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How do variations in dollar exchange rate impact food commodity prices in selected African countries?

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Aim: Commodity exporting nations have significant terms of trade swings, making their actual exchange rate unstable. This study looked at how variations in dollar exchange rate affected food commodity prices in Africa between 1990 and 2021.

Design/Research methods: The study conducted GARCH analysis for ascertaining prevalence of volatilities of exchange rates and interest rates respectively in selected African countries. Also, we estimated both static and dynamic analysis driven by panel least squares and generalized method of moments (GMM) estimators on panel data from some commodity-exporting African, namely, Ghana, Gabon, Tunisia, Nigeria, and South Africa.

Findings: The dynamic GMM results reveal exchange rate and interest rate variations taken together had positive effects on commodity prices. GARCH estimates demonstrate significant volatility growth using both normal and t multivariate distributions. However, based on empirical findings, t-distribution had largest maximized log-likelihood of -8920.1 and also had a satisfactory df of 26.82 (<30). The results demonstrate that the Nigerian Naira had highest coefficient of volatility of approximately 71.2%. This was followed by the Ghanaian Cedi with a negative volatility rate of 71% and the South African rand with a coefficient of 65%. However, while all countries had negative volatility with respect to interest rate, all countries except Ghana had positive volatility in exchange rate of their currency. Ghana, Gabon, Tunisia, and Nigeria showed negative exchange rate volatility. A possible explanation for this high volatilities in the aforementioned countries is persistent domestic inflation.

Originality: The originality is rooted on establishment of food prices having some positive relation with pervasive exchange rate shocks. This is an indication of adverse effects of downward adjustment of exchange rate of local African currencies vis-à-vis the US dollar on food prices in the African countries covered in the study.

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Contributions: The contribution of the study lies on its explanation of the increase of food commodity prices due to variability calculated in terms of depreciation in dollar exchange rate. Empirically, it is a confirmation of a significant structural problem, exchange rate variation as a cause of domestic inflation in selected African countries.

Limitations: Results have to be interpreted with care due to the small sample size. The results are rather a working hypothesis for future research.

Key words: Interest rate variation, exchange rate variation, commodity export, food commodity prices, Africa

JEL: A20, F46, G20

1. Introduction

Commodity exporting nations have significant terms of trade swings, making their actual exchange rate unstable. The volatility of the actual exchange rate harms the economy because it harms the consumption and investment decisions of private agents. Africa is not immune to such volatility in the actual exchange rate (Ricci, 2005). Although sustaining stable exchange rate regimes is challenging, it stimulates international trade and investment, in turn stimulation GDP growth. In 1973, the introduction of floating exchange rates in African countries added to the volatility of nominal and real interest rates, discouraging investment due to foreign exchange risk and increasing the transaction costs of international trade.

Floating exchange rates, in particular when leading to high volatility, can seriously hamper international trade. Besides exchange rate risk, unpredictability of exchange rates creates uncertainty about agreements with other countries. Volatility is defined as the danger or doubt related with unpredictable adjustment in exchange rates over time. Shocks in exchange rates are a major contributor to the unpredictability of commodity prices, inflation, lending rates, portfolio investments, savings and loans (Clarida, Gali 1994). Lending rates are used in financial market as benchmarks that reflect competition (Bostan, Firtescu 2019). This benchmark has increased in importance in the context of processes of globalization, the global financial recession, increasing rates of transmission and deregulation of capital movements and globalization.

A range of empirical studies show the effects of exchange rate variations on export and import, investment, as well as development of capital markets in emerging and developed markets (Schnabl 2008; Jamil et al. 2012; Alagidede, Ibrahim 2017; Dal Bianco, Loan 2017; Hatmanu et al. 2020). The link between exchange rates and interest rates is of great relevance, due to the importance of these variables in the composition of nominal and real economic changes, such as domestic inflation, the development of production, as well as exports and imports.

