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Supply response of maize in Zambia

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Abstract

The objective of this study is to analyze the supply response of maize in Zambia. The study uses the elasticities of supply to explain how farmers respond to both endogenous and exogenous factors. In this research paper, the method adopted is the Error correction model of the univariate to analyze the response of farmers. The Error correction model estimate both the short run and long run elasticities of agricultural output.

However, the model uses maize (Y_t) as the dependent variable measured per annual metric tons, maize own price (P_m) as the independent variable measured per metric tons, price of close substitute crop (P_{sb}) measured per metric tons, price of fertilizer (F_t) measured per metric tons and average annual rainfall amount (R_t) to determine how a farmer will respond when these factors change both in the short run and long run. The analysis will be done by using E-views statistical software and the data used will be macroeconomic time series -secondary data for the period of forty (40) years from 1980 to 2020.

Keywords: Exogenous; Univariate; Tones; Error Correction Model; Univariate

1. Introduction

Agriculture has conventionally played a key role in the Zambian economy through export earnings, provision of food, raw materials to industries and as a market for manufactured goods. Maize is the most important crop in Zambia, being both the major feed grain for livestock and the primary staple food crop for the majority of Zambian population. Increased attention on government pricing policies among African nations leads directly to a need for information about producer responses to price adjustments. This is especially true in the case of Zambian maize production. Immediately after independence the Zambian government embarked on the active promotion of cooperatives throughout the country and for many types of economic and social ventures. Cooperatives at that time were largely viewed as a mechanism for stimulating rural development. This view of cooperatives was further reinforced by the policies of central planning which were actively pursued in Zambia in that period. To formulate an effective price policy and food security policy in the country, the government-imposed price regulations in order to bring stability in the market price of maize.

Today's agricultural sector cannot be understood without a closer look at the policies that took place since Zambia attained its independence. For a period of twenty-seven years, Zambia adopted the socialist command of the economy which was a centrally planned economy. The adopted socialist system was based on state intervention in every sector of the economy. In the 1980s, the Zambian agricultural marketing system was organized by marketing boards, parastatals and cooperatives that had a monopoly in marketing produce and other government-supported institutions to deliver agricultural services as well as production of commodities to some extent. Government's dominance in the agricultural sector was seen through strict control of retail prices, input supply and actual production causing a cut down on private sector development. The effects in the agricultural sector where the government organized the market structures for agricultural produce can be seen in provision of inputs and disease control as well as set prices of maize

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on the market. These policy interventions were costly and economically unsustainable. In order to continue providing and promoting the agricultural sector, the Zambian government had to borrow and this resulted into unsustainable debt. (Fraser 2008, 305).

