Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.6, No.18, 2015

Analysis of the Relationship between Inflation, Economic growth and Agricultural growth in Swaziland from 1980-2013

Z.S. Mkhatshwa,, A.A. Tijani and M. B. Masuku*
Department of Agricultural Economics and Management Luyengo Campus, University of Swaziland

Abstract
While there is an on-going debate on the nexus between economic growth and inflation, with some authors arguing a positive relationship and others arguing a negative relationship, policymakers are faced with the need to balance economic growth with low inflation. Although monetary policies have been undertaken to curb inflation in Swaziland, its economic growth remains slow. This study investigated the relationship between inflation, agricultural growth and economic growth in Swaziland for the period 1980 to 2013. The existence of long-run relationship and causality were tested. The study also determined the inflation threshold in Swaziland. Using the Autoregressive Distributed Lag (ADRL) model, a long-run relationship between these variables was found to exist. Granger causality results show that, in 1980-2013, there was uni-directional causality in Swaziland that flows from economic growth to inflation, no causality was detected between economic growth and agricultural growth, and between inflation and agricultural growth. Using the non-linear model, Swaziland's inflation threshold was estimated at 12.56% with respect to economic growth and 10.36% with respect to agricultural growth. The elasticities from the long-run and short-run regressions showed that inflation has a negative impact of about 2% in the long-run on the economy and impacts positively by about 0.05% in the short-run. In the short-run, the agricultural growth has a positive relationship with the economic growth in Swaziland, with an influence of 15% on economic growth.Based on these findings it is recommended that the Government promote the agricultural sector and that the monetary authorities in Swaziland Government pay more attention to the inflation trend and pursue policies that will ensure single digit inflation.

Keywords: Agricultural growth, ARDL, GDP, economic growth, inflation, threshold

1. Introduction

1.2 Background

There have been different views on the relationship between inflation and economic growth especially with respect to the nature of the relationship and the direction of causation. There is the structuralists' view that inflation is good for growth and the monetarists' belief that inflation is harmful to economic growth. Researchers have embarked on empirical analysis to determine evidence have been given, first is that inflation has a positive relationship with economic growth; secondly is that inflation has a negative relationship with economic growth. The issue of causality between these variables has also been a cause for research in many studies, which has also been proved to be different across countries. Fischer (1993) argued that, while inflation is negatively associated with economic growth, the direction of causality remains unclear (Fischer, 1993).

Fischer (1993) in his research confirms a non-linear relationship between inflation and economic growth. Evidence has shown that inflation reaches a certain point or level where a positive effect on growth becomes negative (Fischer, 1993). Fischer's findings have triggered researchers to investigate the turning point, at which inflation becomes harmful to growth. As put by Khan and Senhadji (2001) that for most countries, maintaining a stable economy with low inflation coupled with a high and sustained output, is one of the major macroeconomic objectives. The estimation of inflation threshold is useful to policy makers in formulating policies that will keep the inflation rate below the threshold, thus evading the negative effects. Studies have come up with different inflation threshold levels for specific countries, for developing countries and industrialized countries.

Agriculture is one of the key sectors in the economy of Swaziland, contributing about 10% to the country's GDP in the recent years (Central Bank of Swaziland, 2013). The Agricultural sector can be linked to other sectors such as manufacturing and transport. Agriculture plays the biggest role in manufacturing by supplying raw material such as sugarcane, cotton lint and citrus for further processing. Moreover, the agricultural sector is the key sector that provides employment in the country to both skilled and unskilled labour.

The Government of Swaziland has come up with some agricultural policies to promote the sector. One of the policies is the Agricultural Comprehensive Policy of 2005 whose one of its objectives is to increase agricultural output and productivity. Though not many studies have been done to evaluate these policies, between 1994 and 2013, agricultural growth seems to follow the downward growth trend of the national GDP.

There have been different views on the relationship between inflation and growth especially with respect to the nature of the relationship and the direction of causation. Also, empirical studies have shown that results on this subject differ from country to country. The structuralists' view inflation as good for economic growth while the monetarists view inflation as harmful to growth (Mallik & Chowdhury. 2001). Moderate inflation is however helpful to growth and faster economic growth feeds back into inflation (Mallik & Chowdhury, 2001). Negative relationship between inflation and growth is reported by Fischer (1993) while Barro (1991) opined that this negative relationship is weak. The relationship between inflation and growth has been found to be negative in the medium to long run (Barro, 1991; Andres & Hernando, 1997; Gokal & Hanif 2004), and positive in the short run (Patnaik & Joshi, 1998). The magnitude of inflation rate determines whether it will have positive or negative effect on growth.

While inflation is negatively associated with growth, it is not clear which way the causality runs (Fischer, 1993). According to Ghazaouan (2012), the estimated thresholds are different due to econometric modeling, sampling, estimation procedure and choice of control variables.

