THE AGRICULTURAL INDUSTRY AND ECONOMIC GROWTH IN SOUTH AFRICA – AN EMPIRICAL ANALYSIS

M.Y., TEWELDEMEDHIN*, H.D. VAN SCHALKWYK**, Rena RAVINDER***

Abstract: This study measures the source of short-term agricultural economic growth in South Africa, using the Exact Maximum Likelihood (EML) method by categorizing the variables into five main categories: cyclical reversion, structural policies and institutions, stabilization policies, cyclical volatility and external conditions. The statistically significant finding of structural policies and institutional category variables imply that the sector growth was achieved with improved education, financial depth, and trade openness. However, the negative relationship of financial depth (RDGDP) indicates the sector is suffering from a debt crisis. Therefore, farmers need to follow an effective debt management system. The cyclical reversion was found to be statistically significant and related negatively. This shows that there is an important connection between the business cycle and agricultural economic growth.

Keywords: agricultural sector, South Africa, Debt crisis, economic growth, cyclical reversion

JEL Codes: Q13, Q18

* M.Y., Teweldemedhin, Postgraduate student, Affiliation: Department of Agricultural Economics, University of the Free State, South Africa
** H.D., Van Schalkwyk, Professor, Affiliation: Department of Agricultural Economics, University of the Free State, South Africa
*** Rena Ravinder, (corresponding author) Professor, Affiliation: Department of Economics, Polytechnic of Namibia (Namibia’s University of Science and Technology), 13 Storch Street, Private Bag 13388, Windhoek, Namibia, Email: drravinderrena@gmail.com; ravinder_rena@yahoo.com
1. INTRODUCTION

The positive relationship between agricultural growth and overall economic growth is empirically well established (Kieran and Karl, 2007). Evidence consistently shows that agricultural growth is highly effective in reducing poverty. Gallup et al (1997) (in Department for International Development (DFID), 2005) show that every 1% increase in per capita agricultural output leads to a 1.61% increase in the income of the poor. However, developing countries are still ineffective in reducing poverty (Romea and Marcelle, 1998).

From 1970 to 2002 South Africa’s average annual contribution of the agricultural sector to the total GDP and to employment has dropped by 0.09% and 0.22% respectively. To aggravate matters, the South African economy is characterised by high levels of poverty, especially in the rural areas where approximately 70% of poor people reside. Where almost all the productive and social activities of rural towns and services are dependent on primary agriculture and related activities (NDA, 2005). This makes it complicated to reach government objectives.

This study measures the determinants and the source of short-term agricultural economic growth in South Africa. More specifically, estimates agricultural growth regression with its set of explanatory variables postulated as growth determinates.

Although the study does not deal directly with the long-term relationship between growth and its determinants, but it accounts indirectly for it by including cyclical output movements.

2. LITERATURE REVIEW ON ECONOMIC GROWTH

The shortcoming of the neoclassical model is defining economic growth within the context of diminishing returns. The theory states that the application of additional resources yields less than the proportional increases in output (Sam, 1976 in Norman and Soto, 2003). This implies that developed countries experience diminishing returns although they invest more. Furthermore, this theory predicts that the return differentials generated by large gaps in the capital stocks will produce massive capital flows from rich to poor countries. Both implications are strongly rejected by evidence (Norman and Soto, 2003).

The weakness of the neoclassical growth model led several researchers to propose alternatives. Romer (1986) presents a model in which economic growth
occurs not only because of exogenous technological progress, but also as a result of capital accumulation endogenous to the sector that compensates for diminishing returns. Lucas (1988), another pioneer of economic growth research, introduces a model in which human capital plays a fundamental role in perpetuating economic growth and preventing the diminishing of capital accumulation.

