THE EFFECT OF MONETARY POLICY ON AGRICULTURAL PRODUCTION OF SOUTH AFRICA

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Abstract

This study looks at the impact of monetary policy on South African agriculture making use of the linkages that exist between gross value of agricultural production, real effective exchange rate, monetary policy rate and agricultural credit using annual data from 1971-2020 and empirically investigates the impact of monetary policy on agricultural production in South Africa using econometrics model such as unit root test, co-integration and vector error correction method. The results showed that, in the long-run monetary policy rate, agricultural credit and real effective exchange rate have significant impact on gross value of agricultural production. In conclusion, polices that tend to discount rates should be encourages in order to increased gross value of agricultural production, this can be achieved through increasing productivity in agriculture, improve investment in commercial agriculture and food production, improve quality of production and improvement of marketing system. Agricultural policy makers and monetary policy makers work closely together in designing and implementing monetary policy in South Africa in order to boost agricultural productivity.

Key word: Monetary Policy, gross value of agricultural production, co-integration, vector error correction model.

1. Introduction

Agriculture plays a crucial role in the development process and well-being of humanity and it is classified a strategic sector of the economy (Muruyiwa et al., 2012). Furthermore agriculture has strong linkages in the economy so that the agro-industrial sector contributes an additional 12% to GDP (South African Government, 2014). Kargbo (2007) asserts that 48% of agricultural sector spending is on buying farm inputs whilst 66-71% of agricultural output is used as intermediate inputs in the industrial sector. These statistics are clear testimony to the fact that the role agriculture plays in the South African economy can never be over-emphasized. Agriculture not only has various inter-relationships with other sectors of the economy but more importantly it shares a distinct relationship with the monetary sector of the economy (Muruyiwa et al., 2012).

Monetary policy conduct influences agricultural sector activities due to backward and forward linkages of agriculture and monetary transmission mechanism, therefore a clear understanding of monetary policy practice in South Africa is crucial in order to link it with agriculture. The primary objective of monetary policy in South Africa is to achieve and maintain price stability in the interest of sustainable and balanced economic development and growth (South African Reserve Bank, 2021).

A broad sum of literature has attempted to discuss the linkages between agriculture and monetary policy with enormous body of knowledge on the subject mainly found on the United States. Early contributions are attributed to (Devadoss et al., 1985; Orden and Fackler, 1989; Orden, 2003). These researchers focused on impact of monetary policies on the aggregate farm sector variables as well as impact of macroeconomic factors on agricultural sector. Their findings provide sufficient evidence of significant linkages among monetary policy, agricultural sector and macroeconomic variables.

Kargbo (2007) utilizes a vector error correction model to investigate the dynamic effects of money supply, exchange rates and other macroeconomic variables on the agricultural sector in South Africa and his results highlight that monetary policy has significant impact on the South African agriculture sector. Similar to Kargbo (2007), Asfaha and Jooste (2007) use the Johansen approach for co-integration and vector error correction model to investigate the short run and long run effects of monetary changes on relative agricultural prices of South Africa.

Their findings confirm a long run relationship between South African agricultural and industrial prices, the money supply and exchange rate.

The primary objective of this study is to analysis how monetary policy affects agricultural production in South Africa. With the sub- objective of examining the impact of real effective exchange rate (as a weighted index against a basket of 15 currencies)**,** agricultural credit (total amount of credit made available – supply of credit) and monetary policy rate (bank rate- lowest rediscount rate at South African Reserve Bank) on agricultural production and to find out if there is a long-run relationship between certain monetary channels and variables such as real exchange rates, monetary policy rate, agricultural credit and agricultural production.

