Production and Sales Risks in the Manufacturing Sector: The Role of Electricity Supply, Inflation and Fuel Price Volatility

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ABSTRACT

The manufacturing sector occupies a critical position in the South African economy. However, in recent decades this sector experienced significant instability due to challenges within macroeconomic indicators. The sector's challenges include the issue of electricity distribution, growing inflation rate and commodities price instability. This study aims to assess the effects of electricity supply, inflation and fuel prices on food and beverage production and sales in the manufacturing sector. To this end, the study applied different econometric approaches such as Johansen test for cointegration, vector error correction model (VECM) and Granger causality test on a monthly time series data ranging between January 2002 and December 2019. The study findings suggested the existence of a joint long-run relationship between electricity distribution, inflation rate, fuel price and production and sales of both food and beverage within the manufacturing sector. The result also indicated that both electricity supply and inflation highly impact the production of food and beverage sales compared to the effect of petrol price. Granger causality results have shown that inflation rate can serve in predicting short term production and sales of food and beverage in the South African manufacturing sector. Given the aforementioned findings, the study suggested that to increase production and sales of food and beverage in the manufacturing sector, policymakers should reduce tax on imported fuel. This would assist in lowering petrol prices that may have a repercussion on the inflation rate. Additionally, besides the government support towards electricity production in the Eskom, more effort and resources (financial) would also be allocated to generate and improve other sources of energy such as solar, wind, gas and biogas.

Keywords: Inflation, Eskom, Electricity, Fuel price, Manufacturing, South Africa
JEL Classifications: L60, E31, L11

1. INTRODUCTION

Since the Second World War, the world experiences a significant increase in fuel prices that creates constraints in the production and sales of various products. A high price of fuel and other forms of energy impact negatively on the global economy in both developed and developing countries (Cunado and Perez de Gracia 2005). In addition, fuel remains indispensable energy whose price oscillation influences most economic sectors (Katircioglu et al., 2015). From World War II till nowadays, the fuel price experiences drastic instability especially since the 2008 financial crisis. In December 2008, the price of the Brent crude oil $40 per barrel and increased to $126 in 2012. However, this price drastically dropped to $30.5 per barrel in January 2016, risen again to $81 per barrel in 2018, and fall below $ 20 per barrel in April 2020 (Macrotrends, 2018; The Economic Times, 2020). As a fuel importer, South Africa economy is severely affected by this fuel price fluctuation were between 2017 and 2018, the fuel prices increased by more than 21 percent (SAPIA, 2018). As consequence, the country experienced a high inflation rate and low growth of below.

Despite the strong measures established by the South African Reserve Bank that include inflation targeting in 2002, the country continues to experience a growing inflation rate which negatively

impacts both consumers and producers (Khoza et al., 2016). High inflation increases the cost of production on the producers' side and causes a reduction in consumers' purchasing power (Fedderke and Liu, 2018). Nonetheless Owing to the increase of interest rate proposed by the monetary policy committee (MPC) in 2018, the South African inflation rate responded by declining from 5.09 percent to 4.06 percent. However, it was expected to rise again due to the increase in both fuel price and domestic electricity tariffs (Industrial development corporation (IDC), 2019).

Besides the role played by fuel price in the global economy, and particularly in South Africa, an uninterrupted and secured electricity supply is essential to economic activities. However, due to population growth and the rapid speed of industrialisation, electricity demand outstrips its supply. Thus, the shortage in supply and load shading (Umar and Kunda-Wamuwi, 2019). The high electricity demand has put South Africa's public electricity provider (Eskom) in a position where to reduce the imbalance between demand and supply of electricity it has touch its reserves (Khobai et al., 2017). This leads to low supply commonly known as load-shedding. As most commercial and industrial sectors such manufacturing sector are energy and electricity reliant, their activities are mostly affected by load-shedding (Adebola, 2011). Additionally, electrical energy is considered as a core input to industrial production (Isaksson, 2016).