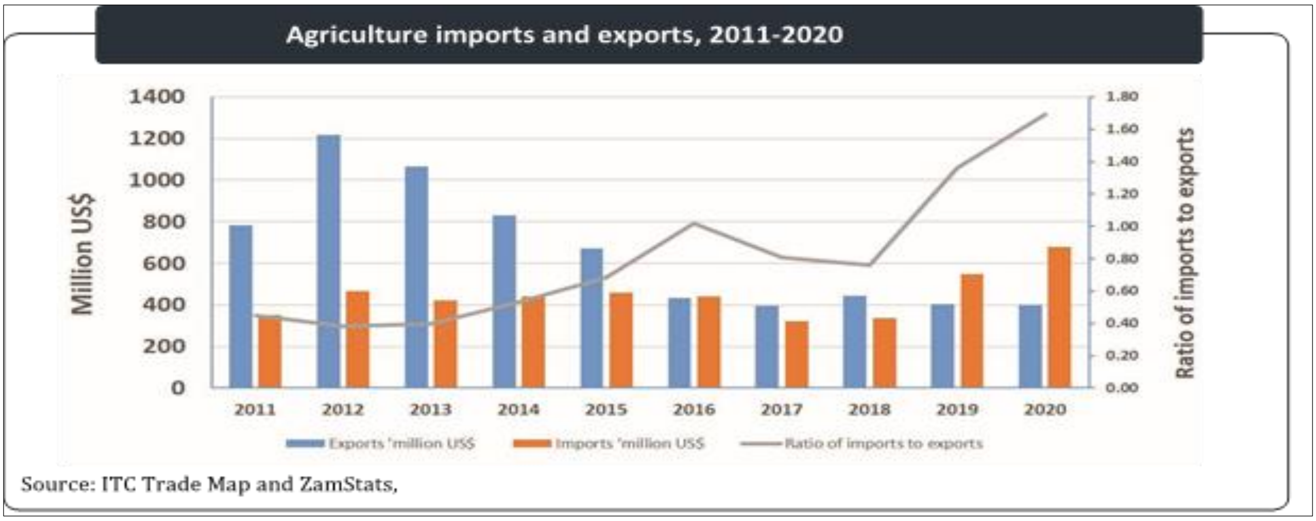

Figure 1 Agriculture imports and export 2011- 2020

However, with market liberalization in 1991, the government of Zambia stopped subsidizing production and consumption of maize because it led to the accumulation of unsustainable debt immediately causing the price of basic foods, including maize, to sharply increase. The urban population consumers resorted to rioting, a situation which resulted in food pricing policy becoming highly politicized under the new multi-party democratic system. Due to this pressure, the Movement for Multi-party Democracy (MMD), the party that formed government then, decided to revert to some government controls on the food market. As a result of the inefficiencies that occurred in the economy because of change of government, the birth of the Food Reserve Agency (FRA) was the seen in 1996. Unlike its predecessor, NAMBOARD, which was the sole buyer and seller of grain in the country, Food reserve agency (FRA) was originally conceived to hold buffer stocks to dampen price variability, when necessary, provide liquidity in the maize market during the initial years of market liberalization while the private sector was establishing itself (Jayne and Jones 1997).

The poor maize production in the past seasons has been attributed to several factors including the late delivery of agricultural inputs, crop diversification, unfavorable weather conditions and low producer Prices. (IMF ,2010). The table below shows maize production for the period of ten (10) years from 1998 to 2008.

Table 1 Maize Production in Zambia (1998-2008)

Year	ZAMBIA	Central	Copper belt	Eastern	Luapula	Lusaka	Northern	N/West ern	Southern	Western
1998	638,134	144,347	29,493	194,292	9,216	22,731	44,225	20,287	149,386	24,158
1999	822,057	100,865	64,145	284,356	21,117	32,909	62,388	23,365	200,574	32,337
2000	850,466	117,303	58,454	279,964	15,250	20,177	38,523	21,092	251,946	47,757
2001	801,889	162,272	68,080	196,317	14,998	58,127	43,496	19,196	211,281	28,120
2002	601,606	130,655	64,300	202,385	15,714	48,355	38,022	19,558	63,093	19,525
2003	1,157,860	342,856	144,458	201,521	14,860	177,865	79,881	33,114	127,277	36,028
2004	1,213,599	331,856	141,483	260,469	20,462	58,590	91,878	47,783	211,976	49,102
2005	866,187	204,230	118,737	169,315	31,883	33,061	118,017	40,814	120,518	29,612
2006	1,424,439	416,835	165,329	285,519	37,774	61,180	123,239	71,971	230,105	32,487
2007	1,366,158	405,282	130,601	225,178	32,225	84,127	138,057	70,765	238,570	41,353
2008	1,211,566	329,294	150,248	267,596	40,008	41,199	171,232	60,561	115,421	36,007

Source: TSB Northern Province (2009)

1.1. Statement of the Problem

Maize production performance in Zambia has been considerably good in the recent past due to government policy intervention and market incentive policies put in place to induce farmers to produce more maize. Though Zambia maize production fluctuated substantially in recent years due to natural calamities and poor Government policies in the agriculture sector such as low floor price of maize, late delivery of farming inputs and lack of information on the part of the farmers about the market. Zambia's crop (maize) production is largely rain dependent with a distinct production season running from November to April. Rainfall and Agro – input prices are the major determinant of the crop performance in any given year. The devastating droughts of 1991/92, 2000/01 and 2001/02 correspond to years of poor food security which manifested in a lot of donor assistance in terms of food relief. The poor maize production in the past seasons has been attributed to several factors such as late delivery of agricultural inputs, unfavourable weather conditions, lack of crop diversification, lags in technological progress and low producer prices hindered maize production at a large scale in zambia. (GRZ, 2000).

1.2. General objective of the Study

The major aim of this study is to determine the supply response of maize in Zambia which depend partly on the economic, political and environmental policies.

1.2.1. Specific objectives of the study

- The study will assess the effect of price on maize production in Zambia.
- To evaluate the impact of Agro- input prices on the maize production in Zambia.
- To determine if rainfall pattern has an effect on maize production.
- To assess how the price of substitute cash crop affect maize production in Zambia.

1.3. Theoretical Review

A neoclassical firm is an organization that controls and manages the transformation of factor inputs (the resources that it owns or purchase) in order to process them into outputs or product which it then sells as valued or finished product to different customers at prevailing market prices and earn the difference between what is sells and the cost it incurred in buying inputs. Firms are profit maximizing agents and they choose the best technology available that will maximize the difference between revenue and cost. The term technology describes the process by which inputs are converted into finished products or output. Production can be done both in short and long run. In the short run, factors of production tend to be fixed at predetermined levels and this tends to limit a farmer to produce the desired level of maize. On the other, in the long run, all the factors of production can be varied and this would result into higher production of maize in that given year. (Varian, 2010: p340).

