presence of ARCH effects at lag 2 and lag 1 for both rural food price returns and transport market returns, respectively. These attributes justify the estimation of these returns series using EGARCH model. The unit root with break test reveals that there are structural break dates of 2005M07 and 2001M06 for food and transport price returns series, respectively.

In the same vein, the post diagnostic evaluation of the squared residuals obtained from the EGARCH estimation for both returns series, the evidences are clear that the behavior of both food and transport markets have been appreciably captured. The residuals show no sign of autocorrelation and no ARCH effect as this behavior in the price series has been well accounted for in the estimation.

EGARCH model

The output of the EGARCH equation estimated for the food and transport price returns (Table 1). Volatility conditional volatility persistence is very high (0.99% apiece) for both food price and transportation price (cost) at 1% significant level. It implies volatility moves slowly through time in both food and transport markets. According to Ogega (2014), persistence volatility is an indication of long memory characterized by very slow hyperbolic decay in autocorrelations of returns. Therefore, persistence in food price volatility has a major effect on the future fluctuations in the food market. It induces rising food inflation rate (Sehkar et al., 2017) as a result of long suspense of price uncertainty. This allows net food sellers to explore this market condition for marginal increase in return (Morales-Opazo et al., 2014). Consequently, the poor consumers are compelled to re-order their consumption habits in order to adjust into the new food price behavior regime (Haile et al., 2014; FAO et al., 2011). The distress producers in the low income countries, mostly risk averse, are likely going to be affected because uncertainty curtails investment. Therefore, when there is shock (fall) in food price, it results in low income depending on the volatility persistence (Subervie, 2008). In the sub-Saharan Africa, a number of studies have investigated the persistence in food price volatility (Fasanya and Adekoya, 2017; Ojogho and Egware, 2015; Osarumwense and Waziri, 2013; Omojimite and Akpokodje 2010). However, no study has tested yet for the simultaneous presence of these two effects, especially for transport related series in Nigeria.

Against apriori expectation, food price volatility shows no leverage effect. This result is in line with the findings of Omotosho and Doguwa (2013). This study finds that only the positive shocks increase food price volatility. Historically, periods of festivals and other major traditional/cultural events in Nigeria have witnessed temporarily up-strike in food prices. Nigeria, despite the economic conundrum, is sociable and communally organized with numerous tourism potentials. Beside nationally recognized festival-holidays (that is, religious and other national memories), expectations of other local cultural festivals have been known to induce temporary increase in food prices proportional to rise in demand. However, transport price has asymmetric leverage effect. Although no study has examined leverage effect of transport price volatility, the implications of leverage effect are well documented in the literature (Almeida and Hotta, 2014). This study affirms that transport price is highly responsive to bad news. News that frequently flows into transport market in Nigeria include but not limited to: fossil fuel hike, bad roads and instability of the forex market. That Nigeria is a net fuel importing country predisposes it to shocks from international fossil fuel market economy. During the period under consideration, fuel has notably spiked more than ten times. It is expected that attendant effects would influence the movement transport price behavior.

Spillover effect of transport market on food price volatility

The effect of oil price shocks to food price volatility is well

Table 1. Output of EGARCH Model.

Dependent variable	Conditional mean equation			Conditional variance equation				AIC	SIC	LLR
	C	$\emptyset_1$	θ_1	ω	α	γ	β			
Rural Food Returns	0.0285	0.242*	0.243*	-0.296*	0.343*	0.163*	0.987*	2.327	2.419	-310.6
Transport Price Returns	0.596*	-0.065	-0.278*	-0.058*	0.755*	-0.196*	0.98*	2.849	2.942	-383.4

*Statistically significant at 1%.
Source: Data Analysis 2018.

Table 2. Effect of transport market and period of new market innovation on food price volatility using Bi-Variate EGARCH.

Dependent variable	Conditional mean equation			Conditional variance equation				δ_1	AIC	SIC	LLR
	C	$\emptyset_1$	θ_1	ω	α	γ	β				
Rural Food Returns and Transport Market	0.0209	0.2361*	0.2546*	-0.3271*	0.3366*	0.1814*	0.9759*	0.2094*	2.3182	2.4240	-308.44
Rural Food Returns and Period of New Market Innovation	0.3249	0.2456	-0.0242	-0.0764	0.01527	0.1618	0.7420	-0.1036**	2.2461	2.3518	-298.59

*Statistically significant at 1%.
Source: Data Analysis 2018.

