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Intersectoral linkages and Agricultural growth in Swaziland for the period 1971-2011

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Abstract
Agriculture plays an important role in the Swazi economy as it is the primary source of employment, livelihood and food security. The future success of the contribution of agriculture to economic growth depends largely on how agriculture stimulates growth of the other sectors and especially how the other sectors growth spills over and stimulates agricultural growth. Using bound test approach to cointergration, Granger causality and Impulse Response framework, the study therefore examined the interrelationships between agriculture and the rest of the sectors of the economy and their impact on economic growth over the period of 1971 to 2011 in Swaziland. The empirical results indicated that a long run relation exists among agriculture, the rest of the economy and overall economic growth. Granger causality analysis indicated that there is bidirectional causality between agriculture and economic growth, unidirectional causality between agriculture and services, running from services to agriculture and independence between agriculture and industry. The Impulse Response showed that contribution to GDP forecast error by the industry sector is the highest, followed by agriculture and service sectors. This study recommended that agriculture should be given more priority in order to grow the economy.
Keywords: Agriculture growth, ARDL, Granger causality tests, Inter-sectoral linkages, UECM, Variance decomposition.

1. Introduction

1.1 Background

The agriculture sector plays a vital role in the Swaziland economy. The agricultural sector employs 70% of the population and it is the major source of foreign exchange earnings with agriculture based products accounting for 75% of the country's total export revenues (FAO, 2011). It is also a key supplier of raw materials to many of the country's manufacturing industries, particularly operations, which utilize sugar and wood. Although agriculture is the mainstay of the Swazi economy, agriculture's contribution to GDP has decreased gradually over the last two decades. The share of agriculture to GDP fell from 15% in 1989 to 13% in 1999 and 10% in 2001 to 7% in 2011 (World Bank, 2012). Despite this decline agriculture still remains the key sector in Swaziland's economy directly and indirectly via agro-processing industries (Thompson, 2014). This means that the agriculture sector is a major force in the determination of the country's short term and long term economic growth possibilities.

1.2 Statement of the problem

Even though agriculture is the mainstay of the economy its contribution to GDP of Swaziland has been consistently declining (Mafusire & Leigh, 2014). In 1972 agriculture contributed 40% to the country's GDP, whilst industry and services contributed 26% and 33% respectively. On the other hand in 2011 agriculture's share of GDP had fallen to a mere 7% whilst the share of industry and services rose to 48% and 45% respectively (World Bank, 2012). This uneven pattern of the contribution of these three sectors in the economy's GDP triggers an interest of investigating their interrelationships. The future success of the contribution of agriculture to economic growth depends largely on how agriculture stimulates growth of the other sectors and especially how the other sectors' growth spills over and stimulates agricultural growth (Subramaniam & Reed, 2009). This interaction between sectors has been extensively explored. However, the direction of causality between agriculture, industry and services differs from one country to another, hence this study.

The main objective of this study was therefore to examine the interrelationships between the agricultural sector and the industry and services sectors and their impact on economic growth in Swaziland. Specifically, it investigated the existence of long run growth relationships among different sectors, examined the linkages between agriculture and the rest of the Swazi economy, and determined the relative impact of the sectors on economic growth in Swaziland

2. Literature review

Economists have long been interested in the interrelationships between agriculture and the other sectors and their impact on economic growth. This interaction between sectors has been extensively explored theoretical and empirically. Several authors provide pioneering theories on interaction between agriculture and non-agricultural sectors of the economy (Lewis, 1954; Johnston and Mellor, 1970; Solow, 1960; Swan, 1956; Harrod, 1939; Domar, 1946; and Rostow, 1960). The Lewis (1954) dual sector model provides one of the pioneer theoretical literature of interaction between agriculture and industry. Industrial sector is an engine of growth; this growth is enhanced by employing the surplus labour of agricultural sector in the new industries. Johnston and Mellor (1970) suggests that linkages are based on the agricultural sector supplying raw materials to industry, food for industrial workers, markets for industrial output, and the exports to earn foreign exchange needed to import capital goods. Solow (1960) and Swan (1956) proposed the Neo-Classical economic theory which suggests that increases in income lead to an increased demand for goods, and the industrial sector will grow faster than the agricultural sector. But due to spill over effects the growth in the industrial sector is expected to rub off on the agricultural sector and thereby ensuring positive linkage between the two sectors. The Harrod-Domar model suggests that growth depends on the quantity of labour and capital. The model further implied that economic growth depends on policies to increase investment, by increasing saving, and using that investment more efficiently through technological advances.

