

Effects of COVID-19 on Staple Food Prices in Eswatini

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Abstract

This study examined the impact of COVID-19 on staple food prices in Eswatini using monthly data (2014–2022) from FAOSTAT and COVID-19 data from Our World in Data. Stationarity was tested with the Augmented Dickey–Fuller test, and the Auto-Regressive Distributed Lag and Error Correction models were applied. Four main staple food items in Eswatini were analyzed, namely, maize meal, rice, brown bread, and white bread. The findings show that the stringency index reduced white bread prices, while COVID-19 severity increased them in the short run. In the long run, none of the explanatory variables were statistically significant, and the prices of maize meal, rice, and brown bread showed no short- or long-run relationship with the COVID-19 variables. Based on the white bread results, it is recommended that the Eswatini government work closely with local producers and retailers to design measures that manage public health risks without causing major market disruptions.

Keywords: COVID-19, Food Prices, Stringency Index, Eswatini

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1.0 Introduction

Assessing the impact of COVID-19 on the prices of essential food items in developing and emerging economies has been a matter of great concern. The intense and prolonged shocks of COVID-19 that countries are experiencing have not been seen since the Great Depression. Eswatini's first confirmed case was noted in March 2020. (Ministry of Health [WHO], 2022). On March 14, 2020, the Minister of Health formally announced the confirmed infection. This date is considered in this study to be the outbreak time. After Eswatini

instituted rigorous 14-day quarantine measures, including a partial shutdown of the whole nation starting on March 27, 2020, and a prohibition on commercial flight travel, the severity of COVID-19 became widely known. The outbreak of COVID-19 spread across the country and had distinct effects on the economy of Eswatini. Moreover, the degree of agitation of the equilibrium for each country varies due to each country's diverse macroeconomic conditions, economic structures, and institutions. For instance, in Eswatini, regardless of the forces of demand

and supply, the government of Eswatini holds the power to effect or maintain price changes. Generally, prices change depending on whether a food item is a necessity or a luxury, whether it is imported or made locally, and whether it is highly perishable or can be kept for a long time.

Bairagi et al., (2022) noted a differential effect of COVID-19 on prices of storable and perishable food commodities in a developing country like India. The authors noted that storable commodities such as *atta* (wheat flour) and rice increased significantly in price (3% and 16%, respectively) during the pandemic, whereas a perishable commodity such as onions experienced a significant decline in price (-61%). The author further concluded that the availability, storability, and crop cycle determine the effects of a shock on a commodity. The severity of the COVID-19 outbreak has had distinct effects in China's Shandong, Beijing, and Hubei Provinces; it had no significant influence on rice and wheat flour prices but a positive influence on cabbage and pork prices (Yu Liu et al., 2020). Hamulczuk & Skrzypczyk (2021) established that the agri-food trade balance determines domestic price variations. The study found that there was a negative and statistically significant link between export-import ratios before COVID-19 and price changes in the second and third quarters of 2020. The global supply chain disruption was likely exacerbated by movement restrictions caused by the COVID-19 pandemic. The above studies shed some light on the impact of COVID-19 on food commodities in large economies like India and China. However, this study addressed the impact of COVID-19 on retail prices of essential food items such as maize meal, rice, white bread and brown bread at the consumer or household level in a smaller economy.

It is worth noting that Eswatini households consume products of cereals such as maize meal, rice, brown bread and white bread in some form or another. Importantly, Eswatini is a net importer of essential cereals; therefore, the country is susceptible to imported inflation. To put this in perspective, from 2014 to 2018, the local production of maize decreased from 119000 tonnes (FAOSTAT, 2022) to 110300 tonnes (FAOSTAT, 2022). The importation of maize, on the other hand, steadily increased from 90,970 tonnes in 2014 to 123,187 tonnes in 2016 (FAOSTAT, 2022). In terms of international trade, Eswatini is a net importer of maize meal, rice and wheat. Food prices in Eswatini increased significantly during the COVID-19 pandemic (Table 1). Eswatini is a net importer of essential cereals; therefore, the country is susceptible to imported inflation and supply chain disruption.