Keller (2002) identifies three defining characteristics of research on growth: first, the close connection between theories, empirical data and methods used to test the relationship between economic growth and its determinates; second, the emphasis on endogenous technological progress, in particular the types, that generate increasing returns on the monopolistic competition; and third, the merging of different strands of economics, the interaction between macroeconomics, the business cycle, and economic development. These considerations are centred on institutional analysis and economic planning.

3. Determinates of Economic Growth

A large variety of economic and social variables may be proposed as determinants of economic growth. This study defines and categorises the economic growth determinants as they appear in Norman and Raimundo (2002). The variables are divided into five groups: cyclical reversion, structural policies and institutions, stabilisation policies, transitional convergence (cyclical volatility) and external conditions.

3.1 Cyclical reversion

Aghion et al., (2004) show that: more volatility means more investment risk, which tends to discourage investment and thereby slow down growth. This effect, however, may be partly or totally offset by the precautionary motive for savings: more volatility also means more income risk, which tends to raise precautionary savings, which in turn encourages investment and boosts growth. If the variable is defined as actual minus potential GDP, the expected sign will be negative.

This study follows the general modelling of Norman and Raimundo (2002) to account for the cyclical effect.

3.2 Structural policies and institutions

The overall success of industries is dependent on the structural policies and institutions (Levine et al., 2000). They can influence the determinants either positively or negatively (Van Rooyen et al., 1999).
Education is the first area of structural policies and institutions to be considered. Education represents the human capital formation in general. It may serve as a complement to physical, capital, and natural resources. It may furthermore, facilitate technological innovations and technological adoption. In this study, education is measured as the ratio of primary and secondary school enrolment over the total population between the age of 15 and 64 (Easterly, 2001).

The second variable to be examined relates to financial depth. Well-functioning financial markets promote economic growth and influence economic efficiency. This facilitates risk diversification by trading, pooling, and hedging financial instruments (Levine, et al., 2000). Financial depth is measured by the ratio of domestic farming credit compared to GDP (Norman and Raimundo, 2002).

The third category is the open trade policy (measured by the ratio of import and export to GDP). Researchers point-out five channels through which trade influences economic growth (Lederman and Luisea, 1997):

- Open trade leads to higher specialisation;
- It expands potential markets, which allow domestic firms to take advantage of economies of scale;
- Open trade diffuses both technological innovations and improved managerial practices;
- Freer trade tends to lessen anticompetitive practices of domestic firms; and
- In the final instance, trade liberalisation reduces the incentives of industries to conduct rent-seeking activities that are mostly unproductive.

The bulk of the empirical evidence indicates that the relationship between economic growth and international openness is indeed positive, and that it reflects a virtuous cycle: trade openness leads to economic growth, economic growth to technological slipover which, in turn, generates a large volume of trade (Lederman and Luisea, 1997).

The fourth variable regarding structural policy and institutions is government spending. When government invests in rural infrastructure, agricultural research, health, and education, it can stimulate agricultural growth. Government spending can lead to greater employment and income-earning opportunities and cheaper food prices. Well structured and effectively managed government spending can enhance investments, such as in agricultural research and development, irrigation, rural infrastructure (including roads and electricity), and rural development which is targeted directly to the rural poor. Thus, it can contribute directly to poverty
reduction in rural communities (DFID, 2005). Government expenditure is accounted through a proxy, by the ratio of government expenditure to GDP.

3.3 Stabilisation policies

Including stabilisation policies as a determinant not only affects the cyclical fluctuations, but also long-term growth. An argument may be made for cyclical and trend growth as interrelated processes (see Fatás, Mihov and Ros, 2004), which implies that macroeconomic stabilisation and crisis-related variables have an impact on short-term horizons and the long-term performance of the economy (see Fischer, 1993). Fiscal, monetary, and financial policies that contribute to stabilise the macroeconomic environment and avoid financial and balance-of-payments crises are thus important for long-term growth. By reducing uncertainty, encouraging firm investment, reducing societal disputes for the distribution of ex post rents (for instance between owners and employees in the face of unexpected high inflation), and allowing economic agents to concentrate on productive activities (rather than trying to manage high risk), growth can be facilitated (Fisher, 1993). This is measured by the consumer price index.