1.2 Inflation and economic growth trends in Swaziland

Economic growth in Swaziland saw its highest rate in 1988 recording 18.58%. During this period, the country benefitted from political unrests in the Republic of South Africa and Mozambique During 1990-1991 period the country's economic growth fell to 1.76% in 1991and has remained below 5% ever since. For the period under review, 1980-2013, GDP growth rate averaged 3.84%. The contributing factors to the slowdown in growth was mainly the exodus of companies to South Africa and the regular severe droughts that hit the country, affecting the agricultural sector, which is one of the country's pillars for growth.

Inflation trends for Swaziland show that between 1980 – 2013 inflation rates averaged at 10% with the highest inflation rates experienced in 1983 and 1987 reaching 20.5% and 20.3% respectively. The major shocks of inflation in Swaziland originate from the behavior of world food and oil prices. Being a net importer of both commodities the country's inflation trend shows volatility during the period under review. The country had in the past taken measures to contain high inflation through both monetary and fiscal policies. Adjustments of interest rates by the Central Bank of Swaziland coupled with reduced government expenditure have been the country's key tools in economic growth strategies.

Policy makers are faced with situation where they have to find a balance between stabilizing inflation and growth, but the relationship between inflation and growth is still under debate. Notwithstanding monetary policies that have been taken to keep inflation under control, the economy of Swaziland does not show signs of expanding. Since 2010, the accommodative monetary policy stance taken by the Central Bank of Swaziland have kept the interest rates low (at less than 6%) and inflation rate at single digit, but the economic growth of the country remains slow. Expectations from monetary policy in the agricultural sector is that, when interest rates are cut, investment in the sector is expected to improve thus increasing domestic production of agricultural goods and thereby growing the economy.

The different arguments on whether inflation harms or promotes economic growth have been a motivation to explore the relationship that exists between inflation, agricultural growth and economic growth in Swaziland and to determine the inflation threshold in Swaziland. The main objective of this study was therefore to analyse the relationship between inflation and agricultural growth and how this in turn affects the economic growth in Swaziland. The study also sought to identify the cut-off point after which inflation is harmful to economic growth.

2. Methodology

2.1 Research Design

The study uses annual time series data for the period 1980 to 2013. Inflation data were sourced from the Central Bank of Swaziland. The study used real Gross Domestic Product (GDP) and Agricultural GDP in Swaziland as a proxy for economic growth and agricultural growth respectively, both sourced from the Central Statistics Office (CSO). Other variables used as control variables in the study were Foreign Direct Investment (FDI), Money supply and Exchange Rate all sourced from the Central Bank of Swaziland. Another control variable Trade Openness was calculated using total exports, total imports and GDP.

The time series data were tested for stationarity. The consequence of using non-stationary time series data to specify a model gives spurious results; a phenomenon that was first discovered by Yule (Gujarati & Porter, 2009). Gujarati and Porter further warned that results from a spurious regression are misleading and cannot be used for testing hypotheses about the parameters and also impossible to generalize the behaviour of the time period under review. To perform the unit root tests for the variables; real GDP, Inflation rate, and agricultural production, this study used the Augmented Dickey-Fuller (ADF) technique.

2.2 Model Specification

In order to establish the relationship between inflation, agricultural growth and economic growth, the study used multiple regression where the dependent variable (GDP) was regressed against independent variables (AGDP, Infl, M2, ER, Open). This model was specified as follows:

$$logGDP = c + \beta_1 logAGDP + \beta_2 Infl + \beta_3 logM2 + \beta_4 logER + \beta_5 logFDI + \beta_6 logOpen + \varepsilon_t$$

Where, GDP is the Gross Domestic Product , AGDP is the Agricultural GDP and Infl is the inflation rate; These are M2 representing Money Supply, ER, the exchange rate, OPEN, the trade openness where trade openness was calculated as (exports + imports)/GDP and FDI, the value of Foreign Direct Investment.. The β represent the elasticities of the independent variables, c the constant and ε_t the error term. GDP, FDI, M2, ER, OPEN and AGDP are expressed in natural logarithm.

2.3 Autoregressive Distributed Lag (ARDL) Cointegration Approach

The ARDL bound test for cointegration developed by Pesaran et al.(2001) is a technique that has gained popularity because of its advantages. One of the advantages of the bound test is that it works well even with smaller sample size and that can be used on variables which are not integrated of the same order. The economic growth, agricultural growth and inflation relationship ARDL representation are as follows:

$$\Delta(logGDP)_t = \beta_0 + \beta_1(logGDP)_{t-1} + \beta_2(logAGDP)_{t-1} + \beta_3(logM2)_{t-1} + \beta_4(logER)_{t-1} + \beta_5(INFL)_{t-1} + \beta_6(logFDI)_{t-1} + \beta_7(logOPEN)_{t-1} + \beta_8\Delta(logGDP)_{t-i} + \beta_9\Delta(logAGDP)_{t-i} + \beta_{10}\Delta(logM2)_{t-i} + \beta_{11}\Delta(logER)_{t-i} + \beta_{12}\Delta(INFL)_{t-i} + \beta_{13}\Delta(logFDI)_{t-i} + \beta_{14}\Delta(logOPEN)_{t-i} + \mu_t$$

The test for cointegration using the bound test approach is based on the Wald test. The Wald test hypothesis conducted was;

H_0: $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$

H_1: $\beta_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$

The F-statistic of the Wald test is compared with the two sets of critical value bounds developed by Perasan et al. (2001). The H_0 is rejected when the F-value is greater than the upper bound and the conclusion is that a long-run relationship between the variables exists. If the F-value is less than the lower bound, then the H_0 is accepted with the conclusion that there is no long-run relationship between the variables.