Empirical studies on agriculture interrelationships with the rest of the economy have been done in both developed and developing countries, though a few have been done in Southern Africa. Gasper et al (2014) estimated a trivariate VAR model for the period 1970-2006 to investigate the existence of long-run relationships and causality among industry, agriculture and services in Portugal in terms of value added and productivity. The study used cointergration and causality data analysis techniques to investigate the sectoral interdependence. The results with labour productivity showed that productivity gains in services and industry feedback into productivity growth in agriculture, although the link was weaker in the industry case.

Katircioglu (2006) analysed the relationship between agricultural output and economic growth in North Cyprus using co-integration for period 1975-2002. The results suggested a long-run equilibrium relationship between agricultural output growth and economic growth as well as bidirectional causation between them in the long run.

Kohansal, et al (2013) examined the role of agriculture on economic growth in Iran using the bound test. The results indicated that there was a long run equilibrium relation between the variables as agriculture, services, mine and industry and oil sectors had a positive and meaningful relationship to economic growth.

Matahir (2012) investigated the agricultural-industrial sectors relationship in Malaysia for period 1970 - 2009. The study adopted the Johansen and Juselius co-integration procedure to examine the existence of long-run relationship and employed Granger and Toda-Yamamoto causality tests to test the direction of causality between the sectors in the short and long run. The empirical results revealed that agricultural and industrial sectors are co-integrated in the long run and also showed that there is a unidirectional causality from industrial to agricultural sector both in the short and long run period.

Rahman, et al (2011) examined the causal relationship among GDP, agricultural, industrial and service sector output for Bangladesh using time series data from 1972 to 2008 using the Granger causality/block exogeneity Wald tests statistics. The empirical results found the existence of long run equilibrium relationship among the variables and bi-directional causality between GDP and agricultural sector, industrial sector and GDP, and also industrial sector and service sector. They also reported uni-directional causality from industrial sector to agricultural sector and GDP to service sector.

Tiwari (2011) examined static and dynamic causality among sectorial incomes of agriculture, industry, service and the total GDP of India for the period 1950 to 2009, using the Engle-Granger and Impulse Response and Variance Decomposition framework, respectively. Static causality analysis indicated that the service sector Granger causes industry sector and GDP and the agriculture sector Granger causes service sector. Dynamic causality results showed that contribution to GDP forecast error by the industry sector was the highest, followed by agriculture and service sectors, while the contribution to the industry sector forecast error by GDP was the highest, followed by service sector and agriculture sector.

Tiffin and Irz (2006) using the Granger causality test examined the causal relationships between agricultural value added and economic growth for a panel of countries. The study suggested strong evidence in support of causality from agriculture to economic growth in developing countries, but the causality results from developed countries was inconclusive.

The foregoing studies made useful contributions to understanding these links between different sectors in the economy by applying different methodologies. Although these studies have outlined the theoretical relationship between agriculture and the rest of the economy disagreement still persist. There were differing views in the literature concerning the interrelationships of the different sectors of the economy. The conclusions were mixed. Therefore the causal dynamics between agriculture and the rest of the economy is an empirical question worthy of further investigation. The review revealed a gap in the literature because most of the studies on intersectoral linkages were carried out in other developing countries besides Southern African countries. This study was therefore an attempt to fill this gap by investigating the interrelationship of the agricultural sector with the rest of the economy in Swaziland.

3. Research methodology

3.1 Data and model

The study used annual time series data from the period 1970-2011. Secondary data were obtained from the Central Statistics Office and the World Bank database. Given four endogenous variables, the basic model was mathematically expressed with the following estimation equations:

$$Y1t = \alpha_1 + \Sigma\, \beta_1\, Y1_{t-i} + \Sigma\, \delta_1\, Y2_{t-i} + \Sigma\, \oslash_1 Y3_{t-i} + \Sigma\, \phi_1 Y4_{t-i} + \varepsilon_{1t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$Y2t = \alpha_2 + \Sigma\, \beta_1\, Y1_{t-i} + \Sigma\, \delta_1\, Y2_{t-i} + \Sigma\, \oslash_1 Y3_{t-i} + \Sigma\, \phi_1 Y4_{t-i} + \varepsilon_{2t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$Y3t = \alpha_3 + \Sigma\, \beta_1\, Y1_{t-i} + \Sigma\, \delta_1\, Y2_{t-i} + \Sigma\, \oslash_1 Y3_{t-i} + \Sigma\, \phi_1 Y4_{t-i} + \varepsilon_{3t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$Y4t = \alpha_4 + \Sigma\, \beta_1\, Y1_{t-i} + \Sigma\, \delta_1\, Y2_{t-i} + \Sigma\, \oslash_1 Y3_{t-i} + \Sigma\, \phi_1 Y4_{t-i} + \varepsilon_{3t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where the ε's are the stochastic error terms, Y1 is GDP, Y2 is agriculture value added (constant Local Currency Unit (LCU), Y3 is industry value added (constant LCU) and Y4 is services value added (constant LCU).

The first step in this analysis was to explore univariate properties and test the order of integration of each series. We test for non-stationarity because spurious regressions can arise if time series are not stationary (Gujarati, 2009). All log transformed variables were tested for presence of unit roots using the Augmented Dickey Fuller (ADF) test and the Phillips-Perron (PP) test. The ADF test corrects for higher order serial correlation by adding the lagged difference term on the right hand side, whilst the PP test makes a correction to the t-statistics to account for the serial correlation in the residual term. The PP statistics are modifications of the ADF t-statistics that take into account less restrictive nature of the variables. This study used both the ADF test and the PP test for this reason.

Once the ADF and PP tests were done and the order of integration was known and it was found that all the variables were not stationary, but integrated of order equal to or less than one, the presence of long run relationship was examined by using a co-integration test developed by Pesaran et al (2001). The Autoregressive Distributed Lag (ARDL) test approach to co-integration has some advantages over the Engle and Granger two step method and the Johansen-Juselius method. The ARDL test allows for causal inferences based on Error Correction Models (ECMs) and is a good alternative to conventional cointergration tests because it bypasses the need for potentially biased pre-tests for unit root. The ARDL test can be used even if all the variables are not integrated of the same order, since the tests do not depend on whether variables are integrated of order zero or integrated of order one or a combination of both.

In order to estimate cointergration among variables, the unrestricted error correction model (UECM) of the ARDL model for value added was estimated. The UECM was estimated, using OLS method. Then, in light of the regression diagnostics, a more specific (parsimonious) model was gradually derived using the Hendry's general to specific modelling approach. In the Hendry's general to specific modelling approach, a parsimonious model was selected by gradually deleting the insignificant coefficients (Hendry, 1995). The appropriate number of lags was determined on the basis of the Akaike Information Criterion (AIC). Relevant diagnostic tests were done to ascertain the goodness fit of the ARDL model. These tests examined the normality, serial correlation, heteroscedasticity and the correct specification of the model. The bounds test developed by Pesaran et.al (2001) which, was used to test the null hypothesis of no cointergration is based on F-test restrictions of the joint significance of the estimated coefficients of the lagged variables. Pesaran et.al (2001) provides two sets of adjusted critical values that provide the lower and upper bounds used for inference. If the F-value exceeds the upper bound critical value, the null hypothesis that there is no cointergration among the variables is rejected. If the F-value is below than the lower limit of the bound value then the null hypothesis of no cointergration among variables is accepted. If the calculated F-value falls within the critical bounds limit then the order of integration of the variables needs to be known before drawing any conclusions.

3.2 Granger Causality test

If there is at least one cointergration relationship among the variables, there must be some causal relationship among the variables (Maddala and Kim, 1998).This study employed the Granger (1969) causality tests which, identifies the direction of linkage among the concerned sectors. A unidirectional causality relationship exists if X causes Y but Y does not cause X. If X causes Y and Y causes X, then a bidirectional relationship exists between the two variables. If neither X causes Y nor Y causes X, then independence exist between the variables.

3.3 Variance Decomposition

The main objective of variance decomposition is to obtain accurate information about forecast ability. Variance decomposition shows the dynamic interaction among variables. The variance decomposition indicates the influence each variable on the other variables in the auto regression. Gasper et al (2014) suggests that variance decomposition is one of the most important tools in this analysis since it allows for identification of the main influences in the explanation of the variance of each variable.