3.4 Transitional convergence (cyclical volatility)

This study considers two interrelated effects of fiscal and monetary policies. The first is price stability, which is measured by the average inflation rate. The second aspect is the cyclical volatility of GDP (measured by the standard deviation of the output gap), which reflects the output stability (Dollar and Kraay, 2004).

The risk of balance-of-payments crises is measured by an index of real exchange rate overvaluation. Real exchange rate overvaluation captures the impact of monetary and exchange rate policies that distort the allocation of resources between the export and domestic sectors (Levine et al., 2000).

3.5 External condition

This study takes external conditions into account by including terms of trade and the dummy variable for the period of trade liberalisation (takes one after 1998 period of liberalisation, otherwise zero). Terms-of-trade measures changes in the international demand for a country’s exports and the cost of production (consumption inputs) (Norman and Raimundo, 2002). Since, it is difficult to get the cost of production, this study uses capital formation. Trade liberalisation is
included to measure the effect of trade agreement on agricultural growth and is represented by the dummy variable.

4. Methodology and Data

Before model specification, it is important to explain the characteristics of the Exact Maximum Likelihood (EML) method. The growing empirical literature on EML estimation demonstrates the efficiency and consistency of the method; in its repeated sampling principle estimation procedures. The advantage of EML is the dependability of the long-term range process and characterisation because of the high intensive computational dimension system as used by Lardic and Mignon (2004).

According to Emmanuel, Sandrine and Val’Erie (2004), the EML method procedure is used as a residual-based test of the hypothesis of no co-integration versus the alternative of fractional co-integration. The pertinence of the method lies in using all information concerning the short- and long-term behaviour of the series since it estimates all parameters of the Auto-Regressive Fractionally Integrated Moving Average (ARFIMA) (p, d, q) estimation procedures representation simultaneously. Moreover, the application allows to test the null hypothesis of a unit root (d = 1) against the alternative of fractional integration (d < 1).

Following the general modelling of Norman and Raimundo (2002), the study uses Exact Maximum Likelihood to estimate the variation of a growth regression:

\[ y_{it} - y_{it-1} = \alpha y_{it-1} + \alpha_c(y_{it-1} - y_{it-1}^T) + \beta X_{it} + \epsilon \]

Where \( y \) is the log of per capita output, \( y^T \) represents the trend component of per capita output, \( (y_{it-1} - y_{it-1}^T) \) is the output gap at the start of the period, \( X \) is a set of variables postulated as growth determinants, a period-specific period, \( \epsilon \) represents unobserved factors or error term. The expression on the left-hand side of the equation is growth rate per capita output in a given period. On the right-hand side, the regression equation includes the level of per capita output at the start of the period (to account for transitional convergence) and a set of explanatory variables measured during the same period. The inclusion of the output gap as an explanatory variable allows controlling for cyclical output movements (see appendix for variables definition).
To apply the above method, secondary data are used from sources such as the South African Reserve Bank, Statistics South Africa, National Department of Agriculture, United Nations Development Programme (UNDP) and Food Agricultural Organisation (FAO). The data observation was from 1970 to 2005.

5. RESULTS AND DISCUSSION

In this section, the necessary statistical test has to be done before the model estimation. The first section deals with the stationarity test, while the next section deals with the model estimation.

5.1. Stationarity test (Unit root tests)

Previous studies indicate that time series data, be it monthly, quarterly or annual, are likely to be non-stationary (see for example, Bakucs and Ferto, 2005; Cho, Kim and Koo, 2004). In this study, the Augmented Dickey-Fuller (ADF) unit root test, with and without a linear trend, is performed to test for the stationarity of the variables considered. The ADF test with a linear trend checks if the variables are trend stationary.