2.4 Granger Causality

In order to determine which variable causes the other between inflation, agricultural growth and economic growth, the study employed the Granger Causality Test. The study adopted the multivariate vector autoregressive (VAR) model to determine causality between inflation rate, economic growth and agricultural production in Swaziland.

$$INF_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i INF_{t-i} + \sum_{j=1}^{p} \omega_j AGG_{t-j} + \varepsilon_{1t}$$

$$AGG_t = \beta_0 + \sum_{i=1}^{p} \beta_i AGG_{t-i} + \sum_{j=1}^{p} \varphi_j INF_{t-j} + \varepsilon_{2t}$$

$$INF_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i INF_{t-i} + \sum_{j=1}^{p} \omega_j ECG_{t-j} + \varepsilon_{1t}$$

$$ECG_t = \beta_0 + \sum_{i=1}^{p} \beta_i ECG_{t-i} + \sum_{j=1}^{p} \varphi_j INF_{t-j} + \varepsilon_{2t}$$

$$AGG_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i AGG_{t-i} + \sum_{j=1}^{p} \omega_j ECG_{t-j} + \varepsilon_{1t}$$

$$ECG_t = \beta_0 + \sum_{i=1}^{p} \beta_i ECG_{t-i} + \sum_{j=1}^{p} \varphi_j AGG_{t-j} + \varepsilon_{2t}$$

Where,

INF_t = Inflation rate measured as Consumer Price Index (CPI) annual change rate

AGG_t = Agricultural growth measured as agriculture GDP

ECG_t = Economic growth measured as the real Gross Domestic Product (GDP)

ε_{2t} and ε_{1t} = error terms

2.5 Inflation Threshold Model Specification

The estimation of inflation threshold is useful in policy making and more especially in monetary policy, whose custodian is the Central Bank of Swaziland. In formulating policies the inflation rate needs to be kept below the threshold in order to evade the negative effects of inflation. Studies such as Oteng-Abayie and Frimpong, (2010), and Seleteng (2005) followed the popular model developed by Khan and Senhadji (2000) in estimating inflation threshold. This study did not follow this approach mainly because it is tedious and involves the estimation of numerous regressions where the level that maximizes R^2 is chosen as the optimal value (Hasanov, 2011). The method suggested by Khan and Senhadji (2000) also requires a large number of data to make valid statistical inference (Rutayisire, 2013). Based on these limitations and the sample size , the study followed Pollin and Zhu (2005), Quartey (2010) and Rutayisire (2013) who used the non-linear model to determine the optimal level of inflation that promotes growth in their different countries. Equation (1) represents the non-linear model used to estimate inflation threshold in Swaziland, while Equation (2) is the non-linear model used to estimate the threshold with respect to agricultural growth.

$$Growth_t = \beta_0 + \beta_1\pi_t + \beta_2(\pi^2)_t + \beta_3(Openrate)_t + \beta_4(FDI)_t + \varepsilon_t \quad (1)$$

$$AgricGrowth_t = \beta_0 + \beta_1\pi_t + \beta_2(\pi^2)_t + \beta_3(Agricloans)_t + \beta_4(Exports)_t + \varepsilon_t \quad (2)$$

Model (1) is specified such that economic growth is equal to the growth rate of Swaziland real GDP used as an economic growth variable; π_t is the inflation rate; *openrate* denotes the growth rate for trade openness in

Swaziland calculated as *(imports+exports)/GDP*; ε_t *is* the random error term. Model (2) is specified such that AgricGrowth is the agricultural growth rate ; π_t is the inflation rate; *Agricloans* denotes credit extension to the agricultural sector by commercial banks; Exports is the total exports and ε_t *is* the random error term

Taking the derivative with respect to π_t, we obtained equation (3);

$$\partial Growth/\partial \pi_t = \beta_1 + 2^* \beta_2 \pi_t = 0 \quad (3)$$

Equation (3) can then be reduced to;

$$\pi_t^* = - \beta_1/2^* \beta_2$$

Where π_t^* = the optimal inflation threshold

3. Results and discussion

3.1 Stationarity Test

The use of a mix of formal stationarity tests is essential in investigating the presence of unit root and in deducing the order of integration in the variables being tested. To test for the presence of unit root in the data the ADF stationarity test as well as the Phillips-Peron stationarity test were employed. In both techniques, the study tested for stationarity at constant, constant and trend, and at no constant and trend or none. Likewise, the null hypothesis (series contains no unit root) was against the alternative using both methods. The general rule is that, if the test statistic of a particular technique is more negative than the critical values, then the null hypothesis is rejected. Tables 1 and 2 present the results of the ADF and PP techniques respectively.

