Long-run Dynamics of Maize Price Volatility in Sub-Saharan Africa: Evidence from the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) Model

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Introduction

- Food expenses represent a substantial portion of the budget for low-income families in sub-Saharan Africa (SSA) (Muhammad et al., 2011).
- Prices of food security commodities e.g., maize and wheat prices worldwide have more than doubled, while rice prices have tripled (Assefa et al., 2015).
- Food price fluctuations have a direct impact on households' food security and child malnutrition (Baffes & Gardner, 2003; Nigatu et al., 2020).

Objectives of the study

This study aims:

- To understand the volatile nature of maize prices in five SSA countries before COVID-19 (2013-2018) and during COVID-19 (2019 – 2023).
- To examine the factors influencing domestic maize price volatility within the SSA region.

Five SSA countries: Burkina Faso, Burundi, Congo Dem. Rep., Gambia, and Nigeria

Why focus on maize?

- Characterized by the highest price instability.
- Serves as a major food security crop that is widely grown and consumed.
- Significantly contributes to the overall food supply in SSA.

Data type and source

- Monthly data sourced from the World Bank, World Development, and FAO statistical databases.

Variable Name	Abbreviation	Unit of measurement
Dependent Variable		
Domestic Maize Prices	DMP	USD/100kg
Independent variables		
World Maize Prices	WMP	USD/100kg
Domestic maize supply	DMS	ton
Exchange Rates	ER	LCU/USD
Crude Oil Prices	COP	USD/barrel
Fertilizer Prices	FR	USD/metric ton
Lending Rates	LR	%
GDP per capita	GDPc	USD

Data Analysis Technique

Objectives	Data analysis tool and model specifications
1. Understand the volatile nature of maize prices	Generalized Autoregressive Conditional Heteroscedasticity (GARCH) a. Conditional mean equation: $\triangle X_t = \beta_0 + \beta_1 \triangle X_{t-1} + u_t$ b. Conditional variance equation: $\sigma_t^2 = \lambda + \alpha_1 \Sigma \varepsilon_{t-1}^2 + \alpha_2 \sigma_{t-1}^2$
2. Investigate the factors influencing domestic maize price volatility	Engel-Granger (1982) two-stage procedure: (i) Cointegration test (ii) Error Correction Model (ECM)

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Results - Descriptives

Table 1. Coefficient of Variation (CV) for Maize Price in SSA

Country	Before COVID	During COVID	% change
DRC	16.08%	34.96%	**18.88%**
Burkina Faso	12.50%	25.80%	**13.30%**
Gambia	14.05%	19.69%	**5.64%**
Nigeria	23.89%	28.11%	**4.22%**
Burundi	31.83%	24.87%	**-6.96%**

Maize prices become more unstable as the CV value increases.

Results – Objective 1

Table 2. Measurement of Maize Price Volatility Across SSA

Country	ARCH (α_1)	GARCH (α_2)	Persistence of Volatility ($\alpha_1 + \alpha_2$)
DRC	1.202***	0.030*	1.232
Nigeria	0.589**	0.348**	0.937
Gambia	0.638**	0.228**	0.867
Burkina Faso	0.383**	0.375*	0.758
Burundi	0.503**	0.107*	0.611

*p <0.01, **p <0.05, ***p <0.01.

A higher persistence of volatility score indicates a higher price instability

Results – Objective 2

Table 3. Cointegration Analysis (Long Run Model)

Country	DRC	Nigeria	Gambia	Burkina Faso	Burundi
WMP	ns	0.714***	ns	0.324**	ns
GDPc	0.007***	0.059***	ns	0.033**	0.481***
DMS	-4.804***	-4.084***	-2.727***	ns	-3.996**
COP	0.116***	0.179***	0.237**	0.076**	0.235**
LR	1.728***	1.149*	ns	ns	ns
FR	0.224***	0.064**	ns	ns	0.219**
ER	4.519***	4.398***	ns	-4.430***	5.374***

*p <0.01, **p <0.05, ***p <0.01, ns = not significant

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Results – Objective 2

Table 4. Error Correction Model (ECM) (Short run model)

Country	DRC	Nigeria	Gambia	Burkina Faso	Burundi
ECM_{t-1}	-0.348***	-0.255***	-0.166***	-0.113**	-0.116**

*p <0.01, **p <0.05, ***p <0.01

- Deviations from long-run maize price in the subsequent month could be corrected by an increase in maize price by 25.5% in Nigeria; 16.6% in the Gambia; 34.8% in DRC; 11.3% in Burundi; and 11.6% in Burkina Faso

Discussion and Conclusion

- Different factors had varied impacts on maize price volatility across SSA in the long and short run.
- Crude oil prices, GDP per capita, global market maize price, lending rates, and fertilizer prices positively increased domestic maize prices in most SSA countries.
- Exchange rate had 2 impacts - appreciation of the U.S. dollar relative to the local currencies:
  - Increased maize prices in Gambia, Nigeria, Burundi, and DRC – High import dependence
  - Negatively influenced maize prices in Burkina Faso – High domestic supply

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Policy recommendations

- Stabilizing input prices (e.g., crude oil, fertilizer, and maize seeds) via price control mechanisms.
- Targeting specific fiscal and monetary policies aimed at inducing local currency appreciation relative to the U.S. dollar; and improving lending rates for maize producers.
- Increasing domestic maize supply by providing incentives/subsidies to reduce import dependence.

Study limitation

- Model estimations could be constrained by limited SSA countries based on data availability.

- Study findings may not conclusively indicate causal relationships. Hence should approach the interpretation with caution, distinguishing between complete causal inferences and directional correlations and associations.

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