4. Results and discussion

This study used the ADF test and the PP test to examine the stationary nature of the variables. Kwiatkowski et al (1992) suggests that the combination of the ADF and PP tests is a form of confirmatory analysis that has been shown to be the most robust in determining the presence of unit roots. This study carried out both tests the data series at level and first difference. The ADF test in Table 1 shows that all variables except for agriculture are not stationary in level. The variables are then differenced to make them stationary. The ADF test further shows that all the variables become stationary after being differenced once. The PP result in Table 2 shows that all variables are non-stationary in level except for agriculture. The variables are then differenced once in order to make them stationary. The PP unit root test confirms the ADF test result. This study therefore concludes that all variables used are integrated of either order zero or order one.

Table 1. Augmented Dickey Fuller (ADF) test

Initial level			First difference	
Variable	Constant	Constant & trend	constant	constant & trend
LogGDP	-2.5725(-2.936942)	-0.481535(-3.526609)	-4.602618(-2.938987)*	-4.906775(-3.529758)*
LogAgric	-2.0689(-2.936942)	-3.758779(-3.526609)	-8.116799(-2.93897)*	-8.05265(-3.529758)*
LogIndus	-1.4368(-2.938987)	-1.325829(-3.529758)	-3.47665(-2.938987)**	-3.641309(-3529758)**
LogServ	-1.7734(-2.936942)	-1.786945(-3.526609)	-6.542156(-2.938987)*	-6.759011(-3.529758)*

Numbers in brackets are Dickey-Fuller critical values at 5% significance level; where ***, **,* indicates significance at 10%, 5% and 1% respectively.

Source: Eviews computations

Table 2. Phillip-Perron (PP) test

Initial level			First difference	
Variable	Constant	constant & trend	constant	constant &trend
LogGDP	-2.294402(-2.9369942)	-0.724985(-3.526609)	-4.594862(-2.938987)*	-4.926672(-3.529758)*
LogAgric	-1.916028(-2.936942)	-3.570768(-3.526609)*	-12.95059(-2.938987)*	-17.16335(-3.529758)*
LogIndus	-1.715021(-2.936942)	-0.230094(-3.526609)	-3.376271(-2.938987)**	-3.364275(-3.529758)**
LogServ	-1.859283(-2.936942)	-1.8279(-3.526609)	-6.534257(-2.938987)*	-6.757846(-3.529758)*

Numbers in brackets are Dickey-Fuller critical values at 5% significance level; where ***, **,* indicates significance at 10%, 5% and 1% respectively.

Source: Eviews computations

The order of integration is now known, the next step will be to determine if our model is or not cointergrated. As earlier mentioned the model used in this study is a system of four equations. The first equation is the GDP model. In order to examine the relationship between GDP and the different sectors of the economy, UECM of the ARDL model is estimated with two lags, selected on the basis of the Akaike information criteria (AIC). Then following the Hendry's general to specific modelling approach (Hendry, 1995), a parsimonious model is selected for the GDP model by gradually deleting the insignificant coefficients. The statistically insignificant variables are eliminated by using diagnostic tests to check the validity of the reduction ensuring a specific final model presented in Table 3. The diagnostic tests used are the Breusch-Godfrey serial correlation LM test, Heteroscedasticity ARCH LM test, Jarque Bera normality test and the Ramsey RESET test. The results of these tests showed that the random terms are non-autocorrelated, homoscedastic and normally distributed, and the model is correctly specified.

Table 3. Parsimonious Unrestricted Error Correction Model of GDP

Variable	Coefficient	Std. Error	t-Statistic	P-value
loggdp(-1)	-0.51171	0.076964	-6.64865	0.0000
logagric(-1)	0.256726	0.057872	4.436107	0.0001
logindus(-1)	0.256307	0.046225	5.544786	0.0000
logserv(-1)	0.148014	0.073408	2.016328	0.0531
d(logagric)	0.160533	0.07078	2.268063	0.0310
d(loggdp(-1))	0.483983	0.136262	3.551849	0.0013
d(logindus(-2))	-0.26776	0.079786	-3.35599	0.0022
d(logserv(-2))	-0.15251	0.077008	-1.98043	0.0572
Constant	-2.43145	1.163109	-2.09047	0.0455
R-square		0.726532		
Adjusted R-square		0.651093		
F-statistic		9.630688		
Prob (F-statistic)		0.000002		
Diagnostic tests				
Breusch-Godfrey serial correlation LM test		F-statistic 0.496272,		Prob 0.509823
Heteroscedasticity ARCH LM test		F-statistic 2.547504,		Prob 0.090049
Jarque-Bera normality test		Jarque-Bera 1.342819,		Prob 0.510988
Ramsey Reset test		F-statistic 1.632876,		Prob 0.211799