The relevance of the topic is increasing as some emerging market economies (EMEs) as some of them have recently implemented monetary and exchange rate policy reforms, trying to achieve their inflation aim under a flexible exchange rate regime. As many African countries heavily rely on the import and export of raw materials and food products, this study intends to establish the relation between exchange rate variations and changes food commodity price movements. In order to create proper economic policy in these resource-rich countries, it is necessary to better understand the link between commodity prices and exchange volatility. rates Addressing such concerns is important essentially from a political economy viewpoint. In fact, given the very high levels of commodity price volatility, in general, resource-rich countries must. Furthermore, commodity-exporting nations that open their capital accounts may have quite different experiences than other nations. In fact, the fluctuating and likely huge source of revenue from commodity exports can amplify the influence of capital account liberalization on the exchange rate.

2. Literature review

2.1. Conceptual issues

A currency exchange rate denotes the cost of one currency relative to another (Oloyede 2002). In the context of Nigeria, it refers to the number of naira required to securing one unit of another nation’s money, such as the dollar (Campbell 2010). According to Ahmed and Zarma (1997), the exchange rate is a key factor in decision-making in any country, making it a significant concern for any nation hoping to build its economy. Exchange rates, which are established by the interaction of supply and

demand in a free market system, are a reflection of how strong one currency is when compared to the currencies of other countries.

Currencies are immutable, and managed by using fixed and floating exchange rate schemes, or other mechanisms such as dual management (Onyeizugbe, Umeagugesi 2014). Exchange rate fluctuations will result in changing purchasing power and, as a result influence the level of imports and exports. On the other hand, adjustments to the level of industrial production will have a direct impact on imports as well as the exchange rate. Keynes (1960) argued that interest rates are a reward for temporarily resignation of the use of financial resources, not keeping them liquid. He puts emphasis on the loan interest rate in the interest rate concept. Adebiyi (2002) defines the interest rate as the return on capital or opportunity cost of postponing consumption. Returns on savings, loan rates, and discount rates are part of the interest rate. According to Professor Lerner's Jhingan (2003) definition, interest is the cost of the supply of "credit" or savings compared to net growth in quantity of money over time with respect to the demand for "credit" or investment. This definition means that the interest rate, like any other price, is a credit price determined by forces of supply and demand, in this case the supply and demand for loanable capital.

2.2. Theoretical literature

2.2.1. Optimal currency area (OCA) theory

The first and most influential theoretical framework for selecting an exchange rate regime was created by Mundel and McKinnon in 1961 and is known as the optimum currency area theory (1963). The stability of the business cycle and trade is the foundation of this idea. It emphasizes the ideas of shock symmetry, level of openness, and labour market mobility. This theory states that by lowering exchange rate uncertainty and thus the cost of hedging as well as interest rates, a stable exchange rate can either promote or decrease trade and economic growth. However, by stopping, postponing, or slowing the essential comparative price adjustment process, it can also lower trade and production growth (Erdemlioglu et al. 2012).

2.2.2. Monetary theory of exchange rate

According to the monetary theory of exchange rate, a nation's currency will appreciate as its money supply increases. The use of money has two significant effects. The first is the logical conclusion that a stronger currency is caused by increased relative income. The second is that a weaker currency results from a higher relative interest rate. According to the monetary model, there is a steady nominal demand for money over the long term that is favourably correlated with the amount of national income, but negatively correlated with interest rates. The country's money supply is equivalent to the fiscal base multiplied by the multiplier. The local credit created by the nation's monetary authority plus foreign exchange reserves forms the monetary base of the country. When there is an oversupply of money in the economy, it often leads to an outflow of reserves under a fixed exchange rate regime and a currency devaluation under a supple exchange rate regime. The opposite often occurs when there is excess demand for money (Olayungbo 2008).

2.2.3. Purchasing power parity theory

The relationship between price and exchange rate is described by the concept of purchasing power parity (PPP). The concept of PPP originated from the Salamanca School of Spain in the 16th century. Its recent application as a theorem of exchange rate determination dates back to the article of Gustav Cassel in 1918, who proposed PPP as a form of exchange rate determination – World War I exchange rate. Parity for nations that decide to yield to the gold standard after the conflict is over. A certain amount of adaptation was required since the rates of inflation in the nations that abandoned the gold standard in 1914 varied greatly both through and after the war. In our experience, the simplest and most robust PPP (Absolute PPP) format for determining exchange rates is based on international price law publications. Absolute PPP predicts that exchange rates should be modified to equalize the prices of baskets of national goods and services within two nations by market forces motivated by price differences (Cassel 1918).