Owing to this phenomenon of high fuel prices, high inflation, low electricity supply and their risk towards production and sales in the manufacturing sector; this paper investigates the role and magnitude of production of food and beverage and sales risks owing to fuel price, inflation rate and electricity volatilities within the South African manufacturing sector. The core objective is to indicate to which extent production and sales of manufactured food and beverage are affected by shocks in fuel price, inflation and electricity supply. Additionally, it is important to highlight that the current paper is conducted based on production and consumer theories.

2. LITERATURE REVIEW

2.1. General Review

To maximise their profit and improve their revenues, firms have to produce and sell their products. The production process includes the use of both fixed and variables input factors. Thus, the aggregate outputs and sales depend on the availability of factors of production (inputs) associated with production cost and risk management. The production theory suggests that lower cost of inputs leads to more outputs and sales, whilst the high cost of input causes a decline in output volume, increases selling and lessens the total sales (Gans et al., 2011; Sickles and Zelenyuk, 2019).

Consequently, the firm's output volume and total sales are more likely to depend on input costs, *ceteris paribus*.

The manufacturing sector deserves specific attention compared to other economic sectors as it remains one of the core drivers for the South African economy (Bhorat et al., 2018). This sector is known to have the largest economic and employment multipliers in South Africa (Department of Trade and Industry (DTI) (DTI, 2014). Several studies were established to determine the role of the manufacturing section on the South African GDP and employment. The study of Awolusi (2016) and Tsoku et al. (2017) found a significant share of the manufacturing sector towards economic growth. Additionally, the study of Muzindutsi (2014) and McCamel (2018) revealed that the manufacturing sector plays an important role in creating jobs in South Africa.

Irrespective of the contribution of the manufacturing sector towards employment and economic growth, this sector has been experiencing challenges in recent decades. Since the 2000's the South African manufacturing sector is experiencing a stagnant performance (Bhorat et al., 2016) and a large number of manufacturing companies are experiencing economic challenges. These challenges result from, among others, a low level of domestic demand, poor supply of electricity from ESKOM and import penetration that leaves the South African manufacturing sector less competitive even within the domestic markets. Due to the abovementioned constraints, the manufacturing sector accounted for a decline in its total production. Hence, by the end of 2019, the South African manufacturing sect registered 10.6 percent loss of its annual income and experienced a decline in total production (South African market insights, 2020). Table 1 displays changes in the volume of food and beverage produced between August 2019 and January 2020.

The subsequent paragraphs discussed the linkage between electricity supply, inflation, fuel price and production and sales in the manufacturing sector.

2.2. Electricity Supply and Production Nexus

The seventh UN millennium sustainable development goal is access to sustainable, affordable and reliable energy for both social and economic activities (United Nations, 2015). Although there exist varieties of energies that are useful in the modern economies, Attigah and Mayer-Tasch (2016) assert that electricity supply remains the indispensable form of energy needed within the industrial production process as it can assist in mass production and economy of scales attainment. Therefore, electrical energy is considered one of the major inputs towards industrial production and an unreliable supply of electricity disrupts and impedes the

Table 1: Volume of food and beverage manufacturing production (Base: 2015=100)

Food and beverages	Weights	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
Meat, fish, fruit, etc.	6.69	104.1	102.8	114.1	112.0	106.7	92.5
Dairy products	2.15	118.4	120.5	127.7	117.6	119.0	109.0
Grain mill products	3.37	97.6	99.0	106.1	106.9	95.3	90.9
Other food products	8.14	135.4	127.4	137.2	131.5	100.7	93.3
Beverages	6.29	107.5	107.7	120.5	146.1	137.2	94.5
Total	26.64	114.8	112.4	122.8	125.8	111.6	94.3

