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Role of Macroeconomic Indicators in Uganda's Food Price Inflation: A VECM Approach

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Abstract

This study was conducted to empirically examine the potential impact of macroeconomic indicators such as exchange rate, GDP, money supply, and food exports on Uganda's food price movements. The study employed the Johansen cointegration analysis and VEC model using quarterly data from 2000Q1 to 2022Q1. The outcomes of the analysis show that all variables are positive and statistically significant in influencing food prices in the long run except GDP which was negative and significant. However, in the short run, only GDP and the lag of food CPI were significant and influenced food prices positively. Based on the variance decomposition analysis and the very low R-squared value (0.2493), one may conclude that food prices in Uganda are greatly influenced by factors other than macroeconomic indicators. These factors include changes in the weather pattern which lead to low food supplies, price transmission effects of rising food and fuel prices in the international markets, increased domestic food demand, and higher costs of imported production inputs. Therefore, while it is necessary to recognize the role of macroeconomic indicators in Uganda's food price movements, it is equally important to emphasize the role played by these other factors in determining food prices in Uganda for effective policy implementation.

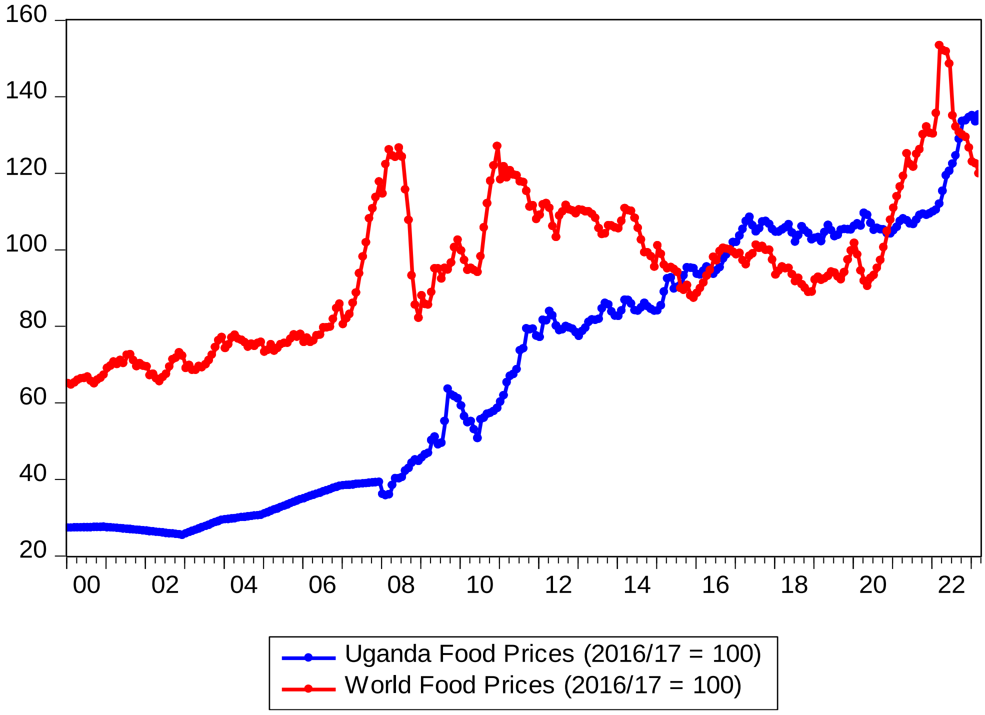
Keywords: *Macroeconomic indicators, food price inflation, unit root, VECM, Johansen cointegration*

1. Introduction

The rise in food prices has received much attention throughout the world, especially after the global food price crisis of 2007-08, and the current impact of the COVID-19 pandemic. According to data presented by the Food and Agriculture Organization (FAO), prices of food commodities on world markets increased slowly at the beginning of the 2000s and then reached alarmingly high levels from 2006 to the middle of 2008 (see Figure 1.). From late 2010, food prices have been relatively stable up to early 2020, when food prices have increased significantly. This increase is attributed to the effects of the COVID-19 pandemic (FAO, 2023; WFP, 2022). It is also worth noting that a drastic increase in global food prices is observed from February 2022 to March 2022, when global food prices increased at a whacking rate of 12.64%. This increase is attributed to the impact of Russia's invasion of Ukraine (FAO, 2022). Indexing Uganda and the world food price series to a common November 2016 base produces Figure 1, which shows the monthly trends in food prices in Uganda and the world from January 2000 to March 2023 (FAO, 2023). In addition to the COVID-19 pandemic and the Russia-Ukraine war as drivers of the increasing global food prices (FAO, 2022; WFP, 2022), the following factors have also been cited as playing a role in inducing increases in global food prices. Droughts in major producing countries, increased feedstock use in the production of biofuels, rapidly rising oil prices leading to an increase in the production and processing costs, expanding populations, underfunding of agriculture (Abbott & Borot de Battisti, 2011; Mawejje, 2016; Mbowa, Mawejje, & Kasirye, 2012; Simler, 2010), sudden and periodic increase in food demand, increase in people's incomes, and changes in consumer preferences (Banse, Nowicki, & van Meijl, 2008).