2.2.4. Fisher's theory of interest rate

According to Fisher, fluctuations in the predicted rate of inflation are primarily responsible for variations in the short-term interest rate. Furthermore, Fisher's theory assumes that the market agents' assumptions regarding the rate of inflation are generally accurate. Fluctuations in inflation become a major factor in real interest rate changes. Since r is real interest rate, i is nominal interest rate, with p is the rate of inflation, we write $r = i - p$ (Mishkin, 2010). This well-known theory, which bears the name of American economist Irving Fisher (1930), serves as the foundation for the received view on interest rate formation. The theory states that competitive financial markets generate nominal interest rates on real assets because real assets often expand nominally in response to inflation and savers must persuade them to hold financial assets rather than real assets. The notable criticism of this concept is that it is insufficient since it considers only the assessment of the capital market and operates on the expectation that costs of goods and services are currently set (Mishkin 2010).

2.2.5. Loanable Funds theory of interest rate

According to the Loanable Funds theory of interest rate, the variables that influence the availability of loanable money determine the level of interest rates. According to Saunders (2010), this theory predicts interest rates based on the supply and demand for products. He continues by stating that, when all other circumstances are held equal, there is a greater demand for loanable funds when interest rates decline. Saunders recognized the following two elements as contributing to the shift in the demand curve for loanable funds: monetary expansions and economic circumstances. The loanable fund's hypothesis postulates that borrowing money today to take benefit of investment possibilities in the economy might increase future actual income. This will only be successful if the rate of yield on investment exceeds the cost of borrowing. These debtors would not agree to pay real interest rates that were higher than the rate of return on capital. Only if a genuine return on their investments is guaranteed, which will enable them to spend more in the future than they otherwise could, would savers be inclined to save and lend. People's taste for timing determines how much consumption they are prepared to delay (Saunders, Cornett 2011).

2.3. Review of empirical studies

Numerous studies have examined influence of interest rate and exchange rate volatility on commodity prices while considering the interrelationship between global commerce and capital flows. Using a GMM estimator, Umoru and Isedu (2018) studied the influence of exchange rate volatility on the total exports of African nations from March 1, 2005, to March 30, 2018, for the US dollar. The findings demonstrate that present and historical volatility had adverse and substantial effects on the combined exports of all the studied chosen African nations. For all nations, except Liberia, the speculative impact of currency rate fluctuation is detrimental and severe. Latief and Lefen (2018) investigated the association between exchange rate volatility, world trade and foreign direct investment (FDI) using GARCH (FDI) model. Statistical data were collected from 1995 to 2016 and the sample made of developing countries. The results of this study showed how important country-specific characteristics are. Exchange rate volatility had a significant favorable effect on trade, but had a significant negative impact in the case of Pakistan. The TGARCH measurement of exchange rate volatility had been shown to contain a remarkably favorable impact on international trade for nations such as Bhutan, Maldives and Nepal. The relationship between exchange rate volatility in addition to FDI had a significantly positive effect in India and Pakistan, but a significant negative effect in Bhutan and Nepal.

Bostan and Firtescu (2019) conducted research on the impact of the currency rate on Romania's competitiveness in international commerce. The study used OLS regression utilizing statistical data from the years 2007 to 2014. While Romanian exports and imports are endogenous factors, exogenous ones include exchange rate, inflation, and interest rate. They concluded that while the exchange rate is a key factor in determining competitiveness, uncertainty has differing effects on export and import. For imports, this effect seems likely less pronounced. The research by Frankel and Rose (2002), using data from over 200 nations to analyze the impact of currency union on trade and output, concluded that a monetary union is advantageous for all nations as part of the trade. They argued that the use of a single currency improved income per capita by at minimal a third of a percentage point for every one percent

increase in overall commerce. The second way to support the actual economy is to look at the relationship within investment and exchange rate instability. Additionally, there is disagreement among empirical research about how exchange rate volatility affects investment. According to research, currency rate volatility makes the economic environment unpredictable and discourages investing. The drop in investment has a detrimental effect on economic accomplishment.

