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**MODELLING THE IMPACTS OF  
MACROECONOMIC AND TRADE POLICIES  
ON THE SOUTH AFRICAN AGRICULTURAL  
SECTOR**

**by**

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# MODELLING THE IMPACTS OF MACROECONOMIC AND TRADE POLICIES ON THE SOUTH AFRICAN AGRICULTURAL SECTOR

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## ABSTRACT

The purpose of this paper is to investigate the importance of macroeconomic and trade policies on the agricultural sector in South Africa. Macroeconomic and trade policies are determined outside the agricultural sector and since the 1990s South Africa has been moving towards deregulation and trade liberalization. Structural econometric model was applied to determine the impacts of changes in macroeconomic and trade policies on the agricultural sector. Two Stage Least Squares (TSLS) was the technique used because of the simultaneous nature of the equations in the model. The results of the study shows that 10 percent reduction in import tariffs will lead to 11.44 percent increase in the degree of openness of the South African economy. Furthermore, the appreciation of the Rand will raise the domestic prices received by farmers.

**Keywords:** government expenditure, real exchange rate, degree of openness, relative prices of agriculture, terms of trade

## 1. Introduction

The South African economy has been undergoing deregulation and trade liberalization since the 1990s. The agricultural sector was previously protected and supported by tariffs and subsidies by the government. After the 1994 election, the South African government has moved towards deregulation and liberalization of the agricultural sector, evidenced by the removal of subsidies and tariffs and the abolishment of marketing boards in the 1997. Furthermore, South Africa has become major proponent of free trade under the auspices of World Trade Organization (WTO), thereby ensuring that South African economy including the agricultural sector is integrated with the world markets.

However, macroeconomic and trade policies are exogenous to the agricultural sector and the agricultural sector has to adapt to changes in the macroeconomic and trade policies. According to Johnson (1975), when policies are inappropriate, farmers find themselves at an enormous disadvantage in making affective use of their natural and human resources. Moreover, Jaejer and Humphreys stated that "*appropriate economic policies can provide substantial latitude for improving agricultural price incentives,*" and Rausser *et al.* (1986) mentioned that, "*if macroeconomic policies were appropriately designed, there would be no need for*

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*sector-specific policies*". Macroeconomic and trade variables such as: government expenditure, money supply, exchange rate and import tariffs are recognized to have an effect on the agricultural performance but the magnitude of the effect are yet to be determined in South Africa.

The objective of this paper is twofold. The first objective is to design an appropriate structural framework that draws heavily on economic theory and allows for investigating the linkages between macro economy and agriculture in South Africa. The second objective is to use the econometric model to analyze the importance of macroeconomic and trade policies on the agricultural sector, which is important for economic analysts and policy makers. Most of the previous studies analyzing the impacts on the agricultural sector have mainly focused on internal factors such as the size of research and development investment, farm size and efficiency and land tenure systems. In addition, there is a consideration lack of empirical evidence investigating the implications of the macroeconomic environment on agricultural performance in developing countries where economic growth and development depend heavily on agriculture and where agriculture is in need of more coordinated policies.

This paper will be organized as follows: the next section will briefly review related literature on the linkages between macro-economy and the agricultural sector. In section 3, the study will integrate theory to develop the methodology to achieve the above-mentioned objectives. In section 4, we will present the structure of the empirical model, the data used for empirical analysis, estimation and simulation results and their implication to the economy and the agricultural sector in South Africa. Summary and conclusion of the study will be presented in section 5.

## **2. Macroeconomic linkages with the agricultural sector**

The macroeconomics of agriculture involves the relationship between the general domestic economy and the agricultural sector, and the world economy and the domestic agricultural sector (Knutson *et al*, 2000). This definition of macroeconomics of agriculture clearly demonstrates that the agricultural sector is integrated with other sectors in the domestic economy as much as it is with rest of the world. Furthermore, Schuh (1976) observed that significant structural change in economic environment and the dramatic integration with world markets indicate that the agricultural sector should no longer be treated as a closed sector.