2. Material and Method

2.1 Empirical Model and Data

Gross value of agricultural production used as dependent variables and the rest of variables used as independent variables. The data used an annual time series data from 1971 to 2020 obtained from Reserve Bank of South Africa (2021) and Abstract of agricultural statistics (2021). From the analytical framework point of view and literature review the model specified in a functional form of:

$$AGOUT = f(REER, MPR, ACR) \quad (1)$$

Where: AGOUT- gross value of agricultural production
REER- real effective exchange rate
MPR- monetary policy rate
ACR- agricultural credit

In an explicit form, the model can be specified in log form as:

$$AGOUT = B_0 + B_1 \ln REER + B_2 \ln MPR + B_3 \ln ACR + U_t$$

Where: Ut- the error term- assumed to be normally distributed with mean of zero and constant variance

B0- constant term/intercept

B1- B3-slope coefficient

An increase in exchange rate (depreciation in value of South African rand) leads to an increase in gross value of agricultural production. Therefore a priori expectation states that there is a positive relationship between AGOUT and REER. The MPR variable represents the bank rate - rediscount rate at SARB. Rediscount rate sets the floor for interest rate regime in the money market and thereby affects the supply of credit, the supply of savings and supply of investment. An increase in interest rate leads to a fall in agricultural output as capital for agribusiness are limited or not available for investors and agribusiness owner to expand or even start up. There is a negative or inverse relationship between interest rate and agricultural output. Therefore a priori expectation states that there is a negative relationship between AGOUT and MPR. A priori expectation of agricultural credit was a positive relationship between AGOUT and ACR.

2.2 Time series properties of the variables

Before starting to test the sets of variables for co-integration and prepare for VECM, the time series properties of each of the variables need to be established. A stationary time series is very crucial in economic modeling and this helps to prevent spurious regressions that are common in economic literature (Enders, 2010).

Dickey and Fuller (1979, 1981) developed the Dickey – Fuller for testing unit root. The DF test was constructed on the assumption of independently normally distributed error. The standard augmented Duckey-Fuller test used to check the statistical properties of the series is expressed as:

$$\Delta\gamma t = \beta_1 + \beta_2 t + \delta\gamma_{t-1} + \sum_{i=1}^{m} \alpha i \, \Delta \, \delta\gamma_{t-1} + \mu_t \qquad (2)$$

$$\Delta \, \gamma_{t-1} = (\gamma_{t-1} + \gamma_{t-2}), \, \Delta \, \gamma_{t-2} = (\gamma_{t-1} + \gamma_{t-3}) \qquad (3)$$

The ADF tests for unit root in “γt” namely the quantity ratio and the price ratio, at time “t”; “t” denotes the deterministic time trend; “Δ γt-1” is the lagged first differences to accommodate serial correlation in the error term “μt”.

The results of Augmented Dickey-Fuller tests are presented in Table 1. The result indicates that all the variables: AGOUT, REER, MPR and ACR were stationary at integrated of order one I(1) and therefore stationary after first difference. This allows us to test for co-integration among the variables, in other words the variables have a long term relationship.

Table 1: Results for Unit Root Tests

Variable	**Level**		**First differences**	
	ADF	**Critical Value (5%)**	**ADF**	**Critical Value (5%)**
AGOUT	-1.985	-2.943	-5.127	-2.943
REER	-2.501	-2.937	-6.121	-2.939
MPR	-2.572	-2.939	-5.847	-2.941
ACR	-2.443	-2.937	-6.244	-2.939

Source: Author's estimate

2.3 Johansen co-integration tests and vector error correction model

Existence of a long-run equilibrium relationship between two or more variables has traditionally been examined by the co-integration techniques of Engle and Granger (1987) and Johansen (1991, 1995). Equation 4 and 5 describes the long-run equilibrium relationship among the variables in the gross value of agricultural production model whose empirical validity will be tested by the Johansen methodology.

If the results indicate the absence of co-integrating vectors between the variables, it means that there is no long-run stable relationship between them. If co-integration exists, then it can be presumed that a one-way or two-way Granger causality exists in at least the stationary series, and further more a dynamic specification of the error correction mechanism is appropriate (Engle and Granger, 1987). If the variables are found to co-integrate, then we estimate the co-integrating vector (s) by applying the method suggested by Johansen (1988) and Johansen and Juselius (1990). The procedure is implemented using the full information maximum likelihood estimation of a system characterized by "r" co-integrating vectors (for $r<n$, where n is the number of endogenous variables in the system), using the following statistical model:

$$Z_t = \sum_{i}^{k} AiZt - i + u + \psi D_t + u_t \quad (4)$$

Where "Zt" is the vector of endogenous variables (AGOUT, REER, MPR, ACR), "Ai" is the matrix of coefficients for the variables, "i" is the lag order, "k" is the maximum number of the lag length, "Dt" is the vector of other deterministic (non-stochastic) components, and "ut" is the vector of independently distributed error terms with constant variance. Then, if co-integration is established in Equation 4, in order to examine the pattern of dynamic adjustments that occur in the short-run to establish these long-run relations in response to various shocks to the system, the following vector error correction model is estimated:

$$\Delta Z_t = \Sigma \Gamma_i \Delta Z_{t-i} + \alpha\beta Z_{t-i} + \mu + u_t \quad (5)$$