Table 1. Augmented Dickey-Fuller (ADF) Unit Root tests Results at level and at first difference

	At Level			At First Difference		
Variable	Constant	Constant and Trend	None	Constant	Constant and Trend	None
LRGDP	-0.871	-1.470	2.948**	-5.199*	-5.230*	-4.067*
LogM2	1.937	-2.470	7.081**	-9.203*	-9.109*	-4.370*
LogER	-3.205*	-1.897	1.254	-4.033*	-4.774	-3.415*
LogOPEN	-1.791	-1.685	-1.060	-4.609*	-4.625*	-4.682*
INFL	-3.258**	-5.211**	-1.139	-14.758*	-14.034*	-13.628*
LogAGDP	-1.328	-2.079	0.536	-6.438*	-6.538*	-6.467*
LogFDI	-1.028	-1.690	0.444	-4.700	-4.618	-4.712

** and * represent significance at 1% and 5% level of significance respectively

Source: Data analysis

Table 2. Phillips-Peron Unit Root Test at level and at first difference results

	At Level			At First Difference		
Variable	Constant	Constant and Trend	None	Constant	Constant and Trend	None
LRGDP	-0.871	-1.470	2.948**	-5.199*	-5.230*	-4.067*
LogM2	1.937	-2.470	7.081**	-9.204*	-9.111*	-4.370*
LogER	-3.205*	-1.897	1.254	-4.033*	-4.774	-3.415*
LogOPEN	-1.791	-1.685	-1.060	-4.610*	-4.625*	-4.682*
INFL	-3.258**	-5.211**	-1.139	-14.758*	-14.034*	-13.628*
LogAGDP	-1.328	-2.079	0.536	-6.438*	-6.538*	-6.467*
LogFDI	-1.155	-2.027	0.376	-4.700	-4.602	-4.703

** and * represent significance at 1% and 5% level of significance respectively

Source: Data analysis

Results presented in both tables show that the series used in this study were stationary at either level or first difference, that is, they were integrated of order 0 or 1.

3.2 ARDL Cointegration for GDP model

To test whether long-run relationship between GDP, agricultural GDP and inflation exists or not, the study used Autoregressive Distributed Lag (ARDL) also known as the bound test approach as opposed to the traditionally approaches developed by Engel and Granger (1987), and Johansen and Juselius (1990). These two methods require the variables to be integrated of the same order; either I(0) or I(1). Whereas the ARDL bound test for cointegration accommodates the different order of integration in the variables in this study.

Before the long-run model of GDP was developed the lag length was determined. Table 3 presents results of the selection of lag length using the Akaike (AIC), Schwarz (SC) and Hanna-Quinn (HQ) information criterion. The lag selected by most methods is usually chosen, but this study chose to use lag order of 1 year.

Table 3. Bounds test lag selection criteria in GDP model

Lag	AIC	SC	HQ
0	0.955	1.279	1.060
1	-6.617	-4.026*	-5.772
2	-6.951	-2.094	-5.368
3	-10.615*	-3.491	-8.292*

* denotes lag order selected by criterion

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hanna-Quinn information criterion

Source: Author's computations from Eviews 8

After the lag of the model was chosen, the test for cointegration between GDP, agricultural GDP and Inflation using the ARDL model was performed. Hendry's general to specific modeling approach was used to derive a parsimonious model from the over-parameterized model (Table 4) by gradually deleting the insignificant coefficients (Sultan, 2014). Thereafter, the diagnostic tests for normality, serial correlation, heteroscedasticity on the parsimonious model were performed. The results of the parsimonious model for GDP and the diagnostic tests for the model are presented on Table 4

Table 4. Over-parameterized model of GDP model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LogGDP(-1)	-0.669*	0.172	-3.896	0.0025
LogAGDP(-1)	0.027	0.104	0.255	0.8031
LogM2(-1)	-0.144	0.111	-1.293	0.2227
LogER(-1)	0.215*	0.056	3.864	0.0026
INFL(-1)	-0.012	0.008	-1.429	0.1809
LogFDI(-1)	0.394*	0.119	3.317	0.0069
LogOPEN(-1)	-0.658*	0.135	-4.869	0.0005
D(LogRAGDP)	-0.058	0.078	-0.747	0.4708
D(LogM2)	0.287*	0.114	2.523	0.0283
D(LogER)	0.130*	0.068	1.927	0.0809
D(INFL)	-0.004	0.004	-1.083	0.3019
D(LogRFDI)	0.114	0.084	1.351	0.2039
D(LogOPEN)	-0.617*	0.146	-4.233	0.0014
D(LogGDP(-1))	0.027	0.226	0.119	0.9074
D(LogAGDP(-1))	0.124	0.138	0.896	0.3894
D(LogM2(-1))	0.250*	0.121	2.060	0.0639
D(LogER(-1))	-0.129	0.076	-1.693	0.1186
D(INFL(-1))	0.008*	0.004	2.041	0.0660
D(LogFDI(-1))	-0.220*	0.084	-2.622	0.0237
D(LogOPEN(-1))	0.081	0.208	0.389	0.7048
C	2.891*	1.099	2.630	0.0234
R-squared	0.86			
Adjusted R-squared	0.61			
Durbin-Watson stat	1.622			
F-statistic	3.432			
Prob(F-statistic)	0.01988			