To emphasize the linkage between world economy and agriculture, Penson and Gardener (1988) mentioned that there are two main channels linking the international (world) economy to agriculture. The first channel is through international commodity markets, where international economic conditions influence the demand for exports and supply of imports (current account). The second is through international capital markets, where the demand for and supply

of investment funds observed in the nation's capital account influences interest rate and exchange rates (financial and capital account).

Fiscal, monetary and exchange rate policies as well as trade policy affect not only farmers' income in real and relative terms with respect to other sectors of the economy, but also the terms of trade between agricultural and non-agricultural sectors. Gardner (1981) argued that, the significance for agriculture of macroeconomic events depends upon what macroeconomic variables are most strongly linked to agriculture and how these linkages function. According to Penson and Gardener (1988) and Knutson *et al* (2000), domestic macroeconomic variables that are most important for agriculture are the rate of inflation, real rate of growth in gross national product, interest rate and exchange rate. However, Knutson *et al* (2000) mentioned that the implications of macro-conditions are transmitted to agriculture through four variables: income growth; inflation rate; interest rate; and value of the currency (exchange rate).

However, the exchange rate is the variable commonly used to capture the developments taking place in the international financial markets. Schuh (1976) started whole body of research on the effects of exchange rates agricultural sector by addressing the effects of exchange rates on the U.S. agricultural sector. In addition, Chambers *et al* (1988) and Lachaal and Womack (1998) concluded that the exchange rate of currency is the primary variable linking international economy to domestic agricultural sector and that exchange rates are an important determinant of commodity prices and trade flows.

According to Fenyes and Meyer (1998), South African agriculture has been affected not only by agricultural policy measures but also by consecutive changes to general economic policy, and by macro-economic performance. Moreover, according to Van Schalkwyk *et al* (1999), the liberation of the South African economy including the agricultural sector will have no impact on the international markets but it has had major impact regionally in SADC.

### **3.2 Model development**

In developing the conceptual framework for this study, assumptions is made that macroeconomic and trade policies influence output price, which in turn affect sectoral productivity and production. The ground of the framework is the trade/nontraded goods model developed by Dornbusch (1974). The standard analysis divides the economy into two sectors: tradable sector and nontradables sector. The relative price of tradables in terms of nontradables is known as the real exchange rate (RER), and it is through this "relative price" that macro-policies affect sectoral performance. A rise in the RER means that the price ratio improves in favour of tradable goods, and vice-versa, the decline in RER means that the price ratio improves in favour of nontradable goods.

Under the hypothesis that inter-sectoral resources flows follow relative price changes, movements in the RER would tend to affect resource allocation

between different sectors of the economy. More specifically, an increase in RER would shift resources out of nontradable sector into tradables and reduce incentives to produce nontradable goods and vice-versa is true.

In order for the model to measure the impacts of policies on exports and imports separately, the economy is further decomposed into three markets: exportables ( $x$ ), importables ( $m$ ), and home goods ( $h$ ). The model's trade components for two traded goods allow domestic supply and demand for these goods to be different. However, this is not true for home goods for which the market needs to clear domestically to meet the equilibrium conditions, which are fulfilled through adjustments in relative prices of traded goods in terms of home goods (Hau, 2000).

In this study the supply of home goods is defined, denoted by  $S_h$ , as a function of the relative prices of exportables and importables in terms of home goods and by resource endowment and technology:

$$S_h = \left( \frac{P_x}{P_h}, \frac{P_m}{P_h}, K, L, t \right) \quad (1)$$

Where  $P_x$ ,  $P_m$ ,  $P_h$  are domestic prices of exportable, importable, and home goods, respectively,  $K$  and  $L$  represent capital and labour and  $t$  denotes technology.  $S_h$  is negatively related to relative prices of both traded goods. Higher prices for exportables and importables would shift resources out of the nontraded sector to the traded sectors and consequently reduce the production of home goods.