Where "α" is the vector of adjustment parameters, "β" is the vector of co-integrating relationships (the long run parameters), "μ" is the vector of constants and the rest of the variables are defined as earlier.

The multivariate co - integration procedure suggested by of Johansen (1991) and Johansen and Juselius (1990) was employed in this study to examine the existence of long - run relationships or number of co - integrating vector among the variables in the model.

The main step in implementing the Johansen procedure is to carry out specification and misspecification tests which include the selection of optimal lag length to be used in estimation a Vector Auto Regression (VAR), normality and autocorrelation tests for the OLS residual in the unrestricted model.

A VAR lag selection criterion was used to select the optimal lag length result available in appendix 1 (Table 1.A). All the criteria of Final prediction error (FPE), Akaike's information criterion (AIC) and Hannan and Quinn information criterion (HQ) dictated to use four lag in the VAR.

The residual test of normality confirms that VAR is correctly specified, result available in appendix 1 (Table 1.B). If the computed p value of the JB statistic in an application is sufficiently low, which will happen if the value of the statistic is very different from 0, one can reject the hypothesis that the residuals are normally distributed. We fail to reject null hypothesis that the residual are normally distributed.

The residual test of autocorrelation also confirms that VAR is correctly specified, result available in appendix 1(Table 1.C). Autocorrelation as lag correlation of a given series with itself, lagged by a number of time unit based on the LM- Lagrange Multiplier principle at lag level 2, there is a correlation, however at lag 1, 3 and 4 there is no correlation in the disturbance terms.

Running the co-integration equation specified in equation 5 yields results reported in Table 2. Both the trace statistic and the maximum Eigen values confirmed 3 and 2 co-integrating vector among the variables respectively. Then, we confirm that there is a long – run relationship among the variables in equation 5. As it explained in Table 2 the Trace test indicates three co-integrating equation(s). The existence of co - integration implies that the variables in the system have a stable equilibrium relationship(s) to which they return after short-run deviations. In other words, the maximum Eigen value test will be used to identify the number of co-integrating equations in our co-integration test because the trace test tends to deviate from normality.

Table 2: Johansen's Test for number of co-integration Vectors

Test Statistics				
	Trace		**Maximal Eigen value**	
Null	**Statistics**	**5% critical value**	**Statistics**	**5% critical value**
r=1*	47.9	38.8	27.6	23.4
r≤ 1*	29.8	15.4	21.1	10.1
r≤ 2	15.5	5.3	5.2	14.3
r≤ 3	3.1	3.8	0.16	3.8

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level (5%)

Max-eigenvalue test indicates 2 cointegrating eqn (s) at the 0.05 level (5%)

* denotes rejection of the hypothesis at the 0.05 level

Source: Author's estimation

3. Empirical Results and Discussion

The results for the long- run co-integrating equation for the Gross value of agricultural production were presented in equation (6):

$$\ln AGOUT = 14.494 + 3.876 \ln REER - 2.677 \ln MPR + 1.185 \ln ACR \quad (6)$$

The results show that, there is a log-run relationship between REER, MPR, ACR and AGOUT. South African AGOUT has a positive long-run relationship with real effective exchange rate. These results provide evidences that the depreciation of the South African rand was associated with increase in gross value of agricultural production.

Moreover, the sign of real exchange rate elasticity was consistent with the theoretical expectation that devaluation will improve agricultural production. The empirical evidence also suggests that AGOUT increase about 3.8% per annum in long - run in response of real depreciation.

The coefficient of MPR was equal to 2.677 and has a negative relationship with AGOUT. Besides it has the lowest impact on AGOUT among other variables. The MPR variable represents the bank rate -lowest rediscount rate at SARB.