2. Material and methods

2.1. The nature of time series data

Most macroeconomic and many financial variables are non-stationary. They drift upwards over time and often exhibit characteristics, which suggest that they have a stochastic trend in other words, a series is considered non-stationary if its mean, variance and covariance are not constant meaning they increase with time. When making use of nonstationary variables in a traditional time series model it would be prudent first to carry out stationarity test and this can be shown by the use of graph or using other statistical means. In the case of this study which uses data from 1990 to 2020 of maize production.

2.2. Conceptual framework

In economics supply is the amount of output that firms, producers are willing and able to provide to the market at a given prevailing price. There are several factors that affect supply of a good on the market and these own price, price of substitutes good, technological advancement, government policies, price of factor inputs and non-factor prices. Most agricultural produce is rain dependent and there to ensure high yield, the country need to experience good rainfall coupled with cheaper factor input prices. At higher prices farmers are willing to produce more of maize therefore, changes in own price of a good leads to a movement along the supply curve in the same direction while change in technology, price of substitutes good leads to a shift in the supply curve.

The production of maize supply model can be mathematically expressed as follows:

$$\boldsymbol{y_t = f(p_{yt}, p_{xt}, F_t, R_t)}$$

Where y_t is maize output at time (t), p_x is the price of close substitute good at time (t), F_t is the average price of fertilizer at time (t) and R_t is the annual average rainfall at time (t). Therefore, output of maize is the function of the own price, price of substitutes goods, annual average rainfall and average price of fertilizer.

2.3. Specification of the variables used in this study

- **Maize output**: Domestic maize (Y) production for the period of 1980 to 2020 is the dependent variable in this model.
- **Price of maize:** Own price of maize in this study is the independent variable. Farmers tend to be motivated if the price of maize on the market is high.
- **(c)Price of fertilizer:** Input factor price (price of fertilizer). The price of inputs tends to have a direct or indirect cost in the production process.
- **Average annual rainfall:** Rainfall which is one of the independent variables used in this study. This is the average **(e) Price of substitute crop:** Price of substitute crop soya beans. The output price of a substitute crop has an important role in farmers' decision on what to produce and how much in a particular year. annual rainfall from 1980 – 2020 in Zambia.

2.4. Hypotheses of the study

- Farmers respond positively to higher output prices.
- Farmers tend to shift their resources to the production of a profitable crop leading to a negative relationship between maize output and a close substitute crop price.
- Farmers react negatively to higher input prices.
- Favourable weather conditions (rainfall) positively affect crop production so that there is a positive correlation between rainfall and maize output.

2.5. The empirical model

Farmers, just like other producers, are rational and profit maximizes. Most studies have used the profit function to ascertain the producer's reaction to changes in prices and other exogeneous factors to derive the agricultural out supply and demand functions. In most research work, the issue of inefficiencies has not received great attention or being incorporated in the model estimation and the effect it has in formulating agricultural policies. (Abrar, 2004).

There are several estimation methods used in analysing agricultural supply response function and the most notable one is the basic Nerlove model which uses the assumption of price expectations and partial area of production, (size adjustment). The model has been extensively used in most research papers and this is because it is capable of capturing the dynamic nature of agricultural supply responses usually in less developed countries with limited technological use. In this study the method adopted is the error correction model (ECM) that captures both the short and long run dynamics of agricultural supply response. (Alemu, et al., 2003). The equation estimation in this study will take the form of the following:

$$Y_t = \emptyset_0 \; P_{M,t-1}^{\emptyset_1} \; P_{SB,t-1}^{\emptyset_2} \; F_t^{\emptyset_3} \; R_t^{\emptyset_4} \; e^{u_t}$$

2.6. Estimation method and data analysis

This section shows the methods or procedures and techniques used to analyze variables used in this research paper and how to carry out the model estimation. The first part of this section is reporting on the unit root test. The second part is reporting is reporting on the cointegration. Thirdly part its reporting on the residual generating process and finally the diagnostic and model specification test.

And the model specification is:

$$\boldsymbol{\ln Y_t = \ln \emptyset_0 + \emptyset_1 \ln P_{M,t-1} + \emptyset_2 \ln P_{SB,t-1} + \emptyset_3 \ln F_t + \emptyset_4 \ln R_t + u_t}$$

This analysis is premised on the following. When all the variables in the model are cointegrated at $I(0)$ both in levels and trend then will apply the ordinary least square method (OLS) to analyze data but when all the variables in the model are cointegrated at first level I(1) will apply the vector autoregressive model (VAR). If the variables have a combination integrated at different levels will apply the autoregressive distributed lag model (ARDL). In this study the Error correction model (ECM) will be used to analyze data upon carrying out the cointegration test.