Campa and Goldberg (1995) looked at the influence of exchange rate volatility in US industrial segments. They found that it had a negative influence on investment because high-margin businesses imbibe exchange rate variations by turning down actual investment. Udoka and Roland (2016) looked at how interest rate changes affect Nigeria's economic expansion. The link between interest rates and economic development, as well as the variation in economic development in Nigeria before and after the deregulation of the interest rates was explored.,. There was an interval association within interest rate and economic performance in Nigeria, according to the results. According to this, an increase in interest rates would lead to a decline in national GDP, slowing down he expansion of the real estate market. Using the Dixit-Pindyck model, Darby et al. (1999) found a considerable negative impact of increasing interest rate on investment.

Basing analysis on data from 10 nations in Latin America and the Caribbean, Dal Bianco and Loan (2017) examine how price and actual exchange rate volatility affects FDI influxes. The GARCH methods and data for the years 1990 to 2012 were used in this study. FDI was calculated as a percentage of GDP. The writers found that price unpredictability is irrelevant for the nations under study and that exchange rate volatility has a detrimental effect on FDI influxes in this area.

According to research by Bleaney and Greenaway (2001) conducted in 14 SSA nations between 1980 and 1995, exchange rate volatility has an impact on investment but not economic development. Aghion et al. (2009) expanded their research to 83 nations for the period 1960–2000. They discovered that the detrimental consequences of exchange rate fluctuation are displayed in nations where the financial market has not yet been established. This adverse effect is lessened in industrialized nations when riskier transactions are covered by hedging products Holland et al. (2011) found that a stable exchange rate has a positive impact on economic growth.

Jamil et al. (2012) studied effects of exchange rate volatility on development across two time interval for four non-Euro adopting nations and eleven European countries that are representatives of the European Monetary Union. For the nations analyzed, the findings are varied, although the common currency lessens the negative effects of exchange rate fluctuation on manufacturing productivity (Janus, Riera-Crichton 2015). Furthermore, both before as well as after the adoption of a single currency, exchange rate volatility had a detrimental effect on Germany and the Denmark.

For countries in the process of catching up with highly developed economies, where capital markets are still undeveloped and the possibility of macroeconomic instability is high, Schnabl's (2008) study shows a negative relationship linking economic development and exchange rate volatility. The study by Janus and Riera-Crichton (2015) uses the approximation of IV and found negative association between the real actual exchange rate volatility and economic development. However, Bagella et al. (2006) find that nations with flexible exchange rates enjoy further advantages than countries with fixed exchange rates, as they have less difficulties with absorbing surprises. Under this approach, nations with flexible exchange rate systems achieve economic success, and exchange rate instability helps them develop. The underlying hypothesis therefore is that exchange rate variability had no adverse effects on food prices in selected African countries.

3. Methodology

The study analyzes both static and dynamic relations between commodity prices, exchange rate and interest rate variation. For the static models, we conducted Hausman test to choose between random and fixed effects model while it also estimated differenced GMM and system GMM to ascertain dynamic relation, robustness, and also minimize endogeneity issues in our model specifications. Countries covered in this study included Ghana, Gabon, Tunisia, Nigeria, and South Africa and type of food exported by each country is detailed in Table 1. Country

selection was determined on basis of available data. The study covers the period, 1990M1 – 2021M12. Data were sourced from wits.worldbank.org/countries.

Table 1. Major food items exported by selected African countries

Countries	Major food exports
Ghana	Cocoa and timber
Gabon	Tobacco and oil kernels
Tunisia	Olive oil and fish products
Nigeria	Cocoa and sesame seeds
South Africa	Sugar and citrus fruits

Source: Authors' compilation.