Statistics South Africa (StatsSA) (2020)

production process (Isaksson, 2016). The relationship between electricity supply and industrial production and sales was assessed by various researchers and their findings suggested the existence of a linear and positive relationship between electricity supply and industry's output (Abokyi et al., 2018; Akinlo, 2008; Mawejje and Mawejje, 2016; Khobai, 2013). A country's economic growth and industrial production in most developing countries are dependent on the availability and affordability of electricity. Electricity is not important only for production but also for the conservation and transportation of products (Umar and Kunda-Wamuwi, 2019). Despite the role of electricity in enhancing production and economic growth, the South African industrial sector has been undergoing severe shocks owing to the shortage of electricity supply (Fedderke, 2014) which reduced the South African industries competitiveness. This energy shortage is the major cause of the high cost of production and high price of products. The issue of electricity supply is far from being solved as Eskom issued a warning stipulation that due to high and growing electricity demand the electricity deficiency will remain a challenge until 2021 (Ateba et al., 2019). Owing to the inefficient electricity South African economy and industry lost billions and this is still to happen (Oxford, 2015).

Although the cost of electricity may have an indirect effect on some of the food manufacturing industry by passing on the cost to customers, the purchasing power of later is directly affected resulting in low demand for matured food and beverages (Deutsche Securities, 2010). Electricity is the most demanded form of energy in South Africa. The significance of the role played by electrical energy within the South Africa economy and particularly in the manufacturing sector, Figure 1 indicates that in 2017, electricity counted 83 percent of the aggregate demand for energy within the commercial and public services sector.

2.3. The Fuel Price, Manicuring Food and Beverages Nexus

Apart from electricity, fuel is another type of energy that plays a significant role in most countries economies and particular in manufacturing food and beverage. Fuel is also considered as an input during the production and selling of the manufactured food and beverages (Green and Zhang, 2013). The earlier studies evaluated the effect of fuel prices on food prices. Analysing the asymmetric impacts of oil prices on food prices, Meyer et al.

Figure 1: Energy demand in the commerce and public services sector, 2015
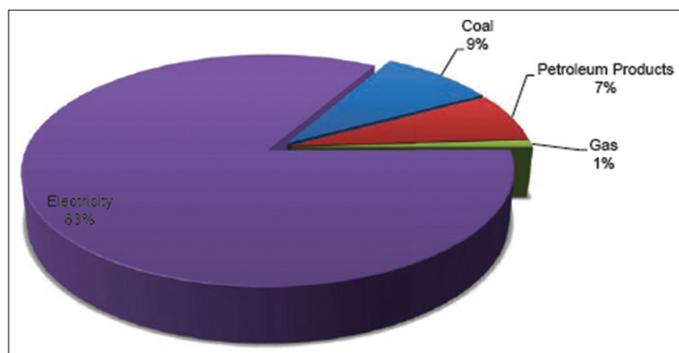
Source: DoE Energy Balances, 2017

(2018) found a linear relationship between fuel price and food price in developing countries. Following the law of demand, the high is the price of goods or services, the lower quantity demanded (Heakal, 2015). Therefore, a rise in fuel price increases the cost of production resulting in a high price for both food and beverages. The high cost of manufacturing food and beverages is expected to reduce industries production and increase the selling price. On the customer's side, a high price for goods and services implies less consumption (Ncanywa and Mgwangqa, 2018; Simionescu et al., 2017). Consequently, the manufacturing sector is seriously affected by fuel price volatility as South Africa is a net petroleum products importer (Kabini, 2019).

2.4. Production, Sales and Inflation Nexus

As highlighted in the demand theory and the previous section, the quantity of food and beverages produced and sold, depends on consumers' demand and purchasing power. The high is the consumer's purchasing power, the more quantity is demand and the high is the quantity produced and sold. However, inflation is one of the major factors that impede consumers' purchasing power (Bagus et al., 2014). An increase in the inflation rate leads to a decline in productivity and aggregate production. Different studies were conducted to analyse the impact of high inflation on manufacturing production. The study of Bans-Akutey et al. (2016) analysed the impact of inflation on the Ghanaian manufacturing sector and findings revealed that inflation growth results in low productivity levels. A similar study was done in Nigeria and the result indicated that an inverse relationship exists between manufacturing output and inflation levels (Amaefule, 2019). Contrary to these studies findings that suggested a negative relationship between manufacturing output and inflation, the study of Ojeyinka and Adegboye (2017) found a positive cointegration between inflation and manufacturing output.