Likewise, we specify the demand for home goods,  $D_h$ , as a function of the relative prices of two traded goods measured in terms of home goods and income (denoted by  $Y$ ). In symbols,

$$D_h = D_h \left( \frac{P_x}{P_h}, \frac{P_m}{P_h}, Y \right) \quad (2)$$

The increase in the prices of exportables and importables will reduce their demand and thereby increasing the demand for home goods. The increase in domestic income will cause domestic consumers demand more of exportables and importables and less of home goods (Abel and Bernake, 2001).

In order to measure the incidence of commercial policy on traded goods, comparative static is needed for analysis of price effects. For this end, we assume  $K$ ,  $L$ ,  $t$ , and  $Y$  to be constant. Hence, the differentiation of equation (to evaluate the incidence of trade policy logarithmically) (1) yields:

$$dS_h = \frac{\partial S_h}{\partial (P_x / P_h)} d(P_x / P_h) + \frac{\partial S_h}{\partial (P_m / P_h)} d(P_m / P_h) \quad (3)$$

From (3) the results are:

$$\hat{S}_h = \mathbf{h}_x (\hat{P}_x - \hat{P}_h) + \mathbf{h}_m (\hat{P}_m - \hat{P}_h) \quad (4)$$

Where  $\eta_x$  and  $\eta_m$  are supply elasticities of home goods with respect to the relative prices of exportables and importables, respectively, the hat (^) denotes a proportionate change in a variable. Similarly, from the demand function this is obtained:

$$\hat{D}_h = \mathbf{e}_h (\hat{P}_x - \hat{P}_h) + \mathbf{e}_m (\hat{P}_m - \hat{P}_h) \quad (5)$$

Where  $\epsilon_x$  and  $\epsilon_m$  are the demand elasticities of home goods with respect to the relative prices of exportables and importables, respectively. By equating (4) and (5), to examine the comparative static properties of the model, this is found:

$$\Delta_x (\hat{P}_x - \hat{P}_h) + \Delta_m (\hat{P}_m - \hat{P}_h) = 0 \quad (6)$$

Where  $\eta_j = (\epsilon_j - \eta_j)$ ,  $j = m, x$ . defining the incidence parameter  $w = (\eta_m / \eta_m + \eta_x)$ , equation (6) can be rearranged as:

$$\hat{P}_x - \hat{P}_h = \mathbf{w} (\hat{P}_x - \hat{P}_m) \quad (7)$$

Or,

$$\hat{P}_h = (1 - \mathbf{w}) \hat{P}_x + \mathbf{w} \hat{P}_m \quad (8)$$

By assuming  $w$  to be constant and integrating equation (8), the real exchange rate for exports is derived as :

$$\ln \left( \frac{P_x}{P_h} \right) = a + \mathbf{w} \ln \left( \frac{P_x}{P_m} \right) \quad (9)$$

Equation (9) provides a framework for investigating the impacts of trade and exchange rate policies on the export sector. However, this framework does not allow for the effects of quantitative restriction on trade. For example, consider the case of an effective import quota. A binding import quota results in higher prices of importable goods in the domestic market, and hence, this sector will attract more resources. The increased demand for resources by the importing sector will alter their prices, causing a change in the price of home goods. These movements in prices will in turn affect the RER and resource allocation. For this reason, the degree of commercial openness (DCO) of the economy is introduced in the model, as both an explanatory variable and as well as endogenous variable.