Regarding food prices in Uganda, Figure 1. shows that the first spell of the rise in food prices in Uganda occurred in the middle of 2009. The situation eased off in 2010. However, since the beginning of 2011, food prices have been on the rise, though moderately. This rise has been linked to the following factors: Firstly, low supplies to markets due to extreme changes in the weather pattern that has led to long dry spells in some regions of the country and floods in other regions (Mbowa et al., 2012). Secondly, the price transmission effects of rising food and fuel prices in the international markets affect the production and transportation costs of food items in domestic markets (Benson, Mugarura, & Wanda, 2008; Mbowa et al., 2012). Finally, the recent increases have been attributed to increased domestic food demand, higher costs of imported production inputs, and trade disruptions as a result of the Russia-Ukraine war (FEWSNET, 2022a).

Figure 1: Trend of food prices in Uganda and the world from 2000 to March 2023



Source: FAO (2023) and UBOS (2023)

2. Literature Review

Although several studies have reported the aforementioned factors as the primary drivers of food price movements in Uganda, there is also a wide range of evidence that suggests that macroeconomic indicators play a role in influencing domestic food prices. Several authors have attempted to analyze the relationship between macroeconomic indicators such as Gross Domestic Product (GDP), per capita income, money supply, exchange rates, food imports and exports, and food price movements, using different econometric approaches. The following section presents a review of the available literature on the impact of these factors on food prices.

Baek & Koo (2010) used Johansen's Co-integration technique and Vector Error Correction Model (VECM) to analyze the long-run and short-run effects of energy and agricultural commodities prices, and exchange rate on U.S. food prices. Results revealed that the agricultural commodity prices and exchange rate played key roles in determining the short and long-run movement of U.S. food prices. In contrast, energy prices affected food prices in the long run but had little effect in the short run. Azeem, Munawwar, & Mushtaq (2012), Abdullah & Kalim (2012), and Rehman & Khan (2015) used the same approach to determine the main determinants of food price inflation in Pakistan.

Azeem et al. (2012) concluded that per capita income had a positive and statistically significant effect, the crude oil price had a positive but statistically insignificant effect, while money supply and wheat support prices had a negative effect on food prices in the long run. The lag value of food prices had a positive, while money supply and wheat support prices had a negative effect in the short run. Abdullah & Kalim (2012)'s results revealed that inflation expectations, per capita GDP, support prices, food imports, and food exports affected food price inflation positively and significantly, while money supply was insignificant in the long run. In the short run, food price inflation was influenced by only inflation expectations, support prices, and food exports. Rehman & Khan (2015) reported that indirect taxes and food exports had positive and significant impacts on food price inflation while government subsidies and GDP had a negative impact in the short run. A long-run relationship was also reported to exist between indirect taxes, food exports, subsidies, and food price inflation.

Similar to Baek & Koo (2010), Haji & Gelaw (2012) and Norazman, Khalid, & Ghani (2018) also employed the VECM approach to examine the determinants of food price inflation in Ethiopia and Malaysia, respectively. Among the factors reported to influence food price inflation in both countries was the continuous depreciation of domestic currencies against the dollar. Qayyum & Sultana (2018) used the simple regression approach to analyze the factors affecting food price inflation in Pakistan. It was concluded that GDP, food exports, and food imports affected food prices positively and significantly while money supply negatively affected food prices.

These studies suggest that macroeconomic indicators play a significant role in influencing domestic food price movements. However, there haven't been any studies conducted to examine the influence of these factors on Uganda's food prices. An attempt is therefore made in this study to empirically examine the potential contribution of these indicators to food price movements in Uganda. This study employs the Johansen co-integration test and a vector error correction (VEC) model. The Johansen approach is used to identify the long-run equilibrium relationships among the variables, while the VEC model provides information on the short-run dynamic adjustment to changes in the variables with the model (Baek & Koo, 2010). The VECM has the following advantages: The model accounts for the deviation of the variables from their long-term equilibrium state under external shocks in the short term. In other words, the VECM not only estimates the long-term equilibrium relationship between variables but also corrects short-term deviation from the long-term equilibrium state. Additionally, the model treats all variables as endogenous to avoid endogeneity problems (Shao, Chen, Zhong, & Weng, 2021).

The remaining sections of the paper are organized as follows. Section 2 describes the data and econometric methodology; Section 3 presents the empirical results and discussion while Section 4 provides the conclusion of the study.