In the South African context, inflation fluctuation remains a crucial issue for policymakers and the country's economy. Despite the South African Reserve Bank introduced inflation targeting introduced in 2000 to fluctuate between 3% and 6%, the reality indicated that between 2000 and 2020 inflation rate has been above 3% and closer to 6% between 2000 and 2020 as the average annual inflation in 2020 is expected to be 5.4% (Madito and Odhiambo, 2018; South African Reserve Bank [SARB], 2019). This fluctuation is expected to have a significant impact on the production and sales of food and beverage in the manufacturing sector. The magnitude of this effect is determined by the study analysis presented after the methodology section.

2.5. Production and Sales Risks in the Manufacturing Sector

The aforementioned variables are some of the various determinants of production and sales in the manufacturing sector. The overall business activities in South Africa's manufacturing sector rely on electricity supply. Shortage and/or interruption of electricity may result in low production, low sales and reduction in profitability (Trace, 2020). Additionally, long term electricity cuts may ruin some perishables goods creating losses to the industry. Fuel price shocks is another economic variable that put the manufacturing sector's production and sales at risk. Fuel is the engine of

input procurement and output distribution. The high price of transportation causes an increase in both production cost and selling price. Following, the law of demand and supply, high price leads to fewer sales resulting in low revenue and profitability of firms with the sector. The latter can also result from a high inflation rate. The lower is the purchasing power of money, the smaller is the quantity of the product demanded and sold (Chakauya et al., 2009; Gale, 1995. Therefore, shocks in electricity supply, commodities price (especially fuel) and inflation rate are the major cause of production and sales risks in the manufacturing sector.

3. DATA, MODEL SPECIFICATION AND METHODOLOGY

3.1. Data

The study is quantitative and it is built upon monthly time series data for the period starting from January 2002 to December 2019. The study variables include petrol price, consumer price index (CPI), electricity supply (Stats SA), and production and sales of food and beverages. The entirety of the data was sourced from Quantec Easy Data website. The dependent variable, production and sales of food and beverages, is measured in millions of Rand, the electricity is measured in terms of Gigawatt-hours, inflation rate (CPI) is calculated as a percentage change in the South African GDP deflator (CPI) index Dec 2016 = 100, and the petrol price is measured in terms of cents per litre. For the sake of conformity and standardisation, all variables were transformed into a natural logarithm.

3.2. Model Specification

To assess the effect of electricity supply, inflation and fuel price increase on food and beverage production and sales in the manufacturing sector, the following model was specified:

$$LSALES_t = \delta_0 + \delta_1 LCPI_t + \delta_2 LCPI_t + \delta_3 LELEC_t + \delta_4 LPETP_t + \mu_t \quad (1)$$

Where δ_0 and δ_i are the constant and coefficients respectively, L denotes the natural logarithm, t represents the time factor and μ denotes the white noise. Additionally, *LSALES* represents total production and sales, *LCPI* is inflation, *LELEC* denotes electricity supply and *LPETP* represents the petrol price.

3.3. Methodology

Generally, time-series data is characterised by a non-stationarity aspect. However, if nonstationary data is analysed, the obtained results are more often considered to be spurious. In such cases, the regression outcomes give the impression of being statistically significant, while in reality, variables are serially correlated rather than being cointegrated (Harris and Sollis, 2003:32). Any study based on spurious regression makes erroneous inferences and this can lead to inappropriate policies. Spurious regression is evaded by firstly conducting unit root and stationarity test, before cointegration analysis.