Following the above technique the standard practice of unit root tests literature, both the level and first difference of each data series was tested; the results are presented in Table 4.

In this study, the Augmented Dickey-Fuller (ADF) unit root test, with and without a linear trend is performed. The ADF test with a linear trend checks for the trend stationarity of the variables. The results are presented in Table 4. Since the ADF test is sensitive to the choice of order of the lag, the starting point was the over specification ADF test where the order of the lag was relatively larger and corresponds to the highest (absolute value) Akaike Information Criterion (AIC).

From Table 4 the absolute values of the ADF test in level shows that it is statistically higher than the 95 percent critical value in the first six variables (Table 4), suggesting the null hypothesis of the unit root is rejected. Conversely, in the latter five variables (Table 4), the test shows that it is statistically lower than the 95 percent critical value. This suggests that the null hypothesis of the (latter five variables) unit root is not rejected and none of these five variables are (trend) stationary in levels at a 5 percent significance level. Each series was differenced and the ADF test performed. The results of the latter five variables show that all the
series tested are not stationary in (log) levels, but stationary at a 5 percent significance level after being differenced once.

**Table 4 ADF test results – with and without trend**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Lags</th>
<th>Critical Test In levels</th>
<th>Critical Test Differenced once</th>
</tr>
</thead>
<tbody>
<tr>
<td>gGDPc constant only</td>
<td>1</td>
<td>-2.9627</td>
<td>-4.8977</td>
</tr>
<tr>
<td>constant with trend</td>
<td>3</td>
<td>-3.5671</td>
<td>-4.3943</td>
</tr>
<tr>
<td>OUTgap constant only</td>
<td>1</td>
<td>-2.9627</td>
<td>-4.6851</td>
</tr>
<tr>
<td>constant with trend</td>
<td>3</td>
<td>-3.5671</td>
<td>-4.3115</td>
</tr>
<tr>
<td>ALI constant only</td>
<td>1</td>
<td>-2.9627</td>
<td>-3.8355</td>
</tr>
<tr>
<td>constant with trend</td>
<td>1</td>
<td>-3.5671</td>
<td>-3.9226</td>
</tr>
<tr>
<td>RDGDP constant only</td>
<td>1</td>
<td>-2.9627</td>
<td>-4.0596</td>
</tr>
<tr>
<td>constant with trend</td>
<td>1</td>
<td>-3.5671</td>
<td>-4.0148</td>
</tr>
<tr>
<td>TOT constant only</td>
<td>1</td>
<td>-2.9627</td>
<td>-3.3655</td>
</tr>
<tr>
<td>constant with trend</td>
<td>1</td>
<td>-3.5671</td>
<td>-3.8933</td>
</tr>
<tr>
<td>STDoutg constant only</td>
<td>4</td>
<td>-2.9665</td>
<td>-4.0595</td>
</tr>
<tr>
<td>constant with trend</td>
<td>4</td>
<td>-3.5731</td>
<td>-4.5129</td>
</tr>
<tr>
<td>Trade constant only</td>
<td>1</td>
<td>-2.9627</td>
<td>-1.6291</td>
</tr>
<tr>
<td>constant with trend</td>
<td>1</td>
<td>-3.5671</td>
<td>-3.1152</td>
</tr>
<tr>
<td>GOVexp constant only</td>
<td>1</td>
<td>-2.9627</td>
<td>-1.5782</td>
</tr>
<tr>
<td>constant with trend</td>
<td>1</td>
<td>-3.5671</td>
<td>-1.7595</td>
</tr>
<tr>
<td>CPI constant only</td>
<td>3</td>
<td>-2.9627</td>
<td>-0.20273</td>
</tr>
<tr>
<td>constant with trend</td>
<td>3</td>
<td>-3.5671</td>
<td>-1.7779</td>
</tr>
<tr>
<td>RER constant only</td>
<td>3</td>
<td>-2.9627</td>
<td>-1.191</td>
</tr>
<tr>
<td>constant with trend</td>
<td>3</td>
<td>-3.5671</td>
<td>-3.0287</td>
</tr>
<tr>
<td>D1 constant only</td>
<td>1</td>
<td>-2.9627</td>
<td>-0.5039</td>
</tr>
<tr>
<td>constant with trend</td>
<td>1</td>
<td>-3.5671</td>
<td>-1.7478</td>
</tr>
</tbody>
</table>