3. Materials and Methods

3.1. Data

Quarterly time series data covering the period from 2000Q1 to 2022Q1 was used in this study. The variables used in this study are presented in Table 1. All variables were transformed into their natural logarithms for the following reasons. One, from a statistical point of view, the logarithmic transformation mitigates fluctuations of individual variables increasing the likelihood of stationarity after first differencing. And two, from an economic point of view, the logarithmic transformation allows the first differences of the variables to be interpreted as growth rates and coefficients in terms of elasticity (Keho, 2021; Waiswa, 2023b).

Table 1: Variables used

Variables	Symbol	Units of measurement	Data source
Food Consumer Price Index	FCPI	Indexed as 2016/17 =100	Uganda Bureau of Statistics (UBOS)
Exchange Rate	ER	Uganda Shilling (UGX) against the United States dollar (USD)	Bank of Uganda
Food Exports	FExp	Million USD	Bank of Uganda
Gross Domestic Product	GDP	Million USD, 2016/17 Constant prices	UBOS and World Bank
Money Supply	MS	Million USD	Bank of Uganda

3.2. *Model Specification*

Food Consumer Price Index (FCPI) was hypothesized to be a function of Gross Domestic Product (GDP), Exchange Rate (ER), Food Exports (FExp), and Money Supply (MS), as presented below:

$$\ln FCPI_t = \beta_0 + \beta_1 \ln GDP_t + \beta_2 \ln ER_t + \beta_3 \ln FExp_t + \beta_4 MS_t + \varepsilon_t \qquad (1)$$

Where, β_0 is the intercept, β_1, β_2, β_3, and β_4 are coefficients of their respective variables, and ε_t is the error term.

As far as the expected signs of each coefficient are concerned, β_2 and β_3 are expected to be positive. A depreciation or appreciation of the domestic currency against foreign currencies results in an increase or decrease in the domestic prices of food items (Rangasamy, 2011). An increase in food exports affects domestic supply and increases the demand for food items, causing demand-pull inflation (Qayyum & Sultana, 2018; Rehman & Khan, 2015). β_1 and β_4 could either be negative or positive. GDP growth could imply growth in the agricultural sector as well because the sector contributes a significant share (24%) to Uganda's GDP (UBOS, 2023; Waiswa, 2023a). Growth in the agricultural sector is manifested in the increase in the production of food items to meet the available demand thus leading to a decrease in the general level of food prices. On the other hand, GDP growth could be a sign of growth in income per capita which induces more production, a shift to more value-added products, and a switch from cereals to consumption of animal proteins. The increased demand for animal proteins eventually induces a relatively higher demand for grain and protein feed, which leads to an increase in the general price level of food items (Banse et al., 2008; Matovu & Twimukye, 2009). The available literature also reported mixed results on the relationship between GDP and food price inflation. Rehman & Khan (2015) reported that GDP had a negative impact on food price inflation, while Qayyum & Sultana (2018) reported a positive impact. Money supply induces food price inflation in case the money supply in the economy grows at a rate faster than the growth rate of real GDP, thus leading to a situation where "too much money chases few goods" (Haji & Gelaw, 2012). However, if GDP grows faster than the money supply in the economy, then a negative relationship between food price inflation and money supply could be obtained.

Analyses were conducted in EViews statistical program version 10. The first step in this study's analysis was to test stationarity and the order of integration of the variables. This was conducted using the Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) and Phillips-Perron (PP) (Phillips & Perron, 1988) unit root tests. The stationarity test was followed by the optimal lag order selection using the VAR lag order selection criteria. The selection was based on the sequential modified LR test statistic (LR), Final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ). The variables were then subjected to co-integration testing to detect the number of co-integration relations. This was conducted using the Johansen co-integration test. This test has the following advantages over other cointegrating tests. One, it avoids the issue of choosing a dependent variable as well as issues created when errors are carried from one step to the next. As such, the test can detect multiple cointegrating vectors and is more appropriate than other cointegration tests for multivariate analysis. Secondly, Johansen's test treats every test variable as an endogenous variable (Abdullah & Kalim, 2012; Shao et al., 2021; Wassell & Saunders, 2000). Johansen's Co-integration test starts with an unrestricted vector autoregression (VAR) involving up to k lags of X_t and can be represented as (Azeem et al., 2012; Baek & Koo, 2010):

$$X_t = \alpha_0 + \partial_1 X_{t-1} + \ldots\ldots + \partial_k X_{t-k} + \mu_t \qquad (2)$$

where X_t is an (n × 1) vector of endogenous variables that are integrated of order one [I(1)], each of the ∂_k is an (n × n) matrix of parameters; α_0 is a vector of constant, and μ_t is the white noise.