3.1. Static specification

The study used a random and fixed effect model alongside the generalized technique of moments (GMM) to estimate the model. The GMM can help to resolve endogeneity, issues, particularly in the panel data studies (Sarafidis 2008). We begin with the panel fixed effect equation given as follows:

$$\ln y_{it} = \ln z_{it}\delta_i + v_i + e_{it} \qquad (1)$$

Using relevant variable notations, we have

$$\ln fdprc_{it} = \phi + \delta_{1i} \ln excrvar_{it} + \delta_{2i} \ln intrvar_{it} + \delta_{3i} \ln oilprc_{it} + v_i + e_{it}$$

where, $\ln fdprc_{it-1}$ lagged value of food prices, excrvar is exchange rate, intrvar is interest rate, oilprc is oil price variations, η_i is individual panel effect, and e_{it} is an idiosyncratic error term. Random effect OLS estimates in practice can be inefficient due to country-specific and time-specific effects.

$$\ln y_{it} = \alpha + \phi \ln z_{it}^{!} + \gamma \ln x_i^{!} + \eta_i + e_{it} \qquad (2)$$

Where a $z_{it}^{!}$ is vector of time varying regressors and $x_i^{!}$ is vector of time-invariant regressors.

3.2. Dynamic specification

3.2.1. GMM model

The differenced panel GMM was used to analyze the data after testing its suitability with the results from the GMM test and the fixed effects panel regression. The GMM model following specification:

$$\ln y_{it} = \delta \ln y_{it-1} + z_{it}^{!}\beta + (\eta_i + e_{it}) \quad (3)$$

The diff-GMM equation is then specified as

$$\Delta \ln y_{it} = \delta \Delta \ln y_{it-1} + \Delta z_{it}^{!}\beta + \Delta \upsilon_{it} \quad (4)$$

Using relevant notations for our variables, we have

$$\begin{aligned} \Delta \ln fdprc_{it} = {} & \delta \Delta \ln fdprc_{it-1} + \beta_{1i} \ln excrvar_{it} \\ & + \beta_{2i} \ln intrvar_{it} + \beta_{3i} \ln oilprc_{it} + (\eta_i + e_{it}) \end{aligned} \quad (5)$$

where all variables are as earlier defined.

3.2.2. GARCH model

To generate conditional variance of the exchange rate and interest rate variability among the selected ECOWAS countries, we specified our GARCH (1, 1). The GARCH model is robust in modelling volatilities (Musyoki et al. 2012):

$$e_t^2 = \delta + \sum_{j=1}^{p} \alpha_j e_{t-1}^2 \quad (6)$$

where u_t^2 is the conditional variance and u_{t-j}^2 is the previous period squared residual derived from previous period information about volatility. A reparameterization of ARCH (p) into GARCH model (1,1) equation yields:

$$\upsilon_t = \phi + \gamma \upsilon_{t-1} + \beta e_{t-1}^2 \quad (7)$$

where v_t is the conditional variance, β represents the ARCH parameters, γ denotes the GARCH parameter, e_{t-1}^2 depicts information about previous volatility measured as the lagged squared residual term and v_{t-1} is the previous forecast error variance.

4. Results and discussions

4.1. Descriptive analysis

In Table 2, the average (i.e. mean and median) of each series showed no good degree of consistency. This was demonstrated by the fact their values do not lie between the Maximum and Minimum values.

Table 2. Statistics

Statistics	fdprc	excrvar	intrvar	oilprc
Mean	4.6	700750	2.995.06	125.06
Media	0	130	0	120.79
Max	66.7	6.7	41.9	142.0
Min	0	0	-93.5	26.1
Std	11.7	2.2	10.4	15.6
Skweness	2.88	0.9	-3.1	7.4
Kurtosis	10.89	958	28.389	72.9
JB	3820	3664200	2764.65	20994.8
Obs.	960	960	960	960

Source: Authors' elaboration.

Nearly all of the chosen series had level spreads that were quite evenly distributed around their average. The low standard deviation values that each of the series had served as proof of this. The series, therefore, lacked very large values. Except for the interest rate, which was negatively skewed, all the factors were positively skewed. The coefficient of skewness indicates that all of the series was near to having a normal distribution since they were all symmetrical around the mean. All other series are not distributed properly in terms of Kurtosis. At the 5% level of significance, Jarque Bera and their associated probability displayed that all variables were not properly distributed.

4.2. ARCH test results

Arch test results of Table 3 confirm existence of volatility clustering. For both multivariate GARCH estimates with normal and t distributions, unconditional volatilities on diagonal elements are relatively high while correlations on off-diagonal elements are relatively low same. These are reported in Table 4.