3.3.1. Unit root tests

The literature provides several procedures that are useful in testing for unit root and stationarity of time series. These procedures and approaches include Dickey-Fuller (DF) test, Augmented Dickey-Fuller (ADF) test, Kahn and Ogaki test, Leyborne-

McCabetest test, Phillips-Perron (PP) test, as well as, the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test. Owing to their simplicity and general nature, ADF and PP are the most popular unit root tests employed by empirical studies (Harris and Sollis, 2003:42). This study employed also the ADF test estimated as follows:

$$\Delta y_t = \hat{\rho} y_{t-1} + \rho_1 \Delta y_{t-1} + \rho_2 \Delta y_{t-2} + \ldots + \rho_{v-1} \Delta y_{t-v+1} + u_t \quad (2)$$

Where $\hat{\rho} = (\rho_1 + \rho_2 + \ldots \rho_v) - 1$

3.3.2. The Johansen-Juselius cointegration approach

The literature represents several approaches and procedures useful to test the presence of cointegration between two or more variables. The presence of cointegration among variables implies the existence long-run relationship among the underlined variables. In other words, the existence of, at least, one cointegrating vector in the model suggests the existence of the long-run relationship. Due to its popularity, the Johansen test for cointegration which includes both Trace and Max-Eigen statistics was selected for this study.

Using the unrestricted vector autoregression (VAR), the vector z_t is expressed as follows:

$$z_t = A_1 z_{t-1} + \ldots A_k z_{t-k} + u_t \quad (3)$$

Where z_t denotes ($n \times 1$) vector of series (variables); A_1 denotes ($n \times n$) parameters' matrix and u_t denotes the residuals or ($n \times 1$) innovations vector. Since the z_t comprises of (n) endogenous variables, each variable presented in the model is regressed firstly on its lagged values and then on other variables in the model. Under the Vector Error Correction Model (VECM) form, the VAR model is estimated as:

$$\Delta z_t = \Gamma_1 z_{t-1} + \ldots \Gamma_{k-1} \Delta z_{t-k+1} + \Pi z_{t-k} + u_t \quad (4)$$

Where $\Gamma_i = -(I - A_1 - \ldots - A_i;$ ($i = 1, \ldots k-1$) and $\Pi = -(I - A_1 - \ldots - A_k)$

According to Harris and Sollis (2003) both Γ_i and Π (in equation 4) denotes short-run and long-run adjustments towards changes in vector z_t respectively. The vector represents a matrix of long-run coefficients and it expressed as a multiplier of two ($n \times r$) vectors, (α) and (β), and these coefficients indicate the speed of adjustment towards long-run equilibrium and a long run coefficient matrix respectively. While analysing the relationship between variables г determine the number of cointegration in the model. If $\Pi = 0$, that is ($r=0$), this implies no cointegration among variables. Inversely, all variables are stationary if Π possesses a full rank, that is ($r = n$). Generally, Π represents a reduced rank. In other words, $r \leq (n-1)$ implies the existence of г cointegration vectors. In the current study, cointegration is assessed using both Maximum Eigenvalue and Trace statistics. However, the unit root tests preceded the cointegration analysis.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. Unit Root Tests

The unit root test was used to determine the integration order for the underlined variables. Table 2 represents the results from the ADF tests. All variables in Table 2 are stationary after the first

Table 2: ADF unit root results

Variables	Level		1st Difference	
	Without trend	**With trend**	**Without trend**	**With trend**
LCPI	0.9569	0.7136	0.0000**	0.0000**
LELEC	0.5904	0.7593	0.0003**	0.0001**
LPETP	0.6394	0.1614	0.0000**	0.0000**
LSALES	0.8980	0.0825	0.0032**	0.0177**

** Denotes the rejection of null hypothesis at 5 percent level

Table 3: Lag selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	656.2524	NA	2.65e-08	−6.095817	−6.03290	−6.070393
1	1869.352	2369.511	3.66e-13	−17.28366	−16.96908	−17.15654
2	1962.866	179.1630*	1.78e-13*	−18.0081*	−17.4418*	−17.77928*

*Denotes lag order selected by the criterion

difference. Therefore, the Johansen test for cointegration is a suitable model to determine the long-run relationship.