This is evident as manufacturing facilities around the world were negatively impacted by factory closures, which caused delays, shortages of raw materials, higher costs, and decreased orders (PWC, 2020). As a result, aggregate demand, supply, and prices were manipulated. The price increases diminish consumers' purchasing power, thereby aggravating food insecurity. In 2020, Eswatini's Vulnerability Assessment Committee (EVAC) reported that food insecurity remained high (EVAC, 2020). It is hypothesized that the COVID-19 pandemic led to the hoarding of storable goods, which was influenced by consumers' psychological factors of panic buying and the rent-seeking behaviour of processors or wholesalers.

All the above-mentioned hypotheses appear to be plausible. However, it may be impractical and burdensome to address all of them in certain circumstances. Following such

inquiries, this study examined the impact of the COVID-19 outbreak, its severity, and the restrictive measures on the prices of four essential food items (maize meal, rice, brown bread, and white bread) consumed by households in Eswatini. The essence is to inform fact-based food security policies and recovery strategies.

2. Literature Review

2.1 Theoretical Framework

Gossen's second law of consumption describes consumer equilibrium as the proportionality between the vector of prices and the consumer's marginal utilities (Barten & Bettendorf, 1989). The consumer's marginal utilities are functions of the quantities of commodities (Moschini & Vissa, 1992), implying that prices are functions of quantities. Barten & Bettendorf (1989) refer to it as the consumer demand system. Inverse functions provide an alternative and dual representation of preferences to the standard analysis of consumer demand (Moschini & Vissa, 1992). Barten & Bettendorf (1989) revealed that in most developed economies, the consumer is both a price taker and a quantity adjuster for most of the products and services regularly purchased. Moreover, a regular demand system is then indicated for highly perishable commodities like fresh vegetables or fresh fish that have a supply that is very inelastic in the short run. In such markets, producers are virtually price takers. The price is taken; producers and consumers are connected by traders who select a price that they expect will clear the market (Barten & Bettendorf, 1989).

In this function, the price must adjust to clear the market and it is more suitable when quantities are exogenously assumed (Moschini & Vissa, 1992). The outbreak of COVID19 was purely an exogenous event. According to Yu et al. (2020), this could shock both the mean and variance of prices. In addition, after the outbreak of COVID19 in Eswatini in March 2020, there were three effects. Firstly, the outbreak itself could cause significant social, economic, and psychological shocks. The pandemic spread over several countries or continents, affecting many people and the government enforced restrictions to ease the spread of the disease.

2.2 Empirical Framework

Yu et al. (2020) examined the impact of COVID19 on food prices in China using a GARCH method. The study used time series data from January 1, 2019, to April 8, 2020. The results showed that the COVID 19 outbreak severity has distinct effects, with the study insinuating that it had no significant influence on rice and wheat flour prices but a positive effect on cabbage and pork prices and a negative effect on pig and cabbage prices. Cariappa et al. (2022) investigated COVID19's effects on agricultural commodity prices and customer behavior in India from November 1, 2019, to August 10, 2020. The Additive outlier (AO) model was used to examine if COVID19 produced a structural break in food prices' long-term trend. ITSA was used to analyze the effects of COVID19 induced lockout on agricultural prices. The results show that COVID19 had a positive effect on the prices of food commodities.

Hillen (2021) investigated online food pricing during COVID19 by employing the Wilcoxon rank sum and logit models, additive outlier (AO) and ITSA model in the analysis. The

study used time series data that spanned from December 2, 2019 to March 18, 2021. The results revealed a declining trend that continued after the lockdown. All product categories, except produce, saw major sales declines. During the lockout, fresh fruit and vegetable discounts rose from 17.82% to 20.10%. Compared to pre-COVID19 with lockdown prices, the following categories experienced price increases Breads & Bakery, Deli & Prepared Foods, and Breakfast Foods. Conversely, meat and seafood, beverages, produce, frozen foods, soya oil, palm oil, potatoes, and tomatoes saw considerable price drops during the lockdown.