Table 3. ARCH test results

LM statistic	CHSQ(1)= 96.6929	[.000]***
F-Statistic	F(1,3777)= 99.0450	[.000]***

Source: Authors' results.

**** indicates rejection of null hypothesis at 1% level*

Table 4. Unconditional volatilities/correlations

Variables	Volatilities
lnexcrvar _Ghana	.91466
lnexcrvar_Gabaon	.91242
lnexcrvar_Tunisia	.75833
lnexcrvar_Nigeria	.79117
lnexcrvar_S/Africa	.82130
lnintrvar_Ghana	-.51242
lnintrvar_Gabon	-.61604
lnintrvar_Tunisia	-.80409
lnintrvar_Nigeria	-.52686
lnintrvar_S/Africa	-.99917
Variables	Correlations
lnexcrvar _Ghana	.2166
lnexcrvar_Gabon	.20142
lnexcrvar_Tunisia	.34803
lnexcrvar_Nigeria	.10117
lnexcrvar_S/Africa	.21130
lnintrvar_Ghana	.21242
lnintrvar_Gabon	.41604
lnintrvar_Tunisia	.20409
lnintrvar_Nigeria	.22686
lnintrvar_S/Africa	.19917

Source: Authors' elaboration.

Table 5. GARCH with normal distribution

Variables	Estimate	t-ratio	Prob.
lnexcrvar _Ghana	.4200	71.1119	0.000
lnexcrvar_Gabon	.5920	182.7011	0.000
lnexcrvar_Tunisia	.6470	135.9445	0.000
lnexcrvar_Nigeria	.6420	281.962	0.000
lnexcrvar_S/Africa	.6020	410.545	0.000
lnintrvar_Ghana	-.0200	5.8790	0.000
lnintrvar_Gabon	-.0340	218.5502	0.000
lnintrvar_Tunisia	-.0260	7.9323	0.000
lnintrvar_Nigeria	-.1220	330.0937	0.000
lnintrvar_S/Africa	-.0276	29.8213	0.000
delta1	.1230	449.2606	0.000
delta2	.0210	15.2928	0.000
Maximized Log-likelihood = -9657.5			

Source: Authors' elaboration.

The result from multivariate GARCH with underlying multivariate normal distribution and the multivariate GARCH with underlying t distribution are presented in Table 5 and Table 6. Convergence was achieved after one iteration for normal distribution, whereas for t-distribution, convergence was achieved after 24 iterations respectively.

Table 6. GARCH with t-distribution

Variables	Estimate	t-ratio	Prob.
lnexcrvar_Ghana	.7110	122.7571	0.000
lnexcrvar_Gabon	.6110	232.2486	0.000
lnexcrvar_Tunisia	.7070	212.5872	0.000
lnexcrvar_Nigeria	.7124	195.7212	0.000
lnexcrvar_S/Africa	.6503	186.5949	0.000
lnintrvar_Ghana	-.2658	-6.0799	0.000
lnintrvar_Gabon	-.0917	-6.7613	0.000
lnintrvar_Tunisia	-.0505	-7.2501	0.000
lnintrvar_Nigeria	-.05412	-8.8712	0.000
lnintrvar_S/Africa	-.0987	-8.9579	0.000
delta1	-.0159	-512.3095	0.000
delta2	-.0191	-14.9974	0.000
df	26.8156		
Maximized Log-likelihood = -8920.1			

Source: Authors' elaboration.

Estimates demonstrate that volatility growth is highly significant for both normal and t distributions. However, when we compared normal and t-distributions, we found -9657.5 and -8920.1 for the normal and t-distribution respectively. Meanwhile, the value for the t-distribution is larger than that of the normal distribution. The df for our t-distribution is approximately 26.82 which is below 30, which further justifies basing empirical findings on t-distribution.

Results demonstrates that the Nigerian Naira had the highest coefficient of volatility of approximately 71.2%. The Nigeria naira showed negative and significant volatility. This was followed by the Ghanaian Cedi with a negatively volatility rate of 71% and thereafter, the South African rand with a coefficient of 65%. However, while all countries had negative volatility with respect to interest rate, only South Africa showed positive volatility in exchange rate of her currency. Ghana, Gabon, Tunisia,

and Nigeria faced negative exchange rate volatility. A possible explanation for this high volatilities in aforementioned countries is dominance of domestic inflation, which shows a significant structural problem.