2.7. Estimation method and data analysis

2.7.1. Unit root test

Statistically, a time series is said to be stationary when the following statistical properties are met such as the mean, variance and covariance of the distribution are constant over time. In other words, there is no trend in the time series. The non-stationarity time series can be graphically depicted as shown below.

The graph above shows that there is positive stochastic trend in the prices and rainfall. The positive trend in the prices and rainfall depict non stationarity in the variables of prices and rainfall. Statistically, the means and variances of the prices and rainfall are non-constant, meaning it increases with time period. The trend can be cyclic or random walk and if there is a shock, it would be permanent and running the regression analysis will result into spurious regression analysis and the coefficients will not make any economic sense for interpretation.

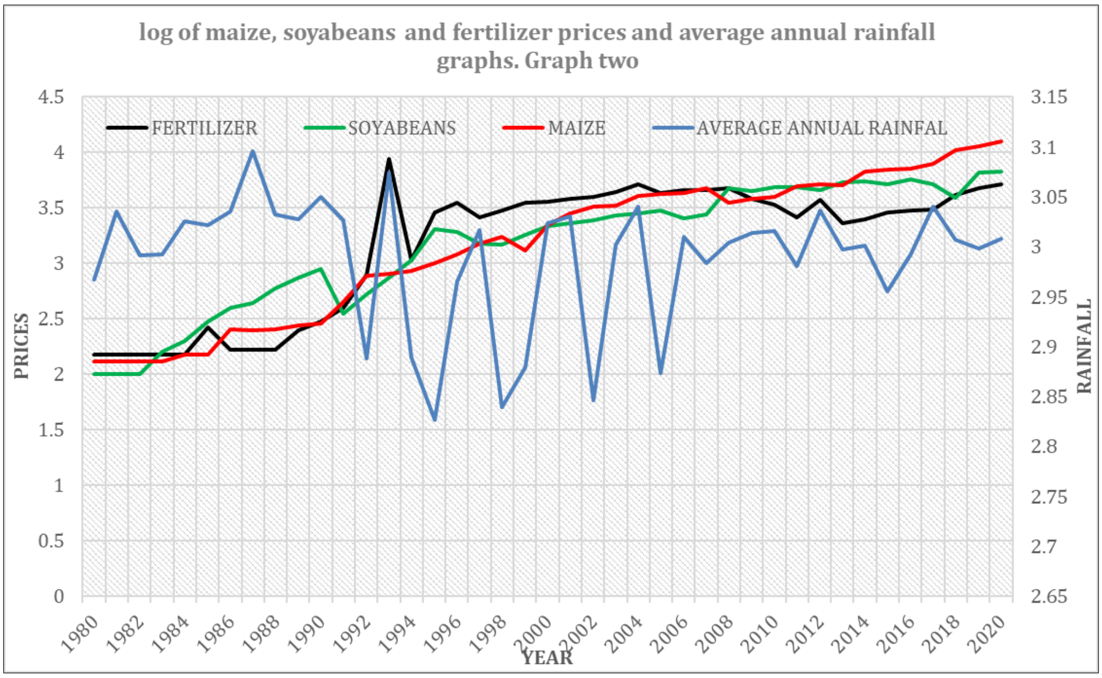

Figure 2 The log distribution of maize, soya beans, fertilizer and annual rainfall

2.8. Performing unit root test for stationarity

Elliot, Rothenberg, and stock (1996**)**, showed the process of how series are generated. Consider the Autoregressive (AR) of order one (1) as shown below:

$$Y_t = \phi Y_{t-1} + u_t \quad \text{Where } \mathbf{-1} \leq \phi \leq 1 \quad \text{............} \quad \textbf{[2.5.2.1]}$$

Where $\boldsymbol{u_t}$ is the error term or white noise error term, with mean zero and constant variance. If ($\boldsymbol{\phi}$) phi is equal to one that is $\boldsymbol{\phi = 1}$**,** Then equation **2.5.2.1** becomes a random walk without a drift and which is a non-stationary process. The equation of the random walk will be:

$$\boldsymbol{Y_t = Y_{t-1} + u_t}, \text{ Where } \phi = 1 \quad \text{..............} \quad \textbf{[2.5.2.2]}$$

$Y_t = \phi Y_{t-1} + u_t$, $\boldsymbol{Y_{t-1}}$ is subtracted from both sides as shown below:

$$Y_t - Y_{t-1} = \phi Y_{t-1} - Y_{t-1} + u_t,$$

$$\triangle Y_t = \delta Y_{t-1} + u_t \quad \text{………….. [2.5.2.3]}$$

2.8.1. Unit root test of estimated residual

If autocorrelation in the equilibrium errors is suspected, then an augmented Engle and Granger test can be used to test for stationarity in the error term generated from equation below:

$$\hat{e}_t = \rho\hat{e}_t + \phi_1(\triangle \hat{e}_t) + \cdots + \mu_t \quad \text{………………..[2.5.3.1]}$$