95% critical value for the augmented Dickey-Fuller statistic

**5.2. Model estimation**

On the basis of results obtained from Table 5, the techniques described in the methodology were applied. The overall explanatory power is at 87 percent. Except for CPI, RER and D1 (not significant at the specified significance level and not reported in Table 5) all other variables were found to be statistically significant at the specified significance level.

The cyclical reversion as one of the determinants and a source of agricultural growth was found to be negative and significant at the indicated significance level.
(see Table 5). This implies that that the agriculture economy follows a reverting trend process to close the output gap. However, the effect to close the gap was not sizable: for example according the point estimate, if initial output, say 5 percent estimated potential output, the economy is expected to grow by about 1.4 percentages in the following year.

### Table 5 Maximum Likelihood Estimation (MLE), determinates of agricultural GDP growth, data from 1971-2005

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Estimated coefficient</th>
<th>T-ratio</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclical reversion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OUTGAP</td>
<td>-0.28</td>
<td>-3.38*</td>
<td></td>
</tr>
<tr>
<td>Structural policies and institutions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education (ALI)</td>
<td>0.47</td>
<td>2.93*</td>
<td></td>
</tr>
<tr>
<td>Financial depth (RDGDP)</td>
<td>-0.56</td>
<td>-5.96*</td>
<td></td>
</tr>
<tr>
<td>Trade openness (TRADE)</td>
<td>1.21</td>
<td>2.87*</td>
<td></td>
</tr>
<tr>
<td>Government support (GOVEXP)</td>
<td>1.03</td>
<td>1.78***</td>
<td></td>
</tr>
<tr>
<td>Stabilisation policies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of price stability (CPI)</td>
<td>0.17</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>Cyclical volatility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviation of output gap (STDOUG)</td>
<td>0.33</td>
<td>2.20**</td>
<td></td>
</tr>
<tr>
<td>Real Exchange overvaluation (RER)</td>
<td>0.087</td>
<td>1.36</td>
<td></td>
</tr>
<tr>
<td>External factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Term of trade (TOT)</td>
<td>-0.035</td>
<td>-3.46*</td>
<td></td>
</tr>
<tr>
<td>Trade liberalisation (D)</td>
<td>0.020</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durbin Watson stat</td>
<td>1.63</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*, ** and *** denotes significance at the 1, 5, and 10 percent level respectively

Results related to structural policies and institution indicators of growth were presented in Table 5. The variables related to this category are Education (ALI), financial depth (RDGDP), Trade openness (TRADE) and Government support (GOVEXP). All variables (except RDGDP) were found to be positively related to growth and statistically significant at the specified significance level. This result implies that the agricultural sector could only be improved with a better educational attainments, financial institutions, and trade openness. However, the result shows that the agricultural sector lacks effective and efficient debt management (which is a necessary prerequisite for sustainable economic growth). For example, a 10 percent increase in secondary school enrolment has resulted in
agricultural growth by 0.49 percent; whereas, an increase of 10 percent in the current debt leads to a decline in agricultural growth by 6 percent (see Table 5). Therefore, the result shows that the burden of debt crisis was a critical problem in the South African agricultural sector. The study was found to be consistent with the vast amount of empirical literature on endogenous growth, including Norman and Raimundo’s (2002) research on the role of education, trade, and government burden; Dollar’s (2004) findings on the role of trade openness; and the study of Levine et al., (2000) on the role of financial depth.