Aligning with the preceding, is a resultant effect of instability of commodity prices which hinders implementation of economic policy. Changes in food prices most often reflect systemic shocks, which reduces supply of agricultural products and consequently escalate cost of supply. For consumers this leads to commodity price inflation. Prices of food commodities respond negatively to pervasive exchange rate shocks. Given the potential for increased transmission linking the volatility of food commodity prices and the currency exchange rate, countries that export commodities must assess the advantages and disadvantages of capital account liberalization. The contentious debate over whether capital regulation are necessary in light of the spikes in capital inflows that several developing markets are currently experiencing may also benefit from taking into account the unique challenges that commodity-exporting nations are currently facing and from putting more of an emphasis on exchange rate and short-term interest rate volatilities than their levels.

4.3. Static analysis

The static analysis as presented in Table 7 was carried out using the panel least square, fixed effect and random effect models. The most efficient model will be adopted for policy implications. The pooled least squares result revealed that a one-year lagged value of industrial output as well as oil price variations are significant in predicting current industrial output. Fixed effects panel OLS also had similar results with a one-year lagged value of industrial output and oil price variation individually significant in the model. Exchange rate devaluation has a negative relationship with industrial output in both estimations, but this effect is insignificant at the 5 percent level of significance. However, these estimations are criticized for being downward biased.

Table 7. Panel OLS estimates

Variables	Pooled least squares
lnfdprc(-1)	0.490*** (124.589)
lnexcrvar	1.134** (2.586)
lnintrvar	0.129*** (90.278)
lnoilprc	-0.149*** (-5.108)
c	1.120*** (100.249)
Adjusted r-squared	0.462
Variables	Fixed effects least squares
lnfdprc(-1)	0.563** (2.472)
lnexcrvar	0.122*** (19.421)
lnintrvar	0.109*** (300.578)
lnoilprc	-1.084** (-2.468)
Adjusted r-squared	0.562

Source: Authors' elaboration.

The pooled least squares result revealed that exchange rate and interest rate variations are significant in predicting current commodity prices. However, the effect of these variations is significantly negative and the impact of exchange rate variability is enormous compared to that of interest rate variation.

The Hausman test is commonly adopted in literature when deciding which model, fixed or random, is more efficient and consistent (preferable). The test checks the null of efficient and consistent REM against the alternative hypothesis. From result presented in Table 8, FEM is found relevant. Fixed effects panel OLS also had similar results for both exchange rate and interest variations. These estimations are criticized for being static in nature.

Table 8. Hausman test

Model	Chi-sq	p-value
FEM(1), REM(1)	11.121776	0.0252
FEM: Fixed effect model, REM: Random Effect model* p<0.05 ** p<0.01 *** p<0.001.		

Source: Authors' elaboration.

First differenced panel GMM was estimated with same dataset and results are as reported in Table 9. To determine the presence of bias in GMM output, the coefficient of the one-year lagged value of the dependent variable was compared with the coefficient of same in fixed effects regression output. The fixed effects coefficient is 0.563 and is higher than its differenced panel GMM counterpart, of 0.374. Therefore, the diff-GMM estimator in this paper suffers from downward bias despite Arellano-Bond serial correlation test shows absence of second-order serial correlation (p=0.79>.05). The foregoing necessitated system GMM as suitable for determining the impact of exchange rate and interest rate variations on commodity prices in Africa.

Table 9. Differenced GMM results

Variables	Differenced panel GMM	t-values
c	10.2897** (0.001)	4.2795
lncomp(-1)	0. 374*** (0.000)	102.476
lnexcrvar	0.115*** (0.000)	90.684
lnintrvar	0.004*** (0.000)	116.785
lnoilprc	-1.091*** (0.000)	-145.586
Effects Specification: Cross-section fixed (first differences)		
AR(1)	-2.9917(0.0000)***	
AR(2)	-0.261954 (0.7934)	
***(**) significant @ 1% (5%)		

Source: Authors' elaboration.