Pambudy et al. (2021) conducted a study to examine animal product prices in modern grocery shops in Indonesia during the COVID19 epidemic by employing 3SLS model estimates. The study used annual data from Jan. 2020 to Dec. 2020. The results revealed that Eggs and chicken had positive regression coefficients. The positive regression coefficient indicates merchants changed pricing differentials in a similar way as before. Using a 20% significance criterion and a one-way test, it indicates that the chicken market price spread affects the egg market price spread. Similarly, beef's price spread affects chickens.

3. Materials and Methods

3.1 Study Area

The research was conducted in Eswatini, a landlocked nation in Southern Africa bordered by South Africa and Mozambique. It has a total land area of 17,364 km². Eswatini has a population of over 1,093,240,000 individuals (Population and Housing Census, 2017). Poverty levels have remained high over the past five years (World Bank, 2022), with an estimated 58.9 percent of the population living below the poverty threshold of 975.30 SZL per

month (EHIES, 2016/2017). The unemployment rate has increased from 23,1 percent in 2013 to 33,3 percent in 2021, from a previous rate of 23,1 percent in 2013. Eswatini's government is an absolute monarchy. According to the constitution, the government is democratic, participatory, and tinkhundla based. To ensure stability of the currency, the lilangeni is pegged to the rand, as Eswatini is a member of the Common Monetary Area (CMA).

3.2 Data

The data used to carry out the study were monthly time series data spanning from January 2014 to April 2022. In order to achieve the study objectives, the following variables were used: food prices per kilogram in Emalangeneni for the foods maize meal, rice, white bread and brown bread, daily new COVID19 infections as a proxy of the severity of the disease; a COVID19 dummy variable demarcating two time periods: (1) the pre COVID19 period (Jan 2014 to Feb 2020) (2) COVID19 period (March 2020 to April 2022) and the strictness of the government enforced restrictions as a proxy of the stringency index. Data on food prices were sourced from FAOSTAT, while data for COVID19 were daily data that sourced from Our World in Data and aggregated to monthly totals. The stringency index is computed by using Simple Average method. The index is determined by taking the average of the eleven measures, which range in value from 0 to 100 on any given day. A stricter approach is indicated by a higher score (100 is the strictest response). The Simple Average method involves averaging non-vaccinated and vaccinated indices. This is described in equation 1 (Phillips, 2022):

$$\text{Simple Average index} = (\text{index}_v + \text{index}_{nv})/2 \quad (1)$$

Where v is the index for the vaccinated, and nv is the index score for the none vaccinated. This approach was chosen because in April 26, 2022 Eswatini had only disbursed 535 393 doses of vaccines (Mathieu et al., 2022), implying that during the period under study Eswatini had large aggregates of both vaccinated and none vaccinated citizens.

3.3 Model Specification

To empirically investigate the long and short-run effect of COVID19 restrictions on food Prices in Eswatini. It is hypothesized in this study that the prices per kilogram of rice, maize meal, brown bread and white bread distinctively are a function of the severity of COVID19 cases, the level of strictness of the government restrictions and a dummy variable that accounts for any other restrictions that are not included in the stringency index. The study adopted and modified the inverse demand function analysis model used by Yu et al. (2014) and Carriapa et al. (2022) in their studies. The general functional models for the study are specified as follows:

$$\text{LogPMZ} = f(\text{LogPMZ}_{t-i}, \text{COV1}, \text{LogCOV2}, \text{LogSTRIND}) \dots\dots\dots (2)$$

$$\text{LogPRIC} = f(\text{LogPRIC}_{t-i}, \text{COV1}, \text{LogCOV2}, \text{LogSTRIND}) \dots\dots\dots (3)$$

$$\text{LogPBRB} = f(\text{LogPBRB}_{t-i}, \text{COV1}, \text{LogCOV2}, \text{LogSTRIND}) \dots\dots\dots (4)$$

$$\text{LogPBRW} = f(\text{LogPBRW}_{t-i}, \text{COV1}, \text{LogCOV2}, \text{LogSTRIND}) \dots\dots\dots (5)$$