The result of the bound test to examine the relationship between GDP and the rest of the variables (Agriculture, Industry and Services) is given in Table 4. In this case GDP is the dependent variable. The result showed that the F-statistic (16.0389) is higher than the UCB computed by Pesaran et al (2001) at 1% level of significance; thereby suggesting a long run equilibrium relationship between GDP and the rest of the variables.

Table 4. Bounds test results for co-intergration for GDP Model

Significance level %	Critical Level	
	Lower bound	upper bound
1	3.74	5.06
5	2.86	4.01
10	2.45	3.52
Calculated F-values 16.0389*		

*Denotes significance at 1%
Source: Pesaran et al. (2001)

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The second equation is the agriculture model. In order to examine the relationship between agriculture and the different sectors of the economy the UECM of the ARDL model is estimated with three lags, selected on the basis of the AIC. Then following the Hendry's general to specific modelling approach, a parsimonious model as shown in Table 5 is obtained. The robustness of the model is confirmed by the diagnostic tests. The result of the long run relationship between the variables when agriculture is the dependent variable is given in Table 6. The result shows that the computed F-statistic (F=15.0132) is greater than the critical upper bound at 1% level. Thus, we may conclude that there exists a long run stable relationship between the variables when agriculture is the dependent variable.

The third equation is the industry model. The parsimonious UECM for industry with three lags is presented in Table 7. The diagnostic tests revealed that the random terms non-autocorrelated, homoscedastic and normally distributed, and the model correctly specified. The result of the bound test in Table 8 clearly shows that the F-statistic of 5.251576 is clearly greater than the critical value at the 1% level significance level. Thus, this result suggests that a long run relationship exist between gross domestic product, agriculture, industry and services when industry is the dependent variable.

Table 5. Parsimonious Unrestricted Error Correction Model for Agriculture

Variable	Coefficient	Std. Error	t-Statistic	P-value
logagric(-1)	-0.69686	0.099318	-7.01643	0.0000
loggdp(-1)	0.697922	0.172609	4.043362	0.0005
logindus(-1)	-0.382	0.086218	-4.430618	0.0002
logserv(-1)	-0.11262	0.119346	-0.943667	0.3551
d(loggdp)	0.649403	0.231113	2.809893	0.0099
d(loggdp(-1))	-1.67931	0.216047	-7.77289	0.0000
d(logserv(-1))	0.326493	0.110523	2.954066	0.0071
d(logagric(-2))	0.535272	0.09841	5.439198	0.0000
d(logindus(-2))	0.680982	0.108968	6.249403	0.0000
d(logserv(-2))	0.300657	0.128312	2.343163	0.0281
d(logagric(-3))	0.164794	0.079321	2.077566	0.0491
d(logindus(-3))	0.205841	0.080857	2.545727	0.0181
d(logserv(-3))	-0.59866	0.099227	-6.033168	0.0000
constant	9.290553	1.753225	5.299122	0.0000
R-square	0.903778			
Adjusted R-square	0.849391			
F-statistic	16.6177			
Prob (F-statistic)	0.00000			
Diagnostic tests				
Breusch-Godfrey serial correlation LM test	F-statistic 1.159813		Prob 0.182197	
Heteroscedasticity ARCH LM test	F-statistic 0.719261,		Prob 0.516094	
Jarque-Bera normality test		Jarque-Bera 1.135086,	Prob 0.566917	
Ramsey Reset test		F-statistic 0.167536,		Prob 0.685797

Source: Computed using Eviews

Table 6. Bounds test for co-intergration for Agriculture Model

Significance level %	Critical values	
	Lower bound	upper bound
1	3.817	5.122
5	2.85	4.049
10	2,425	3.574
calculated F-values	15.0132*	