documented in the literature (Alom et al., 2011; Nwoko et al., 2016). However, the effect of risk associated with transport cost volatility on food price volatility is scarce in literature. Oil is the source fuel energy (Premium Motor Spirit - PMS and Automotive Gas Oil - AGO) use in the transport market; hence, there should be a direct correlation between oil price and transport market dynamics. Table 2 shows that the risk in transport cost, at 1% level of significance, is transmitted to food price volatility in Nigeria (Table 2). On the other hand, the impact of the trend of the period of 3G mobile communication on food price volatility in Nigeria is statistically significant. Comparing the food price volatility persistence without the innovation (0.99) to when the 3G innovation was introduced into the EGARCH model (0.74), there is an evidence of 25% decline (Table 2). Although there is an indication that as it penetrates more communities and period of embracing the innovation increases, food price volatility reduces. However, this study cannot sufficiently justify if the reduction is entirely as a result of the innovation (3G). It is certain that availability of internet (3G) facility has brought many positives to the rural communities and more importantly, accessibility to both input and output markets. This is possible because it has become convenient to draw government attention to the poor state of infrastructure including roads and markets in the rural communities. This position has also been corroborated by Tunde and Adeniyi (2012) and Paul et al. (2009). Furthermore, the importance of efficient information and communication technology in the transport market has been properly highlighted in the literature (Gössling, 2018; Wagner et al., 2004). This has now allayed the fears in the submission of Ogunsanya (1988) that the presence of more rural areas in a country reduces the development of efficient road transport system.

Welfare effect of food price volatility

Output on the welfare effect of food and transport price volatility are presented in Table 3. When the mean, maximum and minimum values of conditional volatility (variance) estimated from EGARCH were put in the Lucas deterministic formula (on the assumption that we adopt the highest level of consumer's risk aversion, γ =4), the welfare implication of food price/transport market volatility in Nigeria is average of 12.2%/13.2% while the maximum values gives 33.3%/43.5%, respectively. On the average, food price volatility causes consumers to cut off about

Table 3. Output of welfare cost implications of food price volatility.

Commodity price	Welfare cost of price volatility (λ)			Welfare remarks on average volatility
	Maximum volatility	Minimum volatility	Average volatility	Effect of price stabilization policy/programmes on consumption
Rural food price returns	33.2694	0.1106	12.1934	It significantly affects consumption
Transport price returns	43.5374	0.1208	13.1790	It significantly affects consumption
Rural food price returns with the Inclusion of period of new innovation	15.1422	0.0264	9.0480	It significantly affects consumption

Source: Data Analysis, 2018.

12%/13% of their consumption/transport expenditure to ensure stability in food market, and at some times, they have had to give up to as high as 33%/44% to achieve stability. The findings are in line with those of Sassi (2014) and Gustafson (2013) who opined that persistent uncertainty in food price volatility has major impact on susceptible households by pushing more of them into poverty and hunger. Similarly, further empirical interrogations have proved that food price volatilityhas serious welfare concern for rural households (Lucas, 1987; IMF et al.,, 2011; HLPE, 2011; IFPRI, 2011; Minot, 2011, 2014). In line with the thought of Bellemare et al. (2013), except government genuinely intervenes, access to adequate nutrition by rural households becomes consistently compromised. Surprisingly, the inclusion of the period of new market innovation to the model, statistics on food price volatility fell drastically. The trade-off on food expenditure as a result of food price volatility declines to 9% (average), and during peak of price volatility, only about 15% is given up to bring about price stability. Since the welfare cost (mean) obtained in this study is higher than Lucas threshold and by implication a price stabilization policy intervention is justified.

CONCLUSION AND RECOMMENDATION

The present findings reveal high persistence in both rural and transport price returns volatility but leverage effect only on transport price volatility. By implication, it implies that food and transport returns conditional volatility decay very slowly through time. Secondly, the leverage effect in transport price volatility is negatively signed and significant. The study concludes that both food and transport price volatilities have welfare implications on household welfare in Nigeria. Put succinctly, in 1% average monthly consumption, welfare costs of volatilities of rural food and transport cost constitute average of 12 and 13%. At the introduction of 3G mobile communication innovation, rural food price volatility declines. Expectedly, the findings in this study corroborate the documented submissions in the literature that globalization enhances human welfare (Ikenberry, 2008; Olayiwola et al., 2004; Goryakin et al., 2015). Introduction of the trend in 3G innovation has significant effect on the food price fluctuations and consequently observed in the visible reduction in the welfare cost of rural food price volatility.

Therefore, despite high budgetary requirements and administrative capacity required to implement costs policy good enough to help eliminate price fluctuations, the study strongly recommends that government should deliberately increase advocacy on the need for food market participants to embrace technological and other market enhancing innovations. In line with the opinion of Tunde and Adeniyi (2012), any effort to achieve price stability in transport market will definitely enhance food price stability. It behooves therefore that policy strategies to eliminate unpredictable food price changes will be socially beneficial.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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