Where;

LogPMZ = the logarithm of the Price per kilogram of maize meal

LogPRIC = the logarithm of the Price per kilogram of rice

LogPBRB = the logarithm of the Price per kilogram of brown bread

LogPBRW = the logarithm of the Price per kilogram of white bread

COV1 = the dummy variable demarcating two periods 1=before COVID19 and 2=within COVID19

LogCOV2 = the logarithm of the monthly total of daily new COVID19 infections as a proxy of the severity of COVID19

LogSTRIND = the logarithm of the stringency index as a proxy of the strictness of the governments enforced restrictions

The following procedures were done before actually examining the effects. The first step was to determine the stability of the variables by preliminary testing for stationarity. Data that is not stationary may yield spurious regression results, a high R^2 and low Dublin Watson statistics (Gujarati, 2004). An Augmented Dickey-Fuller (ADF) test was adopted to test for the unit root problem. The next step encompasses the selection of the optimal lag length among the variables in the system by using different lag length criteria, such as the Akaike information criterion (AIC) over the Schwartz Bayesian Information Criterion (BIC), which has a risk of under-fitting the model (Giles, 2015) before conducting the ARDL Bounds cointegration long-run test. Then a test on the Error Correction Model (ECM) was conducted to check for the short run relationships or dynamics between variables as specified in the equations below. Following the theory of an inverse demand function, the models are empirically stated as:

$$\text{logPBRW} = \alpha + \delta_1 \text{logPMZ}_{t-1} + \delta_2 \text{COV1} + \delta_3 \text{logCOV2} + \delta_4 \text{logSTRIND} \dots (6)$$

$$\log\text{PMZ} = \alpha + \delta_1 \log\text{PMZ}_{t-1} + \delta_2 \text{COV1} + \delta_3 \log\text{COV2} + \delta_4 \log\text{STRIND} \dots (7)$$

$$\log\text{PRIC} = \alpha + \delta_1 \log\text{PMZ}_{t-1} + \delta_2 \text{COV1} + \delta_3 \log\text{COV2} + \delta_4 \log\text{STRIND} \dots (8)$$

$$\log\text{PBRB} = \alpha + \delta_1 \log\text{PMZ}_{t-1} + \delta_2 \text{COV1} + \delta_3 \log\text{COV2} + \delta_4 \log\text{STRIND} \dots (9)$$

Where $\alpha, \delta_1, \delta_2, \delta_3, \delta_4$ are the coefficients to be estimated in the equation. For simplicity the models are then named according to the price they represent;

LogBREADW represents Model 6

LogMAIZEM represent Model 7

LogRICE represents Model 8

LogBREADB represents Model 9

The study further conducted some diagnostic tests in order to confirm the validity and robustness of the regression model. The tests that were performed includes the Breush-godfrey test for serial correlation, the Breush-Pagan Test for heteroscedasticity and the Jarque-Bera normality test.

4. Results and Discussion

4.1 Descriptive Statistics

The first step was to statistically examine if there was indeed a change in prices during the absence and presence of COVID19. This entailed determining if the increases in average prices before and during the pandemic are statistically different. To test this hypothesis a t-test was adopted. The results of the R-Welch Two Sample t-test for the two samples, one before COVID19 and the other during the COVID19 era, are reported in Table 1. The p-value statistics for maize meal, rice, white bread, and brown bread prices per kilogram in Emalangeni are statistically significant, implying that the null hypothesis of no difference between the two means is rejected and the alternative hypothesis, which states that the average price per kilogram in Emalangeni for each food commodity is higher in the presence of COVID19 is accepted. These findings justify the price per kilogram percentage increases in Figure 1.