The result shows that there is a positive long-run relationship between Gross value of agricultural production and agricultural credit. Based on the estimated coefficient of is 1.185. A positive sign of this coefficient, with one percent increase in agricultural credit (supply of credit); Gross value of agricultural production will increase about 1.2%.

After investigating the long-run relationship of the variables, the error correction representation of the model obtained. The short-run coefficients obtained from VECE model has been reported in Table 3. As Table 3 and the co-integration results indicates that there is an evidence of a short - run relation among the variables. The error correction term in the short-run represents the speed of the adjustment which restores equilibrium in the dynamic model. Considering to a vector error correction (VEC) model estimation results, the error correction term ECM (-1) is equal to -0.052 indicating any deviation from the long-term equilibrium is corrected by 5.2% over each year.

The coefficient of the lagged variables in the model shows the short-run dynamics of the dependent variables.

Table 3: Estimation of Vector Error Correction model (Dependent variable Δ AGOUT)

		Coefficient Estimate of				
lags	**ECM**	**Δ AGOUT**	**Δ ACR**	**Δ REER**	**Δ MPR**	**C**
	-0.052 [-3.729]					0.25 [6.594]
1		-0.414 [-2.799]	0.405 [1.109]	0.456 [2.571]	-0.078 [-0.167]	
2		-0.499 [-3.282]	-0.056 [-0.149]	0.551 [3.025]	-0.597 [-1.244]	
3		-0.281 [-1.879]	0.424 [1.15059]	0.626 [3.506]	-0.711 [-1.51168]	
R^2 Adj.R^2	0.65 0.45					

Source: Author's estimation

4. Summary, Recommendation and Conclusion

In this study, we have examined the relationship between the South African gross value of agricultural production, the real exchange rate, monetary policy rate and agricultural credit. A co - integration analysis was carried out to identify the long run relationship among the variables.

The results shows that gross value of agricultural production has a positive relationship with effective exchange rate and agricultural (supply of credit), while a negative relationship with monetary policy rate both in short and long run. These results provide evidences that the depreciation of the South African rand is associated with an increase in agricultural production and competitiveness of South Africa's share of the world market for the sale of agricultural product.

The short-run dynamics of the gross value of agricultural production are shown by the vector error-correction model. The error correction term in the short-run represents the speed of the adjustment which restores equilibrium in the dynamic model. Regarding to (VEC) model estimation results, the coefficient of Error Correction term (ECM) (-1) is equal to -0.052 indicating any deviation from the long-term equilibrium is corrected by 5.2% over each year.

In conclusion, polices that tend to decrease monetary policy rate should be encourages in order to increased gross value of agricultural production. Monetary policy is not a magic bullet in South Africa economy, hence it should be used in concomitant with other polices such as supply side polices like rising productivity. Agricultural policy makers and monetary policy makers work closely together in designing and implementing monetary policy in South Africa in order to boost agricultural production.

Based on the analysis the following recommendations are forwarded: The flexible exchange rate is an integral part of the monetary policy framework - can usefully serve as a shock absorber without harmful side effects owing to the lack of significant balance sheet exposures in foreign currencies. Monetary policy should be eased cautiously taking into account the impact on market sentiment and capital flows. Lately, good communication among policy makers is very important.

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Appendix

Table 1.A: VAR lag structure selection for the Johansen Procedure

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-41.178	NA	0.0001	2.442	2.616	2.503
1	120.844	280.254*	5.08e-08*	-5.451	-4.580*	-5.144*
2	132.123	17.070	6.77e-08	-5.196	-3.628	-4.643
3	149.488	22.528	6.85e-08	-5.270	-3.006	-4.471
4	168.957	21.048	6.75e-08	-5.457*	-2.497	-4.413

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

Source: Author's estimation

Table 1.B: Normality test of residuals

Component	Jarque- Bera	df	Prob.
1	3.506052	2	0.1732
2	3.654453	2	0.1609
3	1.159584	2	0.5600
4	0.050811	2	0.9749
Joint	8.370900	8	0.3981

Source: Author's estimation

Table 1.C: Auto correlation test of VAR residuals

Lags	LM-Stat	Prob
1	22.57087	0.1257
2	9.771051	0.8783
3	11.86160	0.7535
4	18.87080	0.2754

Probs from chi-square with 16 df

Source: Author's estimation