In order to carry out the test for stationarity or unit root in equation **[2.5.3.1]** , a transformation needs to be done, $\hat{e}_{t-1}$ has to be subtracted from both side of equation **[2.5.3.1]** and obtain the following equation:

$$\triangle \hat{e}_t = \delta\hat{e}_t + \phi_1 \sum_{i=1}^{k}(\triangle \hat{e}_{t-i}) + \mu_t \quad \text{…………….. [2.5.3.2]}$$

Where **δ**= (**ρ** – 1), k is the selected order of lags for the white noise residuals. However, equation **[2.5.3.1]** is based on the assumption that the residuals are serially uncorrelated and normally distributed.

2.8.2. Cointegration test

In economic theory, the relationship between economic variables may be described by a non-stationary trend which could reflect the general equilibrium. This long run equilibrium relationship is referred to as cointegration. The implication is that though variables may drift away from each other in the short run, they may not divert from each other in the long run. Short-term departures from this trend could be modelled with the aid of an error correction representation. As such, the concept of cointegration allows us to specify econometric models that are directly linked to economic theory. Engle and Granger (1987).

A natural first step in the analysis of cointegration is to establish that it is indeed a characteristic of the data. Two broad approaches for testing for cointegration have been developed and these are as follows:

2.9. The Engle and granger approach

This method is based on assessing whether single-equation or univariate equation estimates of the equilibrium errors appear to be stationary or nonstationary. This approach helps to determine if unit root do exist or not in each of the variables being tested. If the (variables) are not stationary in levels but are integrated of order one I (1), then they may be cointegrated. If all the variables being tested are integrated of different orders, they cannot be cointegrated.

2.10. The Johansen procedure.

Johansen (1988) established a novel method for determining the number of eigenvalues in a maximum likelihood framework. It suggests that one should order the eigenvalues such that λ (1,) λ (2,) λ 3………λ n. This test uses maximum eigenvalue and trace statistics to determine the number of cointegrating relationships. The number of relationships is equivalent to the rank of the vector error correction model and according to Parlow (2010), if the number of ranks is zero, there is no cointegration. To calculate the estimate for the appropriate rank, the Johansen procedure uses two test statistics, which include the trace statistic and the maximum eigenvalue statistic to test the null and alternative hypothesis for cointegration. If the eigenvalue is greater than the critical value the null hypothesis is rejected and accept the alternative hypothesis that cointegration exist among the variables.

2.11. Error correction mechanism

Where a cointegrating relationship may be used to define an equilibrium relationship, the time paths of cointegrated variables are influenced by the extent of any deviation from the long run equilibrium. he deviation of a cointegrated variable from the path of equilibrium may be modelled with the aid of an error correction representation. The Johnsen test. However, after confirming that all the variables were cointegrated, Alemu, et al. (2003) stressed, that it was possible to express the model as error correction representation. The Error Correction Mechanism (ECM) was then conducted to give information on long run relationship, short run relationship and the speed of adjustment. In this study, ECM model is expressed as follows;

$$\boldsymbol{\epsilon_{t-1} = Y_{t-1} - \alpha_0 - \alpha_1 P_{Mt-2} - \alpha_2 P_{SB\,t-2} - \alpha_3 F_{t-1} - R_{t-1}} \quad \text{………… [2.6.1.1]}$$

2.11.1. Diagnostic test

Unit root test

Table 2 Time series data (1980 – 2020)

Variables	Levels ADF Test	P-value	First differences ADF Test	P-value	Integration I(d)
Log of Maize output	-0.909	0.7744	-0.728	0.0000	I (1)
Log of Average Rainfall	-1.926	0.3174	-7.332	0.0000	I (1)
Log of Price of Fertilizer	-1.507	0.5195	-9.8223	0.0000	I (1)
Log of Price of Soya beans	-1.841	0.356	-5.992	0.0000	I (1)

Source: Eviews 10 output for unit root test. I (d) refer to order of integration and P-value is probability value. Critical values for ADF 5% = -2.9411 and 10% = -2.609. All variables are in logarithm.

Table 3 Unit Root Test of Estimated Residual

	Critical Values				I(d)
Variable	ADF Statistic	1%	5%	10%	I (0)
Residual	-4.064	-2.643	-1.950	-1.611	

Source: Eviews 10, unit root test for estimated residual.