Table 1: Differences in food prices before and during COVID19 in Eswatini

Variable	t-value	DF	p-value	Average price (COVID19)	Average price (before COVID19)	Confidence Interval -95%
Maize meal	6.6745	95.835	8.032e-1	10.39	9.14	935376 Infinite
Rice	9.9438	77.247	8.949e-1	14.17	11.89	892553 Infinite
Brown Bread	12.158	70.265	2.2e-16	12.56	10.78	543241 Infinite
White Bread	12.169	60.663	2.2e-16	13.94	11.90	756279 Infinite

Source: Author's Computation, 2022

Figure 1 illustrates the prices per kilogram in Emalangeni of four basic foods (maize meal, rice, white bread, and brown bread) before and

during the COVID19 era. The prices per kilogram in Emalangeni of maize meal, rice, brown bread, and white bread increased by

approximately 13.8%, 19.3%, 16.7%, and 16.7%, respectively from the period before COVID19. It can be hypothesized that because Eswatini is a net importer of cereals (FAO, European Union & CIRAD, 20220),

hypothetically the price increases may be caused by supply chain disruptions (EVAC, 2021) and the ZAR/USD

exchange rate depreciation.

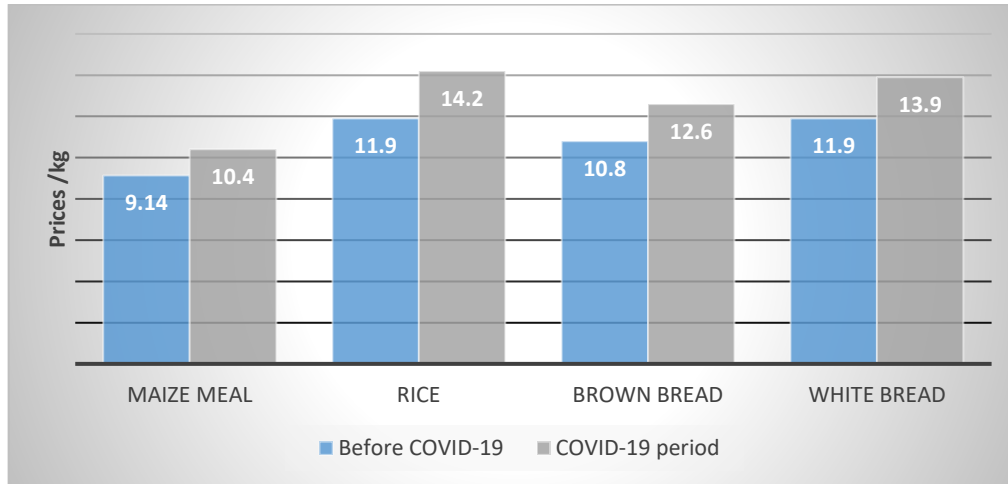


Figure 1. Differences in Food Prices before and during COVID19 in Eswatini.

Source: Authors' computation from FAOSTAT/CSO data in Eswatini

4.2 Trends and Seasonal Variations in Food Prices

4.2.1 Trends in Food Prices

Considering prices as one of the indicators of food insecurity, the trend of the four major food prices such as maize meal, rice, brown bread and white bread are presented below. Trends in the average price per kilogram of food indicated the most serious increases in the years 2016 and 2020 (see Figure 2). It should be noted that those years were the drought periods (2016) and the outbreak time for COVID19 (2020). It should be highlighted that the majority of rice sold in Eswatini comes

from India, Thailand, and Pakistan (WFP, 2016), countries that were mostly untouched by the El Nino drought that severely devastated Southern Africa during this time. Since rice is a close substitute for maize meal, the price per kilogram of rice increased during this time due to the increase in demand for rice, which was substantially less expensive than maize meal in Eswatini (WFP, 2016). The big picture arising from the above trend indicated that price increases in Eswatini are caused by renowned on shocks and price changes of close substitutes. The trends in the yield of the four crops and the overall cereal production during the years 2008-2015 have shown relatively appreciable improvements.