* denotes significance at 1%
Source: Computed using Eviews

Table 7. Parsimonious Unrestricted Error Correction Model for Industry

Variable	Coefficient	Std. Error	t-Statistic	P-value
logindus(-1)	-0.88406	0.196347	-4.50255	0.0002
logagric(-1)	-1.22236	0.334259	-3.65692	0.0015
loggdp(-1)	1.857878	0.433264	4.288097	0.0003
logserv(-1)	-0.67782	0.246318	-2.7518	0.012
d(logagric)	-0.59437	0.199531	-2.97884	0.0072
d(loggdp(-1))	-1.0184	0.355829	-2.86206	0.0093
d(logindus(-1))	1.304917	0.155407	8.396789	0.0000
d(logserv(-1))	0.732374	0.259001	2.827682	0.0101
d(logagric(-1))	0.612691	0.302195	2.02747	0.0555
d(loggdp(-2))	-1.02358	0.608144	-1.68312	0.1072
d(logagric(-2))	0.735338	0.290643	2.530038	0.0195
d(logserv(-2))	0.609805	0.284674	2.142115	0.0441
d(logagric(-3))	0.683842	0.18694	3.658079	0.0015
d(logindus(-3))	1.084907	0.264921	4.095207	0.0005
d(loggdp(-3))	-0.4366	0.389391	-1.12125	0.2748
Constant	17.01797	5.442184	3.127048	0.0051
R-square	0.744961			
Adjusted R-square	0.56279			
F-statistic	4.089358			
Prob (F-statistic)	0.001699			
Diagnostic tests				
Breusch-Godfrey serial correlation LM test	F-statistic 0.158409, Prob 0.738288			
Heteroscedasticity ARCH LM test	F-statistic 1.627585, Prob 0.199696			
Jarque-Bera normality test	Jarque-Bera 0.843237, Prob 0.655984			
Ramsey Reset test	F-statistic 3.338918, Prob 0.08262			

Table 8. Bounds for co-intergration for Industry Model

Significance level %	Critical Level	
	Lower bound	upper bound
1	3.817	5.122
5	2.85	4.049
10	2,425	3.574
Calculated F-values	5.251576*	

*Denotes significance at 1%

The fourth and final equation estimated is the services model. The parsimonious UECM version of the ARDL with three lags estimated is shown in Table 9. The model passes the diagnostic tests against serial correlation, functional form misspecification, and heteroscedasticity as shown in Table 9. The model fails the Jarque-Bera normality test at 1%. However according to Gasper et al (2014) who in their study the residuals from the services equation fail the Jarque-Bera normality tests, this is not as serious for the analysis as would be failing the heteroscedasticity ARCH LM test. The result of the bounds test in Table 10, shows that the F-statistic of is 8.159546 is clearly greater than the critical values at the 1% level significance level. Thus, this result suggest that a long run relationship exists between gross domestic product, agriculture, industry and services exists when services is the dependent variable.

Table 9. Parsimonious UECM for Services

Dependent Variable: DLOGSERV

Variable	Coefficient	Std. Error	t-Statistic	P-value
logserv(-1)	-0.67086	0.126638	-5.29747	0.0000
loggdp(-1)	0.730235	0.137527	5.309761	0.0000
logagric(-1)	-0.27032	0.103078	-2.62246	0.0140
logindus(-1)	-0.11228	0.060192	-1.86543	0.0726
d(logagric(-1))	0.501689	0.115132	4.357513	0.0002
d(logserv(-1))	0.285824	0.137275	2.082126	0.0466
d(logindus(-3))	0.242271	0.09579	2.52918	0.0173
d(logserv(-3))	0.458616	0.117264	3.910971	0.0005
Constant	6.119421	2.005362	3.051528	0.0049
R-square	0.699611			
Adjusted R-square	0.613785			
F-statistic	8.15154			
Prob (F-statistic)	0.000012			
Diagnostic tests				
Breusch-Godfrey serial correlation LM test	F-statistic 0.066569, Prob 0.961298			
Heteroscedasticity ARCH LM test	F-statistic0.117905, Prob0.941025			
Jarque-Bera normality test	Jarque-Bera 81.98402, Prob 0.0000			
Ramsey Reset test	F-statistic 2.96116, 0.096729			

Table 10. Bounds for co-intergration for services

Significance level %	Critical Level	
	Lower bound	upper bound
1	3.817	5.122
5	2.85	4.049
10	2,425	3.574
Calculated F-values	8.159546*	