* *p*-values (Prob < 0.01 – 0.09) indicate significance at 1% to 10%

Source: Author's computations from Eviews 8

Table 5. The parsimonious model results on GDP model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LogGDP(-1)	-0.639*	0.130	-4.921	0.0003
LogM2(-1)	-0.166*	0.077	-2.158	0.0502
LogER(-1)	0.219*	0.045	4.827	0.0003
INFL(-1)	-0.013*	0.005	-2.660	0.0196
LogFDI(-1)	0.377*	0.087	4.337	0.0008
LogOPEN(-1)	-0.659*	0.124	-5.269	0.0002
D(LogAGDP)	-0.053	0.069	-0.761	0.4605
D(LogM2)	0.273*	0.091	2.982	0.0106
D(LogER)	0.135*	0.057	2.361	0.0345
D(INFL)	-0.003*	0.002	-1.995	0.0675
D(LogFDI)	0.108	0.064	1.676	0.1177
D(LogOPEN)	-0.598*	0.120	-4.956	0.0003
D(LogAGDP(-1))	0.148*	0.078	1.913	0.0780
D(LogM2(-1))	0.252*	0.110	2.293	0.0392
D(LogER(-1))	-0.134*	0.066	-2.038	0.0624
D(INFL(-1))	0.008*	0.003	3.272	0.0061
D(LogFDI(-1))	-0.210*	0.071	-2.967	0.0109
D(LogOPEN(-1))	0.099	0.104	0.940	0.3643
C	3.087*	0.730	4.226	0.0010
R-squared	0.86			
Adjusted R-squared	0.67			
Breusch-Godfrey Serial Correlation LM Test		F-statistic 1.708	Prob. F(2,11) [0.2259]	
Heteroskedasticity Test: Breusch-Pagan-Godfrey		F-statistic 0.996	Prob. F(18,13) [0.5143]	
Jarque-Bera Normality Test		0.302 Prob. (0.859984)		
Ramsey RESET Test		0.87255 Prob. F(1, 12) [0.3687]		

* Significant at various levels of significance Source: Data analysis

The regression results in Table 5 show that the lagged variables which were taken at their natural logarithm are statistically significant at convention levels. The table reveals that the previous rate of Inflation is negatively related with the GDP and statistically significant at 5% level. . This result is consistent with the findings of Bittencourt et al. (2013) who conducted a study on the SADC countries and concluded that there is a negative relationship between economic growth and inflation.

The results also show that agriculture was not an important determinant of overall because its coefficient was found to be statistically insignificant at the 5% level of significance. Though disappointing, the insignificance may be explained by the fact that agriculture contribution was low (about 9% to total GDP of the Swaziland).

The results of the test for cointegration using ARDL model is contained in Table 6. As shown in the table, the null hypothesis of no cointegration was rejected at 1% level of significance because the F-value (5.388) from the Wald test is greater than the upper limit of the bound limit.. . This means that that the variables are cointegrated and therefore the existence of a long-run relationship between economic growth, agricultural growth and Inflation and the other control variables exists.

Table 6. Bounds test for Long-run cointegration results

Bounds Critical Values: Unrestricted intercept and no trend		
Level of significance	Critical Level (Lower Bound)	Critical Level (Upper Bound)
1%	2.96	4.26
5%	2.32	3.5
10%	2.03	3.13
Estimated F-value:	5.388	

Source: bounds critical values sourced from Table CI (iii) Pesaran et al. (2001);

F-value computed by author using Eviews 8

The long-run parameters were estimated from the parsimonious model by dividing all the lagged (non-differenced) independent variables.by the absolute value of the coefficient of the lagged dependent variable. Similarly, the parameters of the short-run model were estimated by dividing the differenced lagged independent variables by the absolute value of the coefficient of the level lagged dependent variable. Table 7 presents the estimated long-run and the short-run elasticities of the GDP model.

Table 7. Short-run and Long-run coefficients for GDP model

Variable	Short-Run	Long-Run
Inflation (INFL)	0.0055	-0.0202
Real Agricultural GDP (AGDP)	0.1500	-
Exchange Rate (ER)	0.0013	0.3422
Money Supply (M2)	0.8212	-0.2600
Foreign Direct Investment (FDI)	-0.1608	0.5892
Openness of Trade (OPEN)	-0.7810	-1.0210

Source: Data analysis

Although there is still the on-going debate on the relationship between economic growth and inflation, the negative relationship found is in line with the study's expectations following the findings of some studies conducted on different African countries who found a negative relationship between economic growth and inflation (Bittencourt et al., 2013; Kasidi & Mwakanemela, 2013).