The VECM was then constructed as presented in equation 3 to examine the long-run and short-run relationship among the variables.

$$\Delta lnFCPI_t = \delta_0 + \sum_{i=1}^{k-1}\delta_{1i}\Delta lnFCPI_{t-1} + \sum_{i=1}^{k-1}\delta_{2i}\Delta lnGDP_{t-1} + \sum_{i=1}^{k-1}\delta_{3i}\Delta lnER_{t-1} + \sum_{i=1}^{k-1}\delta_{4i}\Delta lnFExp_{t-1} + \sum_{i=1}^{k-1}\delta_{5i}\Delta lnMS_{t-1} + \lambda ECT_{t-1} + \varepsilon_t \qquad (3)$$

Where t-1 represents the previous quarter's value of the respective variable, Δ is the difference operator, δ_0 and ε_t are the vector of constant and the error term, respectively. δ_{1i}, δ_{2i}, δ_{3i}, δ_{4i}, and δ_{5i}, are the short-run dynamic coefficients of the model's adjustment long-run equilibrium. λ is the speed of adjustment parameter, its negative sign indicates convergence to the long-run equilibrium while a positive sign indicates divergence from the long-run equilibrium. ECT_{t-1} is the Error Correction Term. It is the lagged value of the residuals obtained from the cointegrating regression of the dependent variable on the regressors. It contains long-run information from the long-run cointegrating relationship.

Finally, the impulse response function was constructed, and variance decomposition was carried out. The impulse response function measures the influence of a standard deviation analysis from a random disturbance term of an endogenous variable on the current and future values of all endogenous variables while the variance decomposition analyzes the contribution of structural impact to the change in endogenous variables (Shao et al., 2021).

4. Results and Discussion

The results of the ADF and PP unit root tests are presented in Table 2. These tests were conducted following Hill, Griffiths, & Lim (2018). The undifferenced series of all variables had a linear trend, thus prompting the use of the test equation with both a constant and a trend. While the differenced series except the exchange rate showed no trend but wandered around a non-zero sample average, thus prompting the use of a test equation with a constant but no trend. The differenced series for exchange rate fluctuated around a zero mean, thus the test equation with neither trend nor constant was adopted. The outcomes of both tests show that the series of all variables were integrated of order 1 [I(1)], i.e., their original logarithmic series were nonstationary, however, they became stationary after taking their first differences. Based on this, the VECM is adopted for analysis in this study.

Table 2: Unit root test results

		Augmented Dickey-Fuller (ADF) test				Phillips-Perron (PP) test			
Series in levels (before differencing)									
Variables	**Exogenous variable in test equation**	**Statistic**	**Critical values (5%)**	**k**	**I**	**Statistic**	**Critical values (5%)**	**BW**	**I**
LnFCPI	Constant, Linear Trend	-1.4094 (0.8516)	-3.4623	1		-1.2120 (0.9016)	-3.4617	2	
LnER	Constant, Linear Trend	-2.3226 (0.4169)	-3.4677	9		-1.9473 (0.6213)	-3.4617	2	
LnFExp	Constant, Linear Trend	-1.8388 (0.6770)	-3.4642	4		-3.3722 (0.0618)	-3.4617	5	
LnGDP	Constant, Linear Trend	-1.6661 (0.7576)	-3.4642	4		-0.9067 (0.7819)	-2.8947	13	
LnMS	Constant, Linear Trend	-0.3052 (0.9894)	-3.4617	0		-0.42930 (0.9850)	-3.4617	1	
Differenced series									
ΔLnFCPI	Constant	-6.6197 (0.0000)	-2.8951	0	I(1)	-6.5802 (0.0000)	-2.8951	4	I(1)
ΔLnER	None	-2.0906 (0.0359)	-1.9450	8	I(1)	-6.8583 (0.0000)	-1.9446	6	I(1)
ΔLnFExp	Constant	-9.1186 (0.0000)	-2.8959	2	I(1)	-20.8957 (0.0001)	-2.8951	54	I(1)
ΔLnGDP	Constant	-5.1174 (0.0000)	-2.8963	3	I(1)	-16.8860 (0.0001)	-2.8951	13	I(1)
ΔLnMS	Constant	-7.8136 (0.0000)	-2.8951	0	I(1)	-7.8206 (0.0000)	-2.8951	1	I(1)

Note: Ln denotes logarithms, k denotes lag length, BW denotes Bandwidth, I denote the order of integration, and figures in parentheses are probabilities. The optimal lag structure of the ADF test was chosen based on the Akaike Information Criterion (AIC), while the optimal bandwidth of the PP test was chosen based on the Newey-West Bartlett kernel method. The test critical values are at the 5% level.