Table 4 Result of Johansen Test for Cointegration

Hypothesized No of CE(s)	Eigen Value	Trace Statistic	Critical Value 5%	Probability value P-Value
None*	0.470	46.043	47.856	0.733
At most 1	0.254	22.537	29.797	0.270
At most 2	0.235	11.675	15.495	0.173
At most 3	0.046	1.750	3.841	0.186

Source: Eviews 10,

The table above shows the result of Johansen cointegration test which used the trace statistic at 5% level. The result showed that the probability values were greater than the 5% level. Therefore, the null hypothesis of no cointegration was rejected and the trace test showed, at most, one cointegration equation. The trace statistic also showed that at 5% level were less than the critical values which meant that the null hypothesis of no cointegration was rejected.

Therefore, before presenting the relationship in Error correction model, selection of the number of lags to be included in the model was done using lag selection criteria. The number of lags was two going by the majority rule of lag length criterion rule because of its significance criteria compared to other lag numbers.

Table 5 Lag selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-97.70171	NA	0.000153	5.405353	5.620825	5.482017
1	32.71901	219.6560	6.04e-07	-0.143106	1.149726*	0.316874
2	66.72019	48.31747*	4.04e-07*	-0.616852*	1.753338	0.226444*
3	87.87813	24.49867	6.01e-07	-0.414639	3.032911	0.811973
* 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			

2.12. Wald coefficient test

Wald coefficient diagnostics test was carried out to determine whether price of maize, price of soya beans, annual rainfall and price of fertilizer affect maize production. The null hypothesis was that input factors do change maize production and the alternative hypothesis was that input factors do not change maize production. If the probability value is more than 0.05, then the null hypothesis cannot be rejected or else accept the alternative hypothesis. The table below shows the results.

Table 6 Result for wald coefficient test

Test Statistic	**Value**	**Df**	**Probability**
F-statistic	1.242250	(5, 31)	0.3135
Chi-square	6.211252	5	0.2862

From the table above, the conclusion was that the null hypothesis was not rejected because the chi-square probability value of 0.2862 is greater than 0.05 but that factor inputs in the long run do affect maize production.

2.12.1. Serial correction

A diagnostic test was carried to determine whether data contains serial correction, heteroscedasticity and was normally distributed. The table below shows the test for serial correlation and the null hypothesis was that data has no serial correlation and the alternative hypothesis was that data has serial correlation. Below was the result for serial correlation using LM diagnostic test.

Table 7 Test for serial correction result

F-statistic	0.084845	Prob. F(2,29)	0.9189
Obs*R-squared	0.221058	Prob. Chi-Square(2)	0.8954

2.12.2. Normalty test

The last test was that of normal distribution which used the Jarque-Bera test. The null hypothesis was that data was normally distributed and the alternative was that data is not normally distributed. The graph below shows the results of the test.

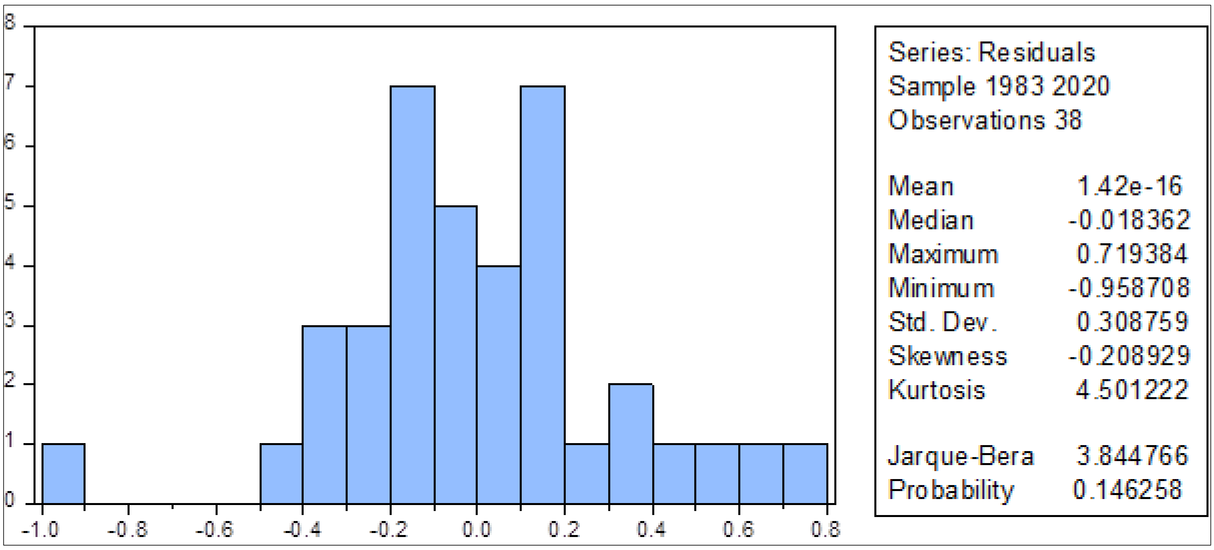

Figure 3 Result for normality test

2.13. Graph three

The above graph above shows that data was normally distributed, the probability value of Jarque-Bera test statistic is 0.14625 which is greater than 0.05. The conclusion was the failure of rejecting the null hypothesis that data was normally distributed.