The next component of the model defines the mechanism channels through which the impacts of trade and macroeconomic policies are transmitted to agriculture. Mechanically, first macro-policies are linked to agricultural prices and then production function for the agricultural sector is specified. It is through this production function that the relative prices and, therefore, macroeconomic and

trade variables influence agricultural performance. Higher output prices are expected to increase productivity, as the increased profitability would make firms allocate more resources to innovation activities and increase their investments in new technologies. Considering agriculture produces at the same time exportable, importable, and home goods, then an aggregate price index for the sector, denoted by  $P_a$ , would be computed as an average of  $P_x$ ,  $P_m$ ,  $P_h$ . utilizing the geometric aggregation method we obtain,

$$P_a = P_x^{a_1} P_m^{a_2} P_h^{(1-a_1-a_2)} \quad (10)$$

$a_1$  and  $a_2$  represent the shares of exportable and importable agricultural products, respectively, in total agricultural output. Since the South African agricultural sector is an exportable sector (agricultural exports exceed imports), it is legitimate to assume imported agricultural products to represent only a negligible proportion of total agricultural output (i.e.  $a_2 = 0$ ). Hence, agricultural prices can be approximated as follows:

$$\ln\left(\frac{P_a}{P_h}\right) = a_1 \ln\left(\frac{P_x}{P_h}\right) \quad (11)$$

Some macro-variables will be included in equation (11) as the share of exportable agriculture ( $a_1$ ) depends on economic variables that determine demand and supply and on the degree of commercial openness (DCO) of the economy. Further, agricultural prices depend on macroeconomic policies that affect the demand for home goods and consequently sectoral output.

The last component of the model is the agricultural sector production function. The specification adopted the concept of endogenous technology introduced by Mundlak (1988), which postulates that prices are technology-changing variables. This approach assumes that prices not only determine the position of a producer across different curves. The hypothesis here is that economic agents choose innovations and adopt new innovations in harmony with their incentives and constraints. Empirically, this is achieved by defining a variable-parameter production function. These parameters are specified as functions of some state variables representing the structure of incentives and constraints facing firms.

This study uses Cobb-Douglas specification with time varying parameters and  $n$  inputs to represent the agricultural production function. Algebraically, this specification takes the following functional form:

$$y(x; \mathbf{b}) = A \prod_{i=1}^n x_i^{b_i} \quad (12)$$

Where,



$$\ln A = a_0 + \sum_{k=1}^m a_k s_k + u_0 \quad (13)$$

$$b_i = b_{i0} + \sum_{k=1}^m b_{ik} s_k + u_i \quad (14)$$

Y is the maximum level of output that can be produced from any given set or combination of input  $x = (x_1, x_2, \dots, x_n)$ .  $S = (s_1, s_2, \dots, s_m)$  is a vector of state variables and  $u$ 's are error terms. The above specification is very flexible in that it allows us to include as many as many state variables as possible.

#### 4.1. Empirical Model

The econometric model used to analyze the impacts of trade and macroeconomic policies on the agricultural sector in South Africa consists of a system of three equations. The endogenous variable is the real exchange rate (RER), the degree of openness (DCO), and relative agricultural domestic prices ( $P_a/P_h$ ). The exogenous variables are import prices ( $P_m$ ), prices of home goods ( $P_h$ ), export tax rate ( $t_x$ ), import tariff rate ( $t_m$ ), the share of government expenditures (G) and the share of money supply (M) in the total income (y).

The empirical model is described by following set of equation:

$$RER = F(P_x / P_m, DCO, G, M^s) \quad (15)$$

$$DCO = F((1 - t_x / 1 + t_m), G, M^s) \quad (16)$$

$$P_a / P_h = F(P_x / P_h, DCO, G, M^s) \quad (17)$$

#### 4.2. The data used

This study will use secondary data between 1981 and 1999 to estimate the impacts of trade and macroeconomic policies on South African agricultural sector. The main sources of the data are be: abstract of agricultural statistics published by National Department of Agriculture (NDA, 2001) and historical economic and statistical database published by the South African Reserve Bank.

The codes of the data and derivation of the variables have be explained in Appendix 1.

#### 4.3. Estimation Procedure and simulation results

The structural econometric model (as in this study) cannot be estimated using ordinary least square (OLS) because ordinary least square (OLS) yields biased and inconsistent estimators when estimating simultaneous equations or cross-equations. Therefore, this study will use the Two Stage Least Squares (TSLS) because TSLS yields unbiased and consistent estimators.