The results reported in Table 7 reveal that, , in the short run, there was a positive relationship between agriculture growth and economic growth. According to the results, a percentage point increase in agricultural growth increases GDP by about 14.9%. There was no long-run relationship found between agricultural growth and economic growth during the period under review. This in contrast to *apriori* positive relationship expected between agricultural growth and economic growth given the contribution of the agricultural sector to the economic activities.

The direction for causality between inflation and growth is another macroeconomic topic that is still under investigation. Since the Granger causality test is sensitive to the number of lags, the study chose the number of lags based on the Akaike (AIC), Schwarz (SC) and Hanna-Quinn (HQ) information criterion as presented in Table 3 in this chapter. The lag of 3 years was chosen as the optimal lag length selected by the AIC and HQ methods. The study then proceeded to run the Granger causality tests using Eviews 8 software.

Based on the results presented in Table 7, hypotheses (a), (b), (c), (e) and (f) were not rejected at 5% level of significance because their p-values are individually greater than 0.05. But the null hypothesis (d) was rejected at 5% level of significance since the p-value is less than 0.05. This means that during the period under study, there was no causality between agricultural growth and economic growth because the null hypothesis that agriculture GDP does not Granger cause GDP was not rejected. This result is inconsistent with the findings of Jatuporn, Chien, Sukprasert, and Thaipakdee (2011) who found a bi-directional relationship running from agriculture to economic growth and from economic growth to agriculture in Thailand. There was also no causality detected between inflation and agricultural growth at 5% level of significance, meaning that inflation does not Granger cause agriculture. The results also show that, within the sample of the study, there was unidirectional causality from economic growth to inflation in Swaziland.

Table 8 . Results of Granger Causality Test for equations (7) to (12)

Null Hypothesis (H_0):	Obs.	F-Statistic	Prob.	*Decision*
LAGDP does not Granger Cause LGDP	31	0.378	0.7699	*Accept (H_0)*
LGDP does not Granger Cause LAGDP		0.850	0.4802	*Accept (H_0)*
INFL does not Granger Cause LGDP	31	2.266	0.1066	*Accept (H_0)*
LGDP does not Granger Cause INFL		6.748	0.0018*	*Reject (H_0)*
INFL does not Granger Cause LAGDP	31	1.081	0.3760	*Accept (H_0)*
LAGDP does not Granger Cause INFL		1.633	0.2081	*Accept (H_0)*

* denotes significance at 5% level of significance

Source: Data analysis

When variables have been proven to be cointegrated, then the relationship between those variables can be captured with an Error Correction Model (ECM).The estimated ECM model is presented in Table 9. The table shows that the coefficient of the error correction term does not only falls between 0 and 1 (-0.345) and negative as expected, it is also statistically significant at 5% level of significance. This means that about 35% of the discrepancy between long-term and short-term GDP is corrected within a year. To test whether the model has no problem and that the OLS assumptions have not been violated, diagnostic tests that include the normality test, serial correlation test, heteroscedasticity test and correct specification test were performed. The results of the diagnostic tests are shown in Table 10.. According to the results, the null hypothesis that there is no serial correlation was not rejected at 5% level of significance since the p-value (0.2259) is greater than 0.05. Similarly, the null hypothesis that there is no heteroscedasticity was not rejected at 5% level of significance since the p-value (0.5143) is greater than 0.05. Also, the Jarque-Bera test shows that the residuals are normally distributed since the null hypothesis was not rejected at 5% level of significance the p-value of Jarque-Bera statistic (0.8599) is greater than 0.05. In addition, the Ramsey's RESET shows that the model is correctly specified since the p-value (0.369) of the F-statistic is greater than 0.05.

Table 9. Vector Error Correction Model results for GDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LRM2)	0.294**	0.123	2.382	0.0259
D(LRFDI)	0.135**	0.063	2.166	0.0410
D(LER)	0.077	0.060	1.298	0.2071
D(LOPEN)	-0.262**	0.115	-2.268	0.0330
D(LRAGDP(-1))	0.131*	0.076	1.721	0.0986
D(INFL(-2))	-0.005**	0.002	-2.455	0.0221
ECM(-1)	-0.345**	0.133	-2.592	0.0163
Constant	0.011	0.011	0.961	0.3463
R-squared	0.55			
Adjusted R-squared	0.41			

** and * denote significance at 5% and 10% level of significance.

Source: Data analysis

Table 10. Diagnostics Tests results for Vector Error Correction Model for GDP

	Value		Probability
Jarque-Bera Normality Test	0.465		0.7924
Breusch-Godfrey Serial Correlation LM Test	*Value*	*Df*	*Probability*
F-statistic	1.655478	Prob. F(3,20)	0.2085
Obs*R-squared	6.166658	Prob. Chi-Square(3)	0.1038
Heteroskedasticity Test: Breusch-Pagan-Godfrey	*Value*	*Df*	*Probability*
F-statistic	1.221703	Prob. F(7,23)	0.3311
Obs*R-squared	8.402325	Prob. Chi-Square(7)	0.2985
Ramsey RESET Test	*Value*	*Df*	*Probability*
F-statistic	0.227711	(1, 22)	0.6379
Likelihood ratio	0.319216	1	0.5721

Source: Data analysis

3.3 Estimation of Inflation threshold level in Swaziland

The study used the ADF technique to test for stationarity and the results are presented in Table 11. The results show that some ofe the variables were found stationary at level while others were after first differencing, that is, the variables were either I(0) or I(1).