Table 3. presents the results of the VAR lag order selection criteria. As can be noted, LR, FPE, and AIC all show that the optimal lag order is 4, while SC and HQ consider 1 to be the most appropriate. Therefore, the lag order was initially selected as 4, with 1 as the other alternative.

Table 3: Optimal lag selection

Endogenous variables: LnFCPI LnER LnFExp LnGDP LnMS; Exogenous variables: C						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	224.5053	NA	3.05e-09	-5.419885	-5.272080	-5.360584
1	710.0840	899.2197	3.51e-14	-16.79220	-15.90536*	-16.43639*
2	734.5415	42.27231	3.58e-14	-16.77880	-15.15294	-16.12649
3	765.1630	49.14552	3.18e-14	-16.91760	-14.55272	-15.96878
4	809.0727	65.05146*	2.06e-14*	-17.38451*	-14.28060	-16.13918
5	832.3428	31.60142	2.28e-14	-17.34180	-13.49886	-15.79996
6	852.3322	24.67816	2.81e-14	-17.21808	-12.63611	-15.37973
7	872.2793	22.16351	3.62e-14	-17.09332	-11.77232	-14.95846
8	893.3419	20.80256	4.78e-14	-16.99610	-10.93607	-14.56473

Note: * indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

Results of the Johansen co-integration test are presented in Table 4. This test points to the existence of a long-run relationship among the economic variables. As can be noted, the trace statistic and Max-Eigen statistic are less than the critical value under 95% confidence from when rank = 1, indicating that the null hypothesis is accepted from this level. However, at 0 cointegrating equations, the probability values of the trace and Max-Eigen statistic are less than the 5% level of significance, indicating that the null hypothesis is rejected. Based on these results, it can be concluded that there is one co-integration equation among the five variables.

Table 4: Johansen co-integration test results

Hypothesized No. of CE(s)	**Eigenvalue**	**Unrestricted Cointegration Rank Test (Trace)**			**Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**		
		Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.341618	73.49983	69.81889	0.0247	35.10948	33.87687	0.0355
At most 1	0.224920	38.39034	47.85613	0.2853	21.40223	27.58434	0.2527
At most 2	0.079448	16.98811	29.79707	0.6409	6.953678	21.13162	0.9557
At most 3	0.077338	10.03443	15.49471	0.2781	6.761326	14.26460	0.5178
At most 4	0.038216	3.273108	3.841466	0.0704	3.273108	3.841466	0.0704
Cointegrating equations at the 0.05 level = 1							

Note: * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values

Table 5. and 6. present the results of the long-run and short-run estimates, respectively. Long-run estimates show that food exports, GDP, and money supply are statistically significant at both 1% and 5% levels, while the exchange rate is statistically significant at a 10% level. Specifically, Uganda's food prices have a positive long-run relationship with the exchange rate, food exports, and money supply. This suggests that an increase in exchange rates (depreciation of the domestic currency), food exports, and money supply leads to a rise in food prices in Uganda. Specifically, a 1% increase in exchange rates, food exports, and money supply leads to a 0.263%, 0.701%, and 0.72% increase in food prices, respectively.

The positive impact of exchange rates could be attributed to the fact that depreciation (appreciation) of the domestic currency against foreign currencies results in an increase (decrease) in the domestic prices of food items (Rangasamy, 2011). While the positive impact of food exports could be attributed to the fact that an increase in food exports affects domestic supply and increases the demand for food items, causing demand-pull inflation (Qayyum & Sultana, 2018; Rehman & Khan, 2015). Finally, the positive impact of the money supply obtained in this study could be an implication of the importance and significance of monetary developments in explaining inflation in Uganda. This could further imply that money supplied in the economy grows at a rate faster than the growth rate of real GDP, thus leading to a situation where "too much money chases few food items" (Haji & Gelaw, 2012).

Additionally, Uganda's food prices have a negative long-run relationship with GDP, suggesting that GDP growth leads to a decrease in food prices. Specifically, a 1% growth in GDP leads to a 1.956% decrease in food prices in the long run. The negative impact of GDP on food prices could be attributed to the fact that GDP growth could imply growth in the agricultural sector as well because the sector contributes a significant share (24%) to Uganda's GDP (UBOS, 2023). Growth in the agricultural sector as manifested in the increase in the production of food items could mean that enough food is produced to meet the available demand thus leading to a decrease in the general level of food prices.

In comparison with the available literature, Baek & Koo (2010), Haji & Gelaw (2012), and Norazman et al. (2018) also reported a significant impact of exchange rates on food prices in the US, Ethiopia, and Malaysia, respectively. Abdullah & Kalim (2012) and Rehman & Khan (2015) reported a positive and significant impact of food exports on food prices in Pakistan. Estimates of money supply and GDP are different from the available literature. While this study's results show a positive impact of money supply on food prices, Azeem et al. (2012) and Qayyum & Sultana (2018) reported a negative impact of money supply on food prices in Pakistan. Qayyum & Sultana (2018) further reported a positive impact of GDP on food prices, unlike this study which reports a negative impact in the long run.