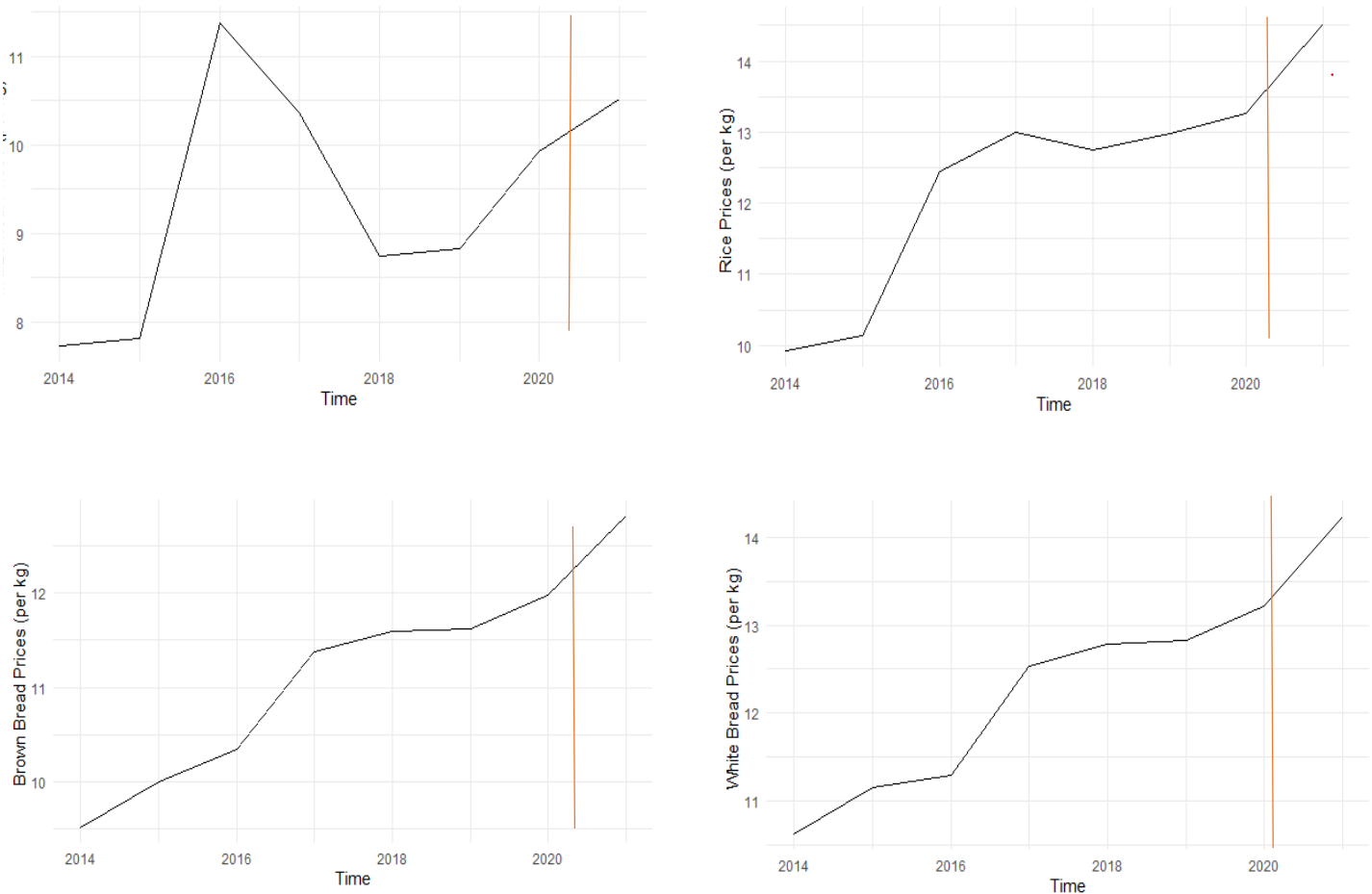


Figure 2. Food Price Trends from 2014 to 2022 in Eswatini
Source: Author's Computation, 2022