Table 11. Augmented Dickey-Fuller (ADF) stationarity test results

ADF at Level				ADF at First Difference		
Variable	C	C&T	None	C	C&T	None
Growth	-5.236	-5.280	-1.805	-11.632	-11.429	-11.828
Inflation	-3.193	-5.095	-3.231	-5.624	-6.449	-7.932
Openrate	-4.642	-4.662	-4.719	-	-	-
log(FDI)	-1.120	-1.511	0.564	-4.818	-4.779	-4.782

Source: Data analysis; C= constant; C&T= constant and trend

The study employed the non-linear approach following Pollin and Zhu (2005), Quartey (2010) and Rutayisire (2013), to determine the optimal level of inflation for Swaziland.. Tthe results of the non-linear regression model are contained in Table 12. As shown in the table, the coefficient of the variable $(infl)^2$ is negative and significant as expected, and the coefficient of the inflation (infl) variable is positive and significant at 5% level.. Diagnostics tests were then conducted to confirm its validity and the model passed all the diagnostic tests.

Table 12. Results of the non-linear model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFL	2.440**	1.064	2.295	0.0304
INFL²	-0.103**	0.045	-2.265	0.0324
INFL(-1)	0.062	1.167	0.053	0.9579
INFL²(-1)	0.006	0.049	0.116	0.9087
OPENRATE	-0.258*	0.130	-1.986	0.0581
Log(FDI(-1))	-0.977	4.108	-0.238	0.8140
C	-6.819	15.244	-0.447	0.6585
R-Squared	0.28			
Adjusted R-squared	0.10			
Diagnostic Tests	Value	df	Prob.	
Normality Test				
Jarque-Bera	0.107		0.947881	
Breusch-Godfrey Serial Correlation LM Test				
F-statistic	0.447	(2,23)	0.6452	
Obs*R-squared	1.196	(2)	0.5498	
Heteroskedasticity Test: Breusch-Pagan-Godfrey				
F-statistic	2.120	(6,25)	0.0866	
Obs*R-squared	10.791	6	0.0951	
Ramsey RESET Test				
F-statistic	0.551	(1,24)	0.4652	
Likelihood ratio	0.726	1	0.3942	

** and *denote significant at 5% and 10% level of significance respectively

Source: Data analysis;

To calculate the threshold of inflation (π_t^*), the study used the following equation:

$\pi_t^* = -(\pi_t coefficient)/(2 * \pi^2_t coefficient)$

$\pi_t^* = -(2.440287)/2(-0.102856 + 0.005703)$

$\pi_t^* = \mathbf{12.56\ \%}$

The study found that the threshold level of inflation in Swaziland is 12.56%, implying that, a rate higher than this threshold will affect the economy negatively. This rate is not far off from the 7% to 11% range estimated by Khan and Senhadji (2001) for developing countries and from 10% estimated for Lesotho (Seteleng, 2005).

3.4 Estimation of Inflation threshold level in Swaziland with respect to the agricultural growth

The Augmented Dickey-Fuller (ADF) stationarity test was used to determine the order of integration of data series included in the model. The stationarity test results are presented in Table 13. The table shows that the variables were either integrated of order 0 or 1, that is, I(0) or I(1).

Table 13

Augmented Dickey-Fuller (ADF) stationarity test results

ADF at Level				ADF at First Difference		
Variable	C	C&T	None	C	C&T	None
AGrowth	-6.010	-6.078	-5.908	-	-	-
Inflation	-3.193	-5.095	-3.231	-5.624	-6.449	-7.933
log(AgriLoans)	-0.402	-3.601	3.311	6.633	-6.503	-9.520
log(exports)	-0.692	-1.697	1.088	-5.532	-3.709	-5.398

C= constant; C&T= constant and trend

Source: Data analysis;

The paper employs the same model (non-linear) used in the estimation of the threshold level with respect to the entire economy. As expected, the coefficient of the squared inflation $(infl)^2$ is negative and significant at 10% level of significance and the coefficient of the inflation (infl) variable is also positive and significant at 10% level of significance. To test the reliability of the model, diagnostic tests were carried out and the results are also presented in Table 14. The results show that the relevant assumptions of the OLS are not violated in the estimated model.