Table 5: Johansen's long-run estimates

	Coefficient	Std. Error	t-Statistic	Prob.**
LnFCPI(-1)	1.000000			
LnER(-1)	0.262526*	0.15766	1.66511	0.0997
LnFExp(-1)	0.701153***	0.11443	6.12735	0.0000
LnGDP(-1)	-1.955763***	0.39136	-4.99738	0.0000
LnMS(-1)	0.720304***	0.14535	4.95572	0.0000
C	8.151632			

Note: **Probabilities were calculated by the author, * and *** denote significance at the 10% and 1% levels, respectively.

To identify the short-run adjustment to long-run steady states, as well as the short-run dynamics between Uganda's food prices and the macroeconomic indicators under study, the VEC model is estimated with the identified cointegration relationship in Table 4. The methodology used to find this representation follows a general-to-specific procedure (Baek & Koo, 2010). After eliminating all the insignificant variables based on the Wald test, the parsimonious VEC (PVEC) model is presented in Table 6. In this table, it can be observed that among all variables used in this study, only the lag of food CPI and GDP significantly influence food prices in the short run. The number of lags included in the PVEC model is the same as those used in the cointegration analysis.

The results in Table 6. show that the error-correction term (ECT) for the estimated model is negative and significant at the 1% significance level. The negative coefficient of the ECT ensures that the long-run equilibrium can be attained. The results indicate that, when deviating from equilibrium conditions, food prices adjust to correct long-run disequilibria. The results imply that it takes approximately 9.7 quarters (1/0.1035 = 9.6618 quarters) to eliminate the disequilibria. The coefficients of the lagged variables in the PVEC model show the short-run dynamics (causal linkages) of the dependent variables. Food prices are positively correlated with their one-quarter lag and the lags of GDP. Unlike the long-run estimates, GDP positively influences food prices in the short run. These results imply that a 1% increase in food prices in the previous quarter leads to a 0.352% increase in food prices in the current quarter. While a 1% increase in GDP in the previous quarter and 3 quarters back leads to a 0.21% and 0.143% increase in food prices in the current quarter, respectively.

The positive impact of GDP on food prices in the short run could be attributed to the fact that GDP growth could signify growth in income per capita which induces more production, a shift to more value-added products, and a switch from cereals to consumption of animal proteins. This is a common scenario reported in developing countries. The increased demand for animal proteins eventually induces a relatively higher demand for grain and protein feed, which leads to an increase in the general price level of food items (Banse et al., 2008; Matovu & Twimukye, 2009).

Furthermore, the multivariate diagnostic tests on the estimated model presented in the lower part of Table 6. indicate the absence of serial correlation and heteroskedasticity in the data. The JB statistic also indicates normality in the series. Therefore, the estimated model does not violate any of the standard assumptions. Among the diagnostic tests still, the Durbin-Watson (DW) statistic is 2.0701, greater than the R^2 value which confirms that the model is not spurious (Gujarati & Dawn, 2009). The p-value of the computed F-statistic (6.6422) is less than 0.05, which rejects the null hypothesis that the regressors have zero coefficients.

Table 6: Vector Error Correction Estimates: short-run estimates

	Coefficient	Std. Error	t-Statistic	Prob.
ECT(-1)	-0.103466***	0.033111	-3.124815	0.0025
ΔLnFCPI(-1)	0.352469***	0.100621	3.502939	0.0008
ΔLnGDP(-1)	0.209918***	0.074662	2.811573	0.0062
ΔLnGDP(-3)	0.143124*	0.071992	1.988046	0.0502
C	0.005850	0.004365	1.340014	0.1840
Diagnostic checks R-squared: 0.2493 Adjusted R-squared: 0.2118 Durbin-Watson stat: 2.0701 F-statistic: 6.6422 (0.0001) Jarque-Bera (JB) Normality: 5.776883(0.055663) Breusch-Godfrey Serial Correlation LM Test: F-statistic 1.3771(0.2498), χ^2 5.7446(0.2191) Heteroskedasticity Test: Breusch-Pagan-Godfrey: F-statistic: 1.9668(0.0552), χ^2 16.2307(0.0622)				

Note: * and *** denote significance at the 10% and 1% levels, respectively.