From Table 5 model estimation TRADE (as proxy for openness) was found to be statistically significant at 1 percent. This implies that agricultural industries were able to increase specialisation and adopt a competitive environment (see Table 5). The study also shows that government support for agriculture is vital; an increase of 10 percent in government expenditure was found to increase economic growth by 10.2 percent.

Stabilisation policy (inflation represented by CPI) as a determinant of economic growth was found to be too insignificant to be reported (see Table 5). However, research reviews show that economic growth generally increases when government is able to carry out policies conducive to macroeconomic stability, including the presence of financial and external crises (Fischer, 1993).

The standard deviation of the output gap (STDOUG) was found to be positive and significant, whereas real exchange rate was found to be too insignificant to be reported (see Table 5). This reveals that there was an important connection between the business cycle and agricultural economic growth. The standard deviation of the output gap reflects a lack of output stability in the sector. This might be due to the volatile nature of the agricultural sector (characterised by drought and other related risks in agriculture) causing it to lack stability.

The last category of this study was external factors (see Table 5). Term of trade was found to be statistically significant and negatively related to growth. This implies that there were imbalances in terms of trade that slowed down the agricultural economy’s growth rate; whereas the dummy variable for trade liberalisation (D1) was found to be too insignificant to be reported. This might be due to the short period of observation of trade liberalisation (after 1998) which was unable to be captured on the model; or this might imply some complication related to trade arrangements that needs revised consideration in order to reap a greater benefit from the trade agreement.
6. CONCLUSION

The determinants and the ability of agricultural economic growth to adjust were analysed into five main categories: cyclical reversion, structural policies and institutions, stabilisation policies, cyclical volatility and external conditions.

In the component of structural policies and institutions category, variables were found to be statistically significant at the specified significance level and except for RDGDP, all variables were found to be positively related to growth. This implies that South African agricultural growth was achieved with improved education, financial depth, and trade openness. However, the negative relationship of RDGDP implies that the sector is suffering from a debt crisis. Therefore, farmers need to follow an effective debt management system to achieve the required growth rate. This study was also found to be consistent with the vast amount of empirical literature on endogenous growth, including that of Norman and Raimundo (2002), on the role of education, trade, and government burden; Dollar (2004), on the role of trade openness; and Levine et al. (2000), on the role of financial depth.

From cyclical reversion and cyclical volatility categories, the standard deviation output gap was found to be statistically significant and related positively. This implies that the agricultural economy follows a reverting trend process to close the output gap, thus, showing that there was an important connection between business cycle factors and agricultural economic growth in the business cycle factors.

The external factor category was statistically significant and negatively related. This reveals that there were imbalances in trade that slowed down the agricultural growth rate.

7. APPENDIX

Variable definitions
1. $g_{GDPc}$ is the percentage change in agricultural growth
   \[
   \left( \ln GDP_t - \ln GDP_{t-1} \right) / \ln GDP_t
   \]
2. Output gap (output gap) is the difference between the log of actual GDP (log) and potential GDP
3. Adult literacy (Ali) is the ratio of total primary and secondary school enrolments to the population of the age group population between age 15 and 64
4. RDGDP is change in the ratio of total agricultural debt to the agricultural GDP (log form)
5. Trade is the difference between log export and import to the log agric GDP
6. Govexp is the difference between the current and the previous year of government exp (log) divided by GDP (in log)
7. CPI is the difference between the actual and the potential of CPI (proxy for inflation)
8. Cyclically volatility of GDP (Stdoutg) is the standard deviation between the actual and the potential of output gap of GDP
9. Real Exchange Rate (RER) is the difference between actual RER (in log) and potential RER (in log)
10. Term of trade (TOT) as one of the external factors category is measured by the ratio export to the total capital formation (in log) in agriculture as proxy for balance of trade payment.
11. Dummy for trade liberalisation (D1), that takes prior year 1998 is zero, otherwise one

REFERENCES