2.14. Vector error correction model

The use of vector error correction model was necessitated because it captured both short run and long run dynamics of the model. The analysis was done in percentage form.

Table 8 Error Correction Estimates Equation

Independent Variables	Coefficients	P-Value
SHORT RUN		
Error correction term	-0.144098	0.0092
Log of difference in maize output	0.0386	0.8687
Log of difference in price of fertilizer	0.142598	0.2377
Log of difference in price of maize	0.174913	0.6232
Log of difference in annual rainfall	0.27226	0.6119
Log of difference in price of soya beans	-0.3163	0.2186
Constant	0.03716	0.6180
LONG RUN		
Log price of maize	- 1.1195	0.000
Log price of soya beans	- 0.8403	0.0012
Log of annual rainfall	11.3781	
Log of price of fertilizer	2.2017	
Constant	- 94.4406	

The above table shows that short run elasticities are lower and insignificant compared to long run elasticities. In the short run, price of maize, price of fertilizer, annual rainfall and annual maize output itself were all statistically insignificant while price of soya beans is statistically insignificant. In the long run, all the variables were statistically significant at 5% level of significant. In the long run, each variable's elasticity has increased in magnitude

3. Results and discussion

3.1. Maize price

The maize price in the short run is insignificant. The variable's sign is positive in short run and negative in long run. The maize price is insignificant in the short run but significant in long run. However, in the long run, the current study found that maize price has a positive relationship to maize production and statistically significant at 5% level. Therefore, higher market prices of maize lead to higher quantities of maize supplied in the market. As a rational producer (Farmer) would maximize profit by producing more of maize because of higher price which in turn lead to more income to the famer and high standard of living.

3.2. Soya beans price

In the short run, the variable's coefficient was negative and insignificant. In the long run, though negative, the relationship between maize supply and soya beans price is significant, in this study, it is statistically significant at 5% level. In this research paper, there is a positive relation between price of soya beans and maize price this and could be as a result of government intervention in the pricing process just as it happened before general election 2021. The government raised the price of maize grain and soya beans and this was not a true reflection of the market price. When the price of soya beans rises more than that of maize, farmers, being rational producers, will shift their resources to the production of soya beans and vice versa. Alemu, et al. (2003) found the variable to have a negative and significant effect at 5 percent level of significance. This study shows that maize and soya beans prices affect maize production in Zambia since they are both cash crops.

3.3. Average annual rainfall

In the short run, the coefficient of this variable has a positive sign and very insignificant in the short run. This could be as a result of irrigation schemes championed by the government and private sectors in the development of the agriculture sector in Zambia. In the long run, it has a positive sign which means a negative relationship between maize production and average annual rainfall. A percentage decrease in rainfall decreases annual maize production by 0.2722 or 27.22% per tonne.

3.4. Price of Fertilizer

Both in the short run and long run, the variable's coefficient is positive but statistically insignificant in the short run. However, in the long run, the current study found that the variable's coefficient has a positive sign which is interpreted economically as a negative sign and statistically significant at 5 percent level of significance. The study by Mose, et al. (2007) also found the variable to have a negative and significant effect on maize supply. Since prices of inputs are producer's cost of production, producers tend to reduce their production levels as input prices increases. Hence, an increase in the price of fertilizer, as one of farm inputs, leads to a reduction in maize production. Therefore, in this model fertilizer price has a negative effect to maize production. A 1% increase in the price of fertilizer leads to 22% reduction in maize production.

4. Conclusion

There has been a positive influence of maize price on the production of maize or maize supply. Currently, in Zambia, maize prices are determined by the government which sets the price floor in order to motive farmers for more production of maize. The government also sets the maximum price floor to motivate farmers with the main objective of food security considering that maize is the staple food with grave political implication. The system of free market economy works better in other sectors of the economy under the assumption of a perfect market as has been proved by many studies. Markets in developing economies are imperfect and government tends to intervene more in the operations of the market. Farmers rarely have enough information about the pricing mechanism. Because of this, prices set by the market may not be efficient enough to motivate farmers and may not stimulate the kind of growth expected in the sector. Here, the implication is that while the market is operating freely, the government should indirectly intervene by putting in place measures that could stimulate efficiency through price mechanism and other regulatory policies that may affect the agricultural sector positively in both the short and long run.