In Table 6., it can also be observed that the R^2 value is very low (0.249), implying that only 24.9% of variations in food prices are explained by the model. This could be an indication that food prices in Uganda are greatly influenced by factors other than macroeconomic indicators in the short run. These factors include low food supplies to markets due to extreme changes in the weather pattern that has led to long dry spells in some regions of the country and floods in other regions (Mbowa et al., 2012), price transmission effects of rising food and fuel prices in the international markets which affect production and transportation costs of food items (Benson et al., 2008; Mbowa et al., 2012), increased domestic food demand, and higher costs of imported production inputs (FEWSNET, 2022a).

Results of the variance decomposition analysis of food CPI over 8 quarters are presented in Table 7. The variance decomposition determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables (Agbonlahor, 2014). The results presented show that in the short run (one quarter ahead), 100% of the forecast error variance in food CPI is explained by food CPI itself. However, its influence decreases as we move further into the future. A two-quarter ahead forecast error is 97.8%, 1.29%, 0.74%, 0.073%, and 0.096% due to variations in the food consumer price index, exchange rate, food exports, GDP, and money supply, respectively. As for the other forecast horizons, although decreasing as we move further into the future, variations in the food CPI remain the most significant throughout the forecast period.

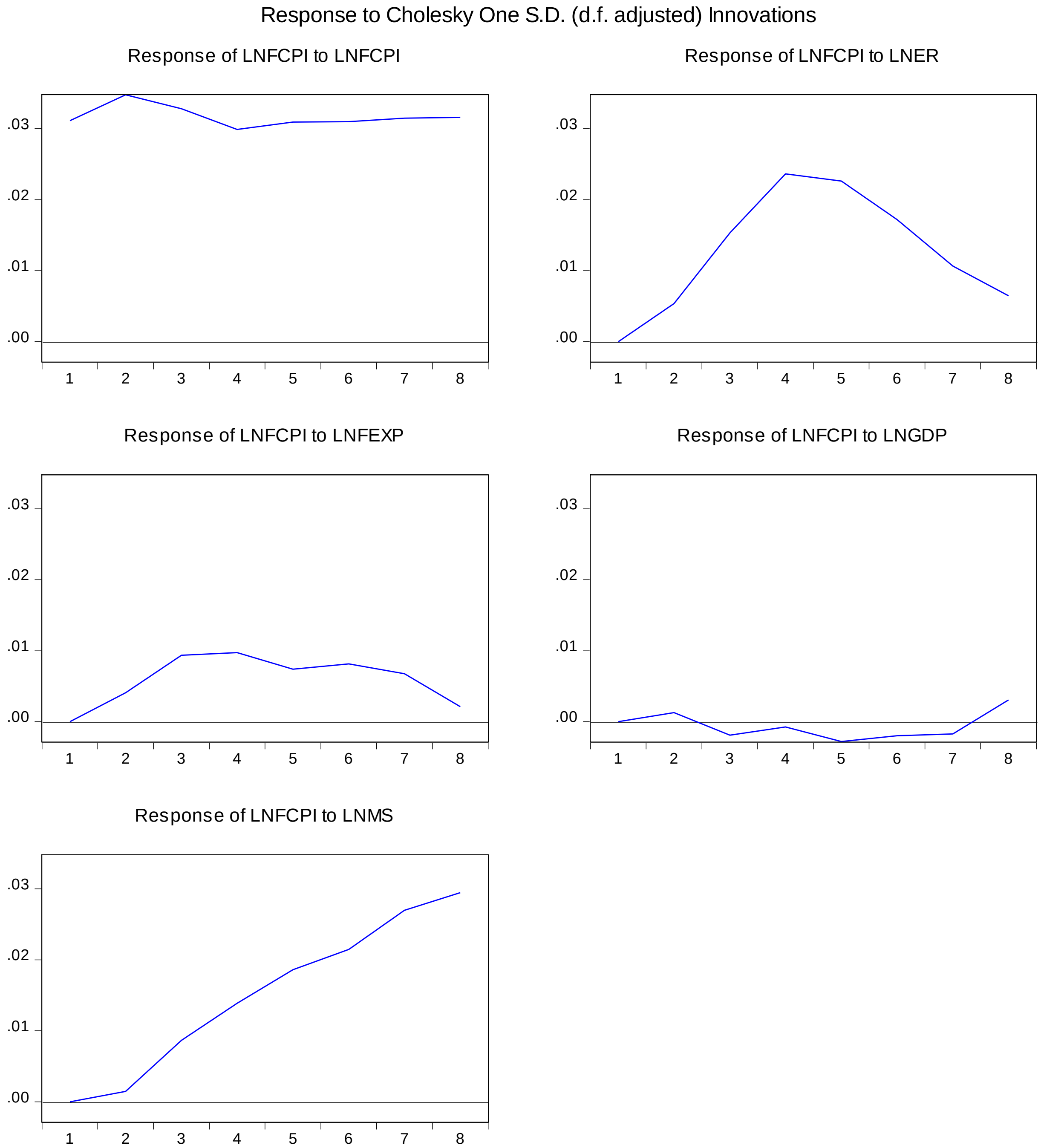
Conversely, the exchange rate and money supply have moderate impacts that increase as the forecast period increases. For example, the 5-quarter forecast error in the food CPI is 18.21% due to variations in exchange rate compared to the 1.29% in the second quarter. While the 8-quarter forecast error in the food CPI is 20.69% due to variations in money supply compared to the 0.096% in the second quarter. And lastly, food exports and GDP have a weak influence in predicting food CPI throughout the forecast period. Overall, it can be concluded that the forecast error variance of food CPI in Uganda can be greatly explained by variations in the food CPI itself than all the macroeconomic indicators used in this study. Thus still, emphasizes the role of other factors rather than macroeconomic indicators in determining food prices in Uganda as also noted in Table 6.