*Denotes significance at 1%

The result of the Granger causality is shown in Table 11. The empirical results in Table 11 indicated bi-directional causality between agriculture and GDP and independence between industry and agriculture. The causality tests results further indicated uni-directional causality between agriculture and services on the one hand and between industry and GDP on the other hand. The results show that services growth does Granger cause agriculture growth but agriculture growth does not Granger cause services growth, while industry does Granger cause GDP growth, but GDP growth does not Granger cause industry growth. Similarly the Granger causality tests suggest a uni-directional causality between services and GDP. This implies that in Swaziland services do not Granger cause GDP, but GDP Granger causes service growth. From the results there is no evidence of causality running either from services to industry

Table 11. Pairwise Granger Causality Test Results

Null Hypothesis	Observations	F-Statistic	Probability
GDP does not Granger Cause AGRIC	38	4.66811	0.0164**
AGRIC does not Granger Cause GDP		3.78076	0.03324**
INDUS does not Granger Cause AGRIC	38	0.5028	0.60939
AGRIC does not Granger Cause INDUS		0.82222	0.44826
SERV does not Granger Cause AGRIC	38	3.24267	0.0518*
AGRIC does not Granger Cause SERV		1.67931	0.20205
INDUS does not Granger Cause GDP	38	3.54026	0.04047**
GDP does not Granger Cause INDUS		0.94292	0.39973
SERV does not Granger Cause GDP	38	1.99825	0.15165
GDP does not Granger Cause SERV		2.48902	0.09844*
SERV does not Granger Cause INDUS	38	0.6263	0.5408
INDUS does not Granger Cause SERV		1.15168	0.32848

**, * indicates significance at 5% and 10% level of significance

The results of the variance decomposition analysis of GDP applying the Cholesky method are presented in Table 12. The results show the variance decomposition of GDP in percent after, an innovation in agriculture, industry and services, from the first to the 10th period (years in a forecast) after the shock. The empirical results in Table 12, show that after the 10th period GDP forecast error is explained by its own shock (41%), by agriculture shock (9%), by industry shock (43%) and by a services shock (6%). This implies that GDP forecast error is mostly explained by industry shocks. This result is consistent with Tiwari (2011) who found that in India the contribution to GDP forecast error by the industry sector was the highest compared to services and agriculture.

Table 12. Variance decomposition (%) of GDP

Period	S.E.	LOGAGRIC	LOGGDP	LOGINDUS	LOGSERV
1	0.077719	0.00000	100	0.00000	0.00000
2	0.09355	5.722837	73.82305	11.32817	9.125935
3	0.098737	12.02905	50.78633	24.53881	12.64581
4	0.100579	12.36682	41.95237	34.20305	11.47776
5	0.102748	10.97333	39.84442	39.96891	9.213334
6	0.10472	9.71646	39.7063	42.9593	7.617934
7	0.106468	9.111906	39.90535	44.16334	6.81941
8	0.107354	8.950813	40.18057	44.31555	6.553064
9	0.107843	8.946319	40.64655	43.95828	6.448852
10	0.108223	8.963377	41.22529	43.48005	6.331287

5. Conclusion and policy implications

5.1 Conclusion

The main aim of this study was to analyse the interrelationships between the agriculture sector and the rest of the economy in Swaziland from 1971 to 2011. The result showed that there is long run relationship between the variables and revealed bidirectional causality between GDP and agriculture, unidirectional causality between services and agriculture, running from services to agriculture, unidirectional causality between industry and GDP, running from industry to GDP and unidirectional causality between services and GDP, running from GDP to services. But, no causality exists between industry and agriculture, and between services and industry. The results of the variance decomposition analysis show that, the GDP forecast error is mostly explained by industry shocks. This study has not only shown the direction and strength of interrelationships between agriculture and the rest of the economy, it has also shown the relative impact of the sectors on economic growth.

5.2 Policy implications

Given these results, the following policy recommendations are provided:

i) Since there is bidirectional causality between agriculture and GDP in Swaziland, this result provides evidence of supported need for an increase in resources allotted to agricultural research and infrastructural development. A developing country like Swaziland which is a net food importer, its growth could be driven by domestic policies that promote agriculture.

ii) The unidirectional causality between services and agriculture running from services to agriculture shows that without downplaying the importance of agriculture, the nature of such intersectoral relationships possibly indicates that at least any policy priority favouring services sector need not necessarily go against agricultural sector since the services Granger causes agriculture.

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