The results from this study have shown a negative impact of fertilizer prices on maize production in Zambia. The implication is that in order to increase maize production in the country, fertilizer prices need to be subsidized by the government. The government, through the farmer input support programme (FISP), has managed to promote the agriculture sector by subsidizing the inputs to stimulate maize production for food security purposes. It has also partnered with private sector to enhance agricultural maize production through venture investment, providing access to credit facilities and improvement of road network system. Fertilizer subsidy alone is not enough to encourage food production. Meaning that there must be markets for the produce as well as improvement in irrigation system so as to improve maize production throughout the year; not solely rain dependent.

Policy recommendations

The government should ensure that policy formulation and implementation target the intended people and every stage of implementation must be monitored and evaluated for efficiencies purpose. The government should intervene in the market when necessary and provide a conducive environment for investment in agricultural sector. The following are some of the government interventions that it can be undertaken:

- Provide access to credit facilities for small scale farmers. This policy would greatly improve food security in the country and provide source of income for small scale holders.
- The government should provide source of information to both small-scale farmers and big scale farmers. To manage this, the government can establish localized farmer information centres in all provinces and district levels from which farmers can get information. This can also be achieved through electronic media. This would improve the working of the market, improve maize production and promote efficiency of price mechanism.
- Government to promote public- private partnership (PPP) for research and development so as to enhance maize production in the country.
- The government to open up external markets for maize. This would help foster economic growth and improve the living standard of people in the country.
- Government to promote diversification of farming system in the countr

Limitations

The data used in this research paper is secondary data which in most developing countries may not be very accurate. To that end, there was no distinction between different agro-ecological zones as these zones have different characteristics in Zambia. There was no distinction between large- and small-scale farmers in this research paper. These Small- and large-scale farmers differ in their production techniques as, in most cases, large scale farmers are operating under commercial motives while small scale farmers operate under food consumption. Infrastructure, technology and agricultural extension services could not be included in this research paper. Measurements of the prices, maize per ton and average annual rainfall may not have been accurately done.

Compliance with ethical standards

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References

[1] Abrar, S. (2004), "Estimating Supply Response in the Presence of Technical Inefficiency Using the Profit Function, An Application to Ethiopian Agriculture", Journal of Agricultural Economics, University of Leicester, Volume 35, No. 3.

[2] ACF (Agricultural Consultative Forum) (2008): Zambian food security monitor 2008, Lusaka: Zambian Ministry of Agriculture and Cooperatives, mimeo. Agricultural Market." The Review of Economics and Statistics 64 (4): 658–667.

[3] Akiyama, T. and P.K. Trivedi, 1987. Vintage production approach to perennial crop supply: an application to tea in major producing countries. J. Econometrics, 36: 133-161.

[4] Arthur, M. S. & Jayne, T. S. Indaba Agriculture Policy Research Institute. 2012. Gender Control and labour Input: Who Controls the Proceeds from Staple Crop Production among Zambia Farmers.

[5] Askari, H. and Cummings, J.T.(1976), "Estimating Agricultural Supply Response with the Nerlove Model, A Survey", Journal of International Economic Review, University of Pennsylvania, Volume 18, No. 2.

[6] Behrman, J. R. (1969), Supply Response in Underdeveloped Agriculture, A Case Study of Four Major Annual Crops in Thailand, 1937-1963, Amsterdam, North-Holland.

[7] Binswanger, H. (1989), "The Policy Response of Agriculture", in Hamusankwa, M. C. (1997) Supply Response of Food Crops in Zambia, The Case of Maize and Sorghum.

[8] Chiang, A. C. (1984), Fundamental Methods of Mathematical Economics, New York, McGraw-Hill.

[9] Cobb, C. W. and Douglas, P. H. (1928), "A Theory of Production", The American Economic Review, Volume 18, No. 1.

[10] Danh, V.T. 2004. "Supply Response of Rice in Vietnam." Unpublished PhD Thesis. University of the Philippines Los Baños, College, Laguna, Philippines.

[11] Engle, R. F. and Granger, C. W. J. (1987), "Co-Integration and ErrorCorrection, Presentation, Estimation and Testing", Econometrica, Volume 55, No. 2.

[12] FAO (2010), Policy Reforms and Agriculture, the Role of Price and Non-priceFactors, www.fao.org retrieved on Thursday 26th April, 2012.

[13] FAOSTAT (2012), Food Supply Quantity, www.fao.org retrieved on Saturday 15th September, 2012.

[14] Galbraith, J. K. and Black, J. D. (1938), "The Maintenance of Agricultural Production during Great Depression", Journal of Political Economy, University of Chicago, Volume 46, No. 3.

[15] Ghosh, N., and C. Neogi. 1995. "Supply Response of Food Grains and Policy Actions: A Model with Rational Expectation Hypothesis." Indian Journal of Agricultural Economics 50 (2): 135.