#### 4.4. Estimation results

The Estimated Results of the Impact on Degree of Openness

$$\ln DCO = 0.103 + 2.38 \ln BARS - 0.34 \ln \text{gexpti} - 0.34 \text{Dum}$$

(0.32)      (3.03)\*                      (-2.31)\*              (-1.58)

$$R^2 = 0.37$$

$$DW = 2.02$$

*Note: the t-statistics are in the parenthesis*

NB: \* = 1% Significant, \*\* = 10% significant

The results above show that the impact of macroeconomic and trade policies on the domestic degree of openness. The results indicate that 1 percent increase (an increase in Bars variable implies that import tariff decrease) lead to 2.38 percent increase in the degree of openness in South Africa. In contrast, the increase of 1 percent in government expenditure will lead to decline in degree of openness by 0.34 percent. However, the dummy variable indicates that the degree of openness in South Africa between 1994 and 2000 has been decreasing, but this is not necessarily true. The degree of openness has increased from 34 percent in 1990 to 0.53 in 1999 for the agricultural sector and for the whole economy; the degree of openness has increased from 39 percent in 1990 to 49 percent in 1999.

The Estimated Results of the Impact on Real Exchange rate of Exports

$$\ln RER = 1.27 - 0.61 \ln \text{relexr} + 0.79 \ln \text{gexpti}$$

(33.92)\*      (-5.5)\*              (31.00)\*

$$R^2 = 0.98$$

$$DW = 2.25$$

*Note: the t-statistics are in the parenthesis*

NB: \* = 1% Significant

The results presented above indicate that 1 percent increase in the terms of trade will lead to decrease of 0.61 percent in the real exchange rate in South Africa. This implies that as South Africa terms of trade rises, the value of the Rand will depreciate against the U.S. dollar. Furthermore, the results indicate that 1 percent increase in government expenditure will lead to an increase of 0.79 percent in the real exchange rate. Under the hypothesis that resource flow follow change in the price of exportables, importables and home goods discussed in section 3, rise in government expenditure implies there will be more domestic investment, hence more consumption of home goods. Total income and money supply variables were dropped from the equation because they have very low t-statistics.

The Estimated Results of the Impact on Relative price of Agricultural sector  

$$\text{Inrelat} = 0.86 + 0.19\text{Inrer} + 0.19\text{Inmospti} - 0.06\text{Ingdp} + 0.0002\text{Indco}$$

(0.93)
(1.77)
(1.17)
(-0.87)
(0.004)

$R^2 = 0.96$

DW = 0.93

Note: the t-statistics are in the parenthesis

NB: \* = 5% Significant

The results above indicate that real exchange rate variable is the only variable that has significant effect on the relative price of agriculture. But, according to Koutsoyiannis<sup>2</sup> (1977: 249), "*multicollinearity may affect only a part of the estimates, while other estimates may remain fairly stable and reliable. In this case, the reliable estimates may be used for any purpose, forecast or policy formulation (which requires reliable information about structural coefficients)*". Money supply, gross domestic product and degree of openness do not have significant effect on relative prices of agriculture in South Africa. The results show that an increase of 1 percent in real exchange rate will lead to an increase of 0.19 percent in relative prices of agriculture.

#### 4.5. BASELINE AND POLICY SCENARIOS

It is clear from the previous section that changes in macroeconomic and trade policies will have implications for both South African economy and the agricultural sector. This section will discuss possible policy scenarios. The external shocks will be introduced to the following variables: import tariff, government expenditure, money supply and real exchange rate.