4.3 Empirical Analysis

Each of the variables that would be included in the model had to go through a preliminary unit root test in order to prevent spurious regression because the research's objectives necessitated the usage of time series data. The

results of the ADF unit root test used in this investigation are displayed in Table 2. Table 2 demonstrates that all other variables are stable at their first differences $I(1)$ and the COVID19 severity (LogCOV2) variable is stationary at levels $I(0)$.

Table 2: Results of Augmented Dickey-Fuller test at Initial and First Differencing

Variables	No Trend		Trend				Order (d)		
	Level	1 st Difference	Level	1 st Difference	Level	1 st Difference			
	t-stat	p-value	t-stat	p-value	t-stat	p-value	t-stat	p-value	
LogPMZ	0.183	0.856	-6.710	1.4e-09	-2.361	0.020	-6.68	1.7e-09	I (1)
LogPRIC	1.334	0.185	-8.949	2.9e-14	-2.423	0.020	-9.16	1.2e-14	I (1)
LogPBRB	2.418	0.017	-9.028	1.1e-14	-2.826	0.058	-9.82	4.8e-16	I (1)
LogPBRW	2.533	0.013	-5.462	3.8e-07	-2.248	0.027	-6.09	2.6e-08	I (1)
LogCOV2	-5.718	1.2e-07	-	-	-7.204	1.4e-10	-	-	I (0)
LogSTRIN	-1.846	0.068	-6.390	6.1e-09	-2.830	0.006	-6.39	6.1e-09	I (1)

Source: Author's Computation

Based on the outcome of the ADF, an Auto Regressive Distributed Lag Model (and Error Correction model were used to analyze the effects of COVID19 and the restriction policies on the selected food prices per kilogram in Emalangeni, namely maize meal, rice, brown bread and white bread. The test statistics for the

cointegration test were based on the ARDL lag structures in Table 3 that were selected based on the Akaike Information Criterion (AIC) over the Schwartz Bayesian Information Criterion and the Hannan Quinn Information Criterion because it eliminates the risk of underfitting the model (Giles, 2015)

Table 3: Lag Length Selection

Model	LogLik	AIC	BIC	HQ	Adj. R ²	Specification
LogMAIZEM	179.656	-3.544	-3.386	-3.479	0.922	ARDL(2, 0, 0, 0)
LogRICE	186.669	-3.687	-3.529	-3.623	0.922	ARDL(2, 0, 0, 0)
LogBREADB	239.451	-4.764	-4.606	-4.700	0.953	ARDL(2, 0, 0, 0)
Log BREADW	285.413	-5.682	-5.497	-5.607	0.981	ARDL(1, 0, 1, 1)

Source:

As stated earlier, the ARDL model is used as the basis for using the bounds test to examine cointegration. The test assumes a lower bound for I (0) and an upper bound for I (1) (Shrestha & Batta, 2018). Table 4 shows that the null hypothesis of no cointegration is accepted at 5%

significance for the F-statistics 1.873 (LogMAIZEM), 0.871 (LogRICE), and 2.001 (LogBREADB) that rank lower than the lower bound I (0). However, the findings for model 16 indicate that the computed f-statistic value (LogBREADW) exceeds the upper bound I (1), implying a

cointegration relationship exists in this equation.