Table 7: Variance decomposition of LnFCPI

Period	S.E.	LnFCPI	LnER	LnFExp	LnGDP	LnMS
1	0.031130	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.047175	97.80070	1.289343	0.741457	0.072515	0.095983
3	0.060842	87.87307	7.106513	2.806267	0.141586	2.072564
4	0.073774	76.19139	15.09847	3.651721	0.106654	4.951762
5	0.085551	69.71984	18.21491	3.460959	0.188096	8.416191
6	0.095426	66.58745	17.88426	3.511366	0.195675	11.82124
7	0.104811	64.20933	15.85461	3.325970	0.189405	16.42068
8	0.113605	62.39017	13.81777	2.865065	0.233613	20.69338

The impulse response function analysis results of the VECM are presented in Figure 2. The scale of the x-axis is the set reaction period (in quarters). These graphs present some interesting relationships. In general, food prices respond positively to changes in the variables under study except with GDP. In the response of food CPI to itself, it can be noted that food prices increase in the first two quarters, and then reduce till quarter 4, after which they level off. In response to changes in the exchange rate, food prices increase till quarter 4, after which they begin to decrease. In response to changes in food exports, food prices increase till quarter 3, after which they stabilize. The relationship of food prices with GDP is generally negative, with slight increases up to quarter 2 after which food prices decrease with GDP growth. The graph of food CPI's response to GDP further proves why the relationship between GDP and food CPI was negative in the long run and positive in the short run as presented in Table 5. and 6. In response to the money supply, food prices keep increasing as the money supply increases.

Figure 2: Impulse response analysis



5. Conclusion

This study utilizes the Johansen cointegration analysis and VEC model to examine the short- and long-run effects of macroeconomic indicators such as exchange rate, GDP, money supply, and food exports on Uganda's food price movements using quarterly data from 2000Q1 to 2022Q1. The results show that all variables are statistically significant in influencing food prices in Uganda in the long run. Apart from GDP which negatively influences food prices, all the other variables positively influence food prices in the long run. Specifically, a 1% increase in exchange rates, food exports, and money supply leads to a 0.263%, 0.701%, and 0.72% increase in food prices, respectively, while a 1% growth in GDP leads to a 1.956% decrease in food prices.

In the short run, it was found that only GDP and the lag of food CPI were significant in influencing food prices in Uganda. The results show that a 1% increase in food prices in the previous quarter leads to a 0.352% increase in food prices in the current quarter. While a 1% increase in GDP in the previous quarter and 3 quarters back leads to a 0.21% and 0.143% increase in food prices in the current quarter, respectively. It can be noted that unlike in the long run where GDP affects food prices negatively, GDP positively influences food prices in the short run. This relationship is further supported by the impulse response function analysis. There is one possible explanation for this: In the short run, growth in the economy induces more consumption (demand) of food items especially animal proteins which eventually leads to an increase in the general price level of food items. In the long run, however, growth in the economy could imply growth in the agricultural sector as well because a significant share of Uganda's GDP (24%) is contributed by the agricultural sector. The growth in the agricultural sector as manifested in increased production could imply that enough food is produced to meet the short-run increase in demand, eventually leading to a decrease in food prices in the long run.

The variance decomposition analysis shows that the forecast error variance of food CPI in Uganda can be greatly explained by variations in the food CPI itself than all the macroeconomic indicators used in this study. This together with the very low R-squared value could imply that food prices in Uganda are greatly influenced by factors other than macroeconomic indicators in the short run. These factors include low food supplies to markets due to extreme changes in the weather pattern that has led to long dry spells in some regions of the country and floods in other regions, price transmission effects of rising food and fuel prices in the international markets which affect production and transportation costs of food items, increased domestic food demand, and higher costs of imported production inputs. Therefore, for policy implementation, the emphasis laid on macroeconomic indicators should as well be laid on these factors to draft policies aimed at stabilizing food prices in Uganda.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this paper.

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