4.2. Lag Period Selection

In order to establish the accurate results from VECM, it is important to determine the optimum number of lags that should be included in the model. To this end, the study employed the Akaike Information Criterion (AIC), Schwartz Criterion (SC), Hannam-Quinn Criterion (HQC) and Final Prediction Error (FPE). As representing in Table 3, the number of lags selected for this study is 2. All lag criteria reach the same conclusion that the optimum number of lags is two periods.

4.3. Stability Test

Additional to the selection the optimum number of lags to be included in the model is determined, it is also indispensable to ensure that the study model satisfies the stability condition. The result reported in Table 4 infers that all inverse roots of characteristic polynomial remain within the unit circle. Therefore, the vector error correction (VECM) is stable.

Before VECM establishment, it is essential to perform a cointegration test to ensure that a long-run relationship exists among variables. Given that all variables are I (1), the cointegration was tested using the Johansen procedures.

4.4. Co-integration Results

Following the Johansen test for cointegration, Eigenvalue and Trace statistics were used to determine the long-run relationship among variables. The results from the test are exhibited in Table 5. Both Trace and Eigenvalue statistics reveal the presence of long-run relationships among variables and at most two cointegrating vectors. The presence of cointegration suggests, ipso facto, the specification of the vector error correction model (VECM) which is discussed further in the section after long-run relationships equilibrium.

4.5. Long-run equilibrium Relationships

Equation 5 below exhibits the long-run relationship for cointegrating vectors with their t-statistics provided in parentheses.

$$LSALES = 2.963602 + 1.648093 \ LCPI + 0.735288$$
$$[\text{T-stat}] \quad [-13.5543] \quad [4.13205] \quad [0.43259]$$
$$LELECT - 0.032261 \ LPETP \qquad (5)$$

Table 4: Roots of the characteristic polynomial

Root	Modulus
0.999853	0.999853
0.875234	0.875234
0.680516−0.146417i	0.696089
0.680516+0.146417i	0.696089
−0.356791−0.137397i	0.382332
−0.356791+0.137397i	0.382332
0.364773−0.100597i	0.378390
0.364773+0.100597i	0.378390

The individual coefficients represented in Equation 5 suggest a positive relationship between inflation, electricity supply and production and sales of food and beverages in South Africa. These results indicate that a 1 percent increased in the inflation rate would cause production and sales of food and beverages to increase approximately by 1.65 percent while a 1 percent increase in electricity supply would enhance the production and sales level by approximately 0.73 percent. In contrast, an increase of a 1 percent in the petrol price would cause production and sales of food and beverages to decline by 0.032 percent. Considering the magnitude impact of the explanatory variables on the dependent variables, it can be inferred that the consumer price index (CPI) impact more on production and sales of food and beverages compared to other underlined variables.

4.6. Vector Error Correction and Short-run Dynamics

Having established the cointegration among variables, the next step is to estimate the short-run dynamics of production and sales of food and beverages resulting from consumer price index (CPI), electricity supply, and petrol price fluctuations. These short term dynamics are presented in Table 6. Before discussing short-run results, it is important to have a close look at the error terms results. In determining whether the model is explosive or not, the rule of thumb suggests consideration of both sign and significant levels of the error correction term. The model is not explosive (adjusted towards long-run equilibrium) if the error term is negative and statistically significant. The sales equation is the only one that meets the aforementioned criteria. Meaning that the short term shocks in the model are adjusted for long-run equilibrium. Considering the short term coefficients, the electricity supply is the only variable that

possesses a significant effect on short term production and sales of food and beverages. Changes in CPI and petrol price are not statistically significant to influence short term production and sales of food and beverages.