Table 7: Short Run Error Correction Results for LogBREADW

Explanatory Variables	Dependent Variables (Price per kg in Emalangeni), log		
	D(LogPMZ)	D(LogPRIC)	D(LogPBRB)
D(LogPMZ(-1))	0.3425** (0.104)		
D(LogPMZ(-2))	-0.1488(0.106)		
D (LogPRIC (-1))		-0.320** (0.103)	
D (LogPRIC(-2))		-0.196*(0.103)	
D (LogPBRB (-1))			-0.471** (0.103)
D (LogPBRB (-2))			-0.177*(0.100)
D(COV1)	-0.0127(0.228)	0.091(0.207)	2.549(0.1.68)
LogCOV2	-0.004(0.032)	-0.002(0.005)	3.588(1.40)
D(LogSTRIND)	0.012(0.033)	-0.013(0.029)	-0.011(0.029)
Constant	0.002(0.004)	0.007(0.004)	0.067*(0.024)
	Adj R-squared = 0.080 F-Static = 2.659 Prob(F-Static) = 0.027	Adj R-squared = 0.060 F-Static = 2.217 Prob(F-Static) = 0.059	Adj R-squared = 0.187 F-Static = 3.455 Prob(F-Static) = 0.001103

Source: Authors Computation, 2022

It can be concluded that seasonal variations and their causes fluctuate in the presence of COVID19 owing to the shock and its several unforeseen repercussions. Perhaps, during the presence of COVID19, the causes of seasonality will deviate from agriculture production cycles to include, among other repercussions, supply chain disruptions and the depreciation of the Rand with which Emalangeni is paired.

The results from Table 8 revealed that the residuals of the model are normally distributed since the Jarque Bera tests have p-values of 0.000 which are less than 0.05; therefore the null hypothesis which states

that the residuals are not normally distributed, is thereby rejected. The Breush-Godfrey test of serial correlation results indicate a p-value of 0.811 (LogMAIZEM), 0.221 (LogRICE), 0.627 (LogBREADB) and 0.567 (LogBREADW) and the study therefore fails to reject the null hypothesis of no serial correlation. Hence, we conclude that there is no serial correlation. The Breush-Pagan test of heteroscedasticity results show a p-value of 0.166 (LogMAIZEM), 0.677 (LogRICE), 0.710 (LogBREADB) and 0.998 (LogBREADW) and the study therefore fails to reject the null hypothesis of no serial correlation.

Table 8: Diagnostic Test Results

	LogMAIZEM	LogRICE	LogBREADB	LogBREADW	Decisions
Breush-Pagan	(0.166)	(0.677)	0.710	0.998	Accept H_0
Breush-Godfrey	(0.811)	(0.221)	0.627	0.567	Accept H_0
Jarque-Bera	(0.000)	(0.000)	0.0000	0.0000	Reject H_0

Source: Author's Computation, 2022

Summary and Conclusions

The purpose of the research was to use time-series monthly data for the months of January 2014 to April 2022 to investigate the impact of the COVID19 crisis on food prices in Eswatini, to determine whether the behavior of food prices changed during the COVID19 period and quantify the effects of the government's enforced restrictions on food prices by employing the ECM and ARDL approaches. The ECM results revealed that the severity of COVID-19 has a negative effect on the price per kilogram of white bread in the short run, but none of them have a significant effect in the long run. The results from the ARDL approach revealed that none of the COVID19 variables has a significant effect on the prices per kilogram of maize meal, rice and brown bread in the short run. The partial restrictive measures implemented by the government of Eswatini have been relevant to the country's economic structure, as they only disrupted the markets for white bread and were not aggressive in other basic food markets. Another possibility is that since Eswatini is a net importer, the price variations are yet to be felt when stocks are depleted. COVID-19 has been shown to disrupt the market for white bread prices per

kilogram. For particular marketplaces, the Eswatini government should collaborate with local retailers and producers who have a better understanding of their markets to devise measures that will help stop the disease from spreading without disrupting the market as a whole.

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