4.4. Dynamic analysis

To understand the dynamic relationship, the system GMM, whose estimation requires setting instruments, was estimated accordingly. The sys-GMM uses the differences of the lag variables as instruments for the level equation and lags of the variables at levels as instruments for the difference equation. The GMM can correct for endogeneity and autocorrelation which is common in panel studies and this makes it statistically more robust for our analysis. The results sys-GMM are presented as dynamic in Table 10 below. Food commodity prices in the immediate past period are responsible for 0.31% of price level change in the present period in the same direction. Exchange rate variation was found to adversely influence food commodity prices in African nations by 1.091%. The relationship is positive, revealing that food commodity price rises as exchange rate fluctuate. Variation in interest rate was also found to be a significant predictor of commodity prices with a negative impact. Worsening exchange rates of local currencies against the dollar and unstable movement in short-term interest rate inflate commodity prices in Africa. Precisely, a 1% rise in variation in short-term interest rate heads to a proportionate increase in food prices by 1.01% respectively. Our findings also suggest that these factors are important drivers of food commodity prices in Africa.

This finding agrees with those reported in studies of Umoru and Isedu (2018), Brahmasrene et al. (2014), Sensoy et al. (2014) and Anjum (2019). The system-GMM estimates show positive and significant effect of previous prices on current food price level. The significance of lagged coefficient validates dynamic relation between commodity prices, exchange rate and short-term interest rate variation. Oil prices variability had a negative relation with commodity prices. Increases in oil prices is a major factor behind a strong increase in food prices in Africa. This could be explained by the fact that oil is an important input in industries and agriculture (production of final goods and services). Hence, increase in cost of oil, increases production cost which translates into increasing commodity prices consequently. The significance of oil prices could be a consequence of the increase in fluctuation of exchange rates in relation to the dollar. The probability value of J-static is significant implying none over-identifying restrictions in the model.

Table 10. System-GMM results

Variable	Sys-GMM coefficient	t-statistic
c	10.456*** (0.000)	211.9056
lnfdprc(-1)	0.3163*** (0.000)	1560.578
lnexcrvar	1.091*** (0.000)	124.578
lnintrvar	1.014 (0.000)***	23357.47
lnoilprc	-0.03594*** (0.000)	-18607.88
Hansen J-statistic	784.2755	
Prob(j-statistic)	0.000000	
***Significant @ 1%		

Source: Authors' elaboration.

5. Conclusion

In this study, we examined how variations in exchange rates of selected African nations against the US dollar affect food commodities prices. Our first findings show that volatility growth is highly significant in all countries examined. The Nigerian Naira had highest coefficient of volatility of approximately 71.2%. The Nigeria naira showed negative and significant volatility. This was followed by the Ghanaian Cedi with a negative volatility rate of 71% and the South African rand with a coefficient of 65%. However, while all countries had negative volatility with respect to the interest rate, all countries, except Ghana, showed positive volatility in the exchange rate of their currency. Ghana, Gabon, Tunisia, and Nigeria showed negative exchange rate volatility. The high volatilities can be a determinant of high inflation rates in these countries.

The outcome, therefore, adds to a lengthy list of difficulties faced by nations that export primary products. Given that food commodity prices have moved into an era of rising instability, the spread of instability out of the oil prices to the exchange rate is a difficulty that is undoubtedly going to stay at the top of policymakers' agendas. Indeed, a flight to commodities has resulted from the perceived scarcity of secure possessions at the start of the financial crunch, which has caused a dramatic rise in the

prices of these commodities. Exporters of food commodities should weigh the advantages and costs of capital account liberalization against fluctuations in commodity prices and greater transitivity between main variables such as exchange rates with lending rates (interest rates). The fierce debate over whether capital controls can match the surge in capital influxes faced by some developing markets can additionally be beneficial when taking into account the specific circumstances faced by countries. Governments and policymakers must implement policies that increase demand for the African currency in order for it to appreciate against the US dollar. This would allow the price of oil to decrease in the face of exchange rate fluctuation in relation to US dollar. When exchange rates play an important role in primary commodity prices, it is necessary to minimize volatility in exchange rates. Furthermore, excessively high short-term interest rates should be prevented in order to mitigate the negative influence on food commodity prices.

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