There are eight cases of scenarios to be simulated: case 1 being 10 percent increase in government expenditure; case 2, 10 percent decrease in government expenditure; case 3, 10 percent increase in import tariff; case 4, 10 percent decrease in import tariff; case 5, 10 percent decrease in import tariffs and 10 percent increase in government expenditure; case 6, 10 percent increase in money supply; case 7, 10 decrease in money supply and case 8, 10 percent increase in real exchange rate.

##### 5.3.1. Degree of openness scenario

The policy scenario in the degree of openness in the South African economy will be to simulate what will be the impact of change in government expenditure and trade policy (import tariff) on the degree of openness in the economy. Table 5.3.1 shows that trade policy will have a huge impact than government expenditure on the degree of openness. The increase in government expenditure will have a negative influence on the degree of openness and a decline in import tariff will lead to an increase in the degree of openness in South Africa. The

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<sup>2</sup> Koutsoyiannis, A. (1977). Theory of Econometrics, 2<sup>nd</sup> edition, Macmillan Press LTD.

combined effect of import tariff and government expenditure will be detrimental to the integration of the economy in the world markets.

**Table 5.3.1: Impact on Degree of openness**

	Degree of Openness	% Change
Baseline	-42.080	
Case 1	-41.480	-1.43%
Case 2	-41.467	-1.46%
Case 3	-37.266	-11.44%
Case 4	-46.894	11.44%
Case 5	-36.666	-12.87%

### 5.3.2. Real Exchange rate scenario

The rise in government expenditure will have a negative influence on real exchange, that is, when the government increases its expenditure the value of the rand will depreciate. In contrast, when government expenditure decline the value of the rand will appreciate.

**Table 5.3.2: Impact on Real Exchange rate of Exports**

	Real exchange rate of exports	% Change
Baseline	8.879	
Case 1	7.482	-15.73%
Case 2	10.276	15.731%

### 5.3.3. Relative Domestic Price of Agriculture scenario

Real exchange rate is the only macroeconomic variable, which was found to have had an influence of the relative prices of agriculture. Hence, 10 percent increase in real exchange rate will lead to 1.46 percent decline in agricultural prices and vice-versa is true.

**Table 5.3.3: Impact on Relative Domestic Price of Agriculture**

	Relative price of Agriculture	% Change
Baseline	12.468	
Case 6	12.270	-1.592%
Case 7	12.667	1.592%
Case 8	12.650	1.46%

## 5. Summary and Conclusion

The objective of this paper was to examine the importance of macroeconomic and trade policies for the South African agricultural sector. More specifically: government expenditure, money supply, import tariff and real exchange rate on the degree of openness, real exchange rate of exports and relative price of agriculture. The major assumption of the study was that macroeconomic and trade policies will affect the agricultural sector through output prices.

Macroeconomic and trade policies will have an effect on the degree of openness, real exchange rate and the relative prices of agriculture. More importantly, an increase in the degree of openness will have implication for the domestic agricultural sector, either positively or negatively. Furthermore, by increasing government expenditure, government will reduce South African economy integration into world markets,

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### Appendix1: The Codes used in the Estimation Process

Variable	Abbreviation	Calculation
Degree of openness	DCOW	Total trade / total income
Trade barriers	BARS	$(1-T_x)/(1+T_m)$ Where $T_x$ and $T_m$ are export and import tariffs; and export tariffs are assumed zero.
Government expenditure as a proportion of total income (GDP)	GEXPTI	
Money supply as a proportion of total income (GDP)	MOSPTI	
Real exchange rate for exports	RER	FOREXP / CPI Where: Forexp – foreign price of export, fob CPI – Consumer price index (price for nontraded goods)
Terms of trade	RELEXR	Forexp / Forimp  Where Forimp – Price of imports, cif
Relative agricultural domestic prices	RELAT	PPIAGR / CPI Where PPIAGR – Index of agricultural product price
Agricultural rate of return on capital	ARRC	$(PY - WL) / PK$
	AGPROCP	SCAPA*LN (AGCAP/LAB) Where AGCAP - Gross capital formation in Agriculture LAB - Agricultural labour