Table 14.Results of the non-linear model with respect to agricultural growth

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFL	4.139*	2.398	1.726	0.0962
$INFL^2$	-0.199*	0.0998	-1.994	0.0567
INFL(-1)	1.142	0.634	1.800	0.0834
Log(AGRILOANS)	13.441	4.201	3.1997	0.0036
Log(EXPORTS)	-31.544	12.453	-2.533	0.0177
Constant	-69.499	41.382	-1.679	0.105
R-Squared	0.37			
Adjusted R-squared	0.24			
Diagnostic Tests	**Value**	**Df**	**Prob.**	
Normality Test				
Jarque-Bera	1.728		0.421475	
Breusch-Godfrey Serial Correlation LM Test				
F-statistic	0.440	(2,24)	0.6493	
Obs*R-squared	1.131	2	0.5681	
Heteroskedasticity Test: Breusch-Pagan-Godfrey				
F-statistic	1.793	(5,26)	0.1494	
Obs*R-squared	8.205	5	0.1453	
Ramsey RESET Test				
F-statistic	0.880	25	0.3872	
Likelihood ratio	0.774	(1,25)	0.3872	

Source: Author's computation; *denotes significance at 10% level of significance respectively

To estimate the inflation threshold with respect to agricultural growth (π_t^*), the following equation was used:.

π_t^* = -(π_t coefficient)/(2* π^2_t coefficient)

π_t^* = -(4.138908)/2*(-0.199142)

π_t^* = 10.39%

The estimated threshold indicates that inflation rate higher than 10.39% will affect the agricultural sector negatively. This rate is lower than that for the entire economy for the period sampled for the study.

4. Conclusions and recommendations

4.1 Conclusions

Using the ADRL model developed by Peseran et al. (2001) to test for cointegration, the study found that economic growth was cointegrated with inflation and agriculture. The existence of cointegration indicates the presence of a long-run relationship between inflation, economic growth and agricultural growth.

With the variables being cointegrated, the ECM was then estimated to reconcile the behavior of the short-run of GDP with its long-run behavior. The ECM term was negative and significant as expected. The study found that economic growth adjusts to inflation and agricultural growth with a lag. Therefore, about 34% of discrepancy is corrected back to long-run within a year.

The Granger causality test suggested a uni-causality direction between inflation and economic growth with economic growth significantly influencing inflation in Swaziland within the period 1980-2013. The study found no causality between inflation and agricultural growth and between economic growth and agricultural growth.

The study obtained an optimal inflation threshold of 12.56% and 10.39% for the economy and agriculture respectively, which imply that policy makers must keep inflation below the threshold as the inflation tends to affect the economy and agriculture negatively at inflation rates higher than their respective optimal level. The elasticities from the long-run and short-run regressions show that inflation has a negative impact of about 2% in the long-run on the economy and impacts positively by about 0.05% in the short-run. In the short-run, the agricultural growth has a positive relationship with the economic growth in Swaziland, with an influence of 15% on economic growth. The negative relationship between inflation and economic growth is in line with the findings of Bittencourt et al. (2013), Kasidi and Mwakanemela (2013) who reported negative relationship between inflation and growth. The positive relationship between agricultural growth and economic growth is in line with the findings of Poonyth et al. (2001).

On the causality direction between inflation, agricultural growth and economic growth, the study found a uni-causality direction between economic growth and inflation flowing from economic growth to inflation. This result was not surprising considering the cost-push factors that determine inflation in many African countries including Swaziland. This result is consistent with the findings of Ahmad and Joyia (2012) who found a uni-directional relation from economic growth to inflation in Pakistan. However, , there was no Granger causality between inflation and agricultural growth which is in contrast to the findings of Olatunji et al. (2012) and, Oyinbo and Rekwort (2014) who found a uni-directional causality from inflation to agricultural output. The estimated inflation threshold for the economy was 12.56%, a value which is not far off from the 7% -11% range estimated by Khan and Senhadji (2001) for developing countries and from 10 % estimated for Lesotho (Seteleng, 2005).

4.2 Recommendations

Based on these findings, the study has the following recommendations.

4.2.1 Recommendations for Policy- Central Bank of Swaziland

The Central Bank of Swaziland should consider the inflation threshold in formulating polices that will keep inflation at single digit since the study has shown that double digit inflation may hurt agricultural as well as overall economic growth.

Since the study found a positive relationship between economic growth and agricultural growth in the short run, the Central Bank of Swaziland should formulate and implement monetary policies that encourage investments in agriculture, for instance, a special interest rate for the sector as well as providing guarantee for agricultural loans from commercial banks.

The Central Bank of Swaziland should also formulate and implement new expansionary monetary policies and sustain and fine tune the current ones in order to accelerate overall economic growth and thereby keeping inflation low since the study found that in the long run, economic growth is negatively related to inflation. Inflation targeting system may be considered to ensure policies taken are targeting a certain level of inflation.

4.2.2 Recommendations for Policy Makers- Government

The government of Swaziland should implement existing policies and programmes (as contained in the Comprehensive Agriculture Sector Policy 2005) targeted towards improving the performance of the agricultural sector in order to grow the economy, since the study found a positive relationship between economic growth and agricultural growth. For example, the government should increase budgetary allocation to 10 percent in the nearest future as contained in the Maputo Declaration.

The Government should implement existing policies and programmes aimed at growing the economy (as contained in the National Development Strategy 2014) in order to improve the investment opportunities to lure investments into the economy.

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