4.7. Pairwise Granger Causality

Granger causality tests is another approach that is used to determine the short-run relationship between two or more variables. It can further be useful in predicting the behaviour of

Table 5: Johansen cointegration test results

H$_0$	H$_1$	Trace			Maximum Eigenvalue		
		Trace Statistic	t-critical value	P-value	Max-Eigen Statistic	t-critical value	P-value
r = 0	r > 0	119.0994	47.85613	0.000**	66.36082	27.58434	0.000**
r ≤ 1	r > 1	52.73854	29.79707	0.000**	34.45673	21.13162	0.000**
r ≤ 2	r > 2	18.28181	15.49471	0.018**	18.04025	14.26460	0.012**
r ≤ 3	r > 3	0.241558	3.841466	0.6231	0.241558	3.841466	0.6231

r denotes the number of cointegrating vectors under the H0 of no cointegration. **, *Suggests the rejection of the H0 of no cointegration at the 1% and 5% level of significance respectively

Table 6: Results of error correction terms and short-run dynamics

| Error Correction	D (LSALES)	D (LCPI)	D (LELECT)	D (LPETP)
ECM	−0.624696	0.018088	0.028946	−0.086428
S.E	(0.08560)	(0.00406)	(0.04400)	(0.04814)
T-start.	[−7.29753]**	[4.45262]**	[0.65789]	[−1.79539]
D (LNSALES(−1))	−0.055307	−0.012522	0.040451	0.037071
S.E	(0.07542)	(0.00358)	(0.03877)	(0.04241)
T-start.	[−0.73330]	[−3.49870]	[1.04348]	[0.87403]
D (LNSALES(−2))	−0.104377	−0.017348	−0.145839	−0.014712
S.E	(0.06660)	(0.00316)	(0.03423)	(0.03745)
T-start.	[−1.56721]	[−5.48907]**	[−4.26039]**	[−0.39283]
D (LNCPI(−1))	1.328864	0.375424	0.613904	1.146031
S.E	(1.48761)	(0.07059)	(0.76460)	(0.83655)
T-start.	[0.89329]	[5.31813]	[0.80291]	[1.36995]
D (LNCPI(−2))	2.172390	0.103461	−1.165734	−0.133883
S.E	(1.48379)	(0.07041)	(0.76264)	(0.83440)
T-start.	[1.46408]	[1.46937]	[−1.52855]	[−0.16045]
D (LNELECT(−1))	−0.524832	0.016523	−0.404227	0.116348
S.E	(0.16311)	(0.00774)	(0.08384)	(0.09172)
T-start.	[−3.21765]**	[2.13471]**	[−4.82167]**	[1.26845]
D (LNELECT(−2))	−0.115084	0.015118	0.174518	−0.023681
S.E	(0.14831)	(0.00704)	(0.07623)	(0.08340)
T-start.	[−0.77595]	[2.14797]**	[2.28935]**	[−0.28394]
D (LNPETP(−1))	0.074622	0.004783	0.163463	0.407144
S.E	(0.12679)	(0.00602)	(0.06517)	(0.07130)
T-start.	[0.58854]	[0.79495]	[2.50830]**	[5.71019]**
D (LNPETP(−2))	−0.136238	−0.015000	0.097745	−0.354116
S.E	(0.12548)	(0.00595)	(0.06449)	(0.07056)
T-start.	[−1.08575]	[−2.51911]**	[1.51559]	[−5.01851]**
Constant	−0.005494	0.002414	0.001483	0.001968
S.E	(0.00816)	(0.00039)	(0.00420)	(0.00459)
T-start.	[−0.67298]	[6.23185]**	[0.35352]	[0.42869]

**Denotes the significance of t-values at 5 percent level

Table 7: Pairwise Granger causality results

Null hypothesis	F-Statistic	Prob.	Causality direction
LCPI does not Granger Cause LSALES	26.4966	6.E-11**	Unidirectional
LSALES does not Granger Cause LCPI	1.12645	0.3261	
LELECT does not Granger Cause LSALES	2.93990	0.0551	Unidirectional
LSALES does not Granger Cause LELECT	8.12742	0.0004**	
LPETP does not Granger Cause LSALES	12.2631	9.E-06**	Unidirectional
LSALES does not Granger Cause LPETP	1.37552	0.2550	
LELECT does not Granger Cause LCPI	2.73951	0.0669	No causality
LCPI does not Granger Cause LELECT	2.71314	0.0687	
LPETP does not Granger Cause LCPI	0.81965	0.4420	Unidirectional
LCPI does not Granger Cause LPETP	7.70634	0.0006**	
LPETP does not Granger Cause LELECT	9.83252	8.E-05**	Unidirectional
LELECT does not Granger Cause LPETP	2.87747	0.0585	

**Denotes the significance of t-values at 5 percent level t-values at 5 percent level

Table 8: Results of diagnostic tests

Test	Null hypothesis	P-value	Decision
Ramsey RESET Test	The model is correctly specified		H0 Not rejected
Jarque-Bera (JB)	Residual are multivariate normal	0.1105	H0 Not rejected
LM Test	No serial correlation	0.4883	H0 Not rejected
White	No heteroscedasticity	0.3541	H0 Not rejected

Figure 2: CUsum test results
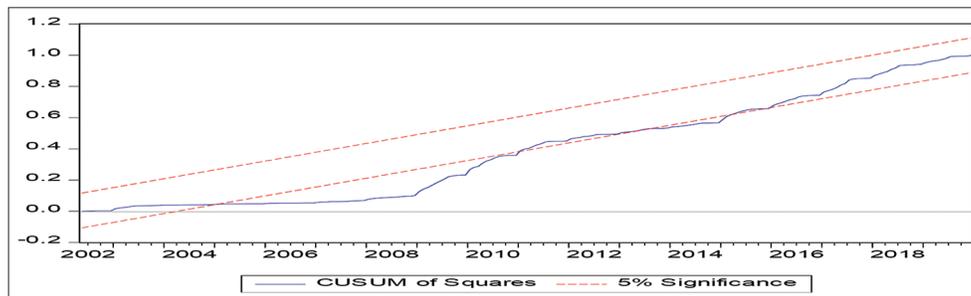
one variable (y) based on past information of another variable (x). Results in Table 7 suggest that all three explanatory variables namely LCPI, LELECT and LPETP can be used to predict the short term behaviour of production and sales of food and beverages. However, it is a one-way relationship, as the LSALES does not Ganger cause any of the independent variables. These results imply that the explanatory variables' behaviour impacts the dependent variable, not vice versa.

4.8. Results of Diagnostic Tests

Stability and residual test were conducted to assess if the employed model met the econometric assumptions. Results in Table 8 show that none of the null hypotheses is rejected. This confirms that none of the econometric assumptions was violated by the employed VECM. Additionally, the plotted CUSAM result in Figure 2 suggests that the study model is stable.

5. CONCLUSION

Production and sales of food and beverages are major factors that sustain economic growth and social wellbeing. It also contributes to manufacturing employing capacity. However, the quantity of food and beverages produced and sold in the manufacturing sector depends on some other economic factors. These factors include purchasing power which depends on inflation level, interest rates, fuel price and production and supply of electricity. This study aimed to assess the impact of electricity supply, inflation rate and fuel price increase on food and beverage production and sales in the South African manufacturing sector. Based on production theories and empirical analysis, the study employed a cointegration test, causality test and error correction model to establish the responsiveness production and sales of food and beverage towards changes in electricity supply, fuel price and inflation. The Johansen test for cointegration findings revealed that a long-run relationship exists between the underlined variables. It was found that major changes in production and sales of food and beverage are caused by the inflation rate and electricity supply. Although the fuel price negatively impacts on production and sales of food and beverages, its effect is manageable compared to the shocks caused by insufficient electricity supply and high inflation rate. The overall conclusion is that electricity supply level, fuel price and inflation rate play a major role in improving production and sales of food and beverage in the manufacturing sector.

Considering the effect of the inflation rate on the production and sales of food and beverage, the South African policymakers should create a conducive environment that strengthens the country's currency and reduces the inflation rate. This would include wage, interest rate and money supply control. Additionally, food and beverage production industries should increase their investments into other sources of energy such as wind and solar energy rather than relying on electricity